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Amardev Singh
Scientist-B & Incharge, Silkworm Seed Production Centre, National Silkworm Seed Organization, Central Silk Board -GOI, Power House Road, Laddan, Udhampur. UT of Jammu and Kashmir, Jammu and Kashmir, India

Shamim Ahmed Bandey
Senior Assistant Professor, Govt Degree College, Poonch, Jammu and Kashmir, India

MT Himantharaj
Retired Scientist-D, CSB, Government of India, India

Corresponding Author:
Amardev Singh
Scientist-B & Incharge, Silkworm Seed Production Centre, National Silkworm Seed Organization, Central Silk Board -GOI, Power House Road, Laddan, Udhampur. UT of Jammu and Kashmir, Jammu and Kashmir, India

Eucalyptus and neem based crude extraction effect in acceleration of natural mounting process in the silkworm, *Bombyx mori* L.

Amardev Singh, Shamim Ahmed Bandey and MT Himantharaj

Abstract
For the successful harvesting of cocoons crop various activities are involved among them mounting is one the important activity in silkworm rearing which finally decides the successful harvesting of cocoons crops. To improve the mounting efficiency eight different plants *viz*., *Neem*, Eucalyptus, Pine, Sapota, Papaya, Marigold, Holy Basil and Basil were tested on silkworm bivoltine hybrid CSR_2 x CSR_4. The results of the study showed that percentage of larvae spun the cocoons on the mountages and percentage of good cocoons was significantly improved in the eucalyptus and neem tested batches. In addition, there was no negative effect noticed on single cocoon weight, shell weight and shell percentage.

Keywords: Repellent, mounting, plants, cocoon characters, *Bombyx mori* L.

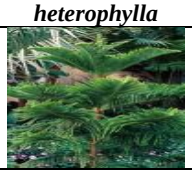
Introduction
Mounting of silkworm at right time of maturation and harvesting of cocoons after the completion of pupation is very vital in terms of quality reelable cocoons as well as in the production of quality silk. Despite, many factors contribute for the production of good quality and quantity of cocoons, utmost care taken during mounting of the mature silkworms also plays a crucial role in the production of quality cocoons. In addition to this, the process of mounting which is an important activity of silkworm rearing during which maximum labour is required in a minimum period. The process of transferring the fully matured silkworms from the rearing bed and distributing them properly on a frame to facilitate spinning of cocoons is known as mounting. Such frames are called mountages. Most of the lepidoptera larvae including *Bombyx mori* produce a silken thread when matured because during pupal stage, insects have no means of defense and armor. Hence, it has been provided for the same during metamorphosis. Spinning is also important for satisfying its physiological requirement by excreting excess amino acids from the body [5]. Mounting of silkworm at right maturity and harvesting of cocoons after the completion of pupation are very important in the production of quality reelable cocoons. The quality and quantity of silk produced are highly related to the care taken during rearing, types of mountages used for spinning and environmental conditions during spinning. To save the time and labour *viz.*, Jobarai (Shoot shaking) and self or natural mounting is recommended. It is estimated that, by adopting Jobarai method 30-40% and by employing self-mounting method, 80-90% labour can be saved (Rajan *et al*., 2000) [16]. But, two methods of mounting *viz*., pick up method and self or natural mounting is very much popular among farmers [1]. For a long time it has been practice to pick mature larvae one by one and transfer them to the cocooning frames. This method is good because it is possible to select only the mature larvae for mounting. However, it needs a large labour force to carry out the work in a longer period. Sometimes it takes even 4-5 days. To get good quality cocoon, early and late mounting should be avoided and the worms should be mounted at appropriate time. Natural or self mounting is the most rational method of utilizing the negative geotaxis of the silkworm at the wandering stage, but the mounting rate is generally low, few larvae make the cocoons in the rearing bed itself, if mounting is delayed and high humidity and poor ventilation in the rearing bed affects the cocoon quality and reelability [7]. Such cocoons are of inferior in quality therefore fetch low price in the cocoon market leading to considerable economic loss to the farmers. To improve the efficiency of self mounting various insect repellents *viz*., cresol and saw dust of Hinoki cypress tried in Japan [2, 11] and lime, saw dust, kaolin and phytoecdysteriod(^{6}) in India. Perusal of the literature revealed that various plants *viz.*, neem, papaya, eucalyptus, sapota, *etc*., also contain repellents and have been tried on some other insects [4].

However, the above said repellents were not tried on silkworm. Hence, the present investigation has been undertaken to examine the effects of these plants repellent in acceleration of self mounting in the silkworm, *Bombyx mori* L.

Materials and methods

Collection of botanicals

Leaves of 8 plants *viz.*, *Azadirachta indica (Neem)*, *Eucalyptus globules* (Eucalyptus or Blue gum), *Araucaria heterophylla* (Pine), *Manilkara zapota* (Sapota) *Carica papaya* (Papaya), *Tagetes patula* (Marigold), *Ocimum sanctum* (Holy Basil or Tulsi) and *Ocimum basilicum* (Basil) were used for the study. Above said plants were subjected to preliminary screening to identify the effective ones in accelerating the mounting in silkworm *Bombyx mori* L. The selected plants photographs and systematic position and photographs are given below.

Scientific Names	*Azadirachta indica*	*Eucalyptus globules*	*Araucaria heterophylla*	*Manilkara zapota*	*Carica papaya*	*Tagetes Patula*
Photographs of the plants						
Common name	*Neem*	Eucalyptus or Blue gum	Pine	*Sapota*	Papaya	Marigold
	Ocimum sanctum	*Ocimum basillicum*				
Photographs of the plants						
Common name	Holy basil or Tulsi	Basil				

For testing, all the concentrations were prepared in the form of crude extract just a day before the treatment and the same was stored in a refrigerator. The method of preparation of crude extract is described below**;**

Testing of plant based repellents for self-mounting on CSR2 x CSR4 silkworm breed

Cold green extract of eucalyptus repellent at 25.0 and 50.0% and neem based repellent at 50.0% were tested on CSR_2 x CSR_4). Three replications were maintained for each of the treatments. Each replication contained 3000 larvae of both the breeds. On mulberry shoots, they were reared. Two controls were also maintained *viz.,* distilled water sprayed and without distilled water sprayed. When 4-5% of the silkworms approached the spinning stage, aqueous solutions of two plant based repellents were sprayed @40-50ml/100 larvae on mulberry leaves. After the spray, plastic collapsible mountages were placed on the rearing bed. After 18h, the mountages were removed from the shoot rearing rack and the number of larvae climbed on the mountages was recorded. Such mountages were placed on another shoot rearing rack for spinning. For the remaining larvae, mountages were placed on the rearing bed and the number of larvae climbing on the mountages was recorded after 30h. On 5th day, percentage of larvae that have spun the cocoons in the rearing bed was also recorded. On 6th day, the cocoons were harvested the rearing data *viz.*,% of good cocoons,% of defective cocoons, single cocoon weight, single shell weight, shell %, floss % and post cocoon parameters such as filament length, non-breakable filament length, raw silk recovery, denier, renditta, reelability were calculated. The experiment was repeated twice and generated data were analyzed by employing ANOVA SPSS package (7.5) [3] for windows to find out the significance.

Results

The data obtained on nine traits such as, larvae climbed on mountages after repellent treatment in different duration, percentage of larvae which spun the cocoons in the rearing bed and on the mountages, percentage of defective and good cocoons, single cocoon weight, single shell weight, shell percentage and floss percentage were recorded. In addition, post cocoon characters such as average filament length, non-breakable filament length, renditta, raw silk recovery and reelability were also recorded and results are depicted as under;

Percentage of larvae climbed on the mountages

0-18 h

The percentage of larvae climbed on the mountages at 0-18h exhibited significant improvement after eucalyptus based repellent treatment in 50.0 & 25.0% concentrations of cold green extraction (55 & 46% respectively) and 50.0% concentration of neem treatment (43%) when compared to the controls (36% in distilled water and 33% in control) (Fig -1).

18-30 h

Non-significant difference was observed in 18-30h duration in 25.0 & 50.0% concentrations of cold green extraction of eucalyptus and in 50.0% concentration of cold green extraction of neem as compared to the controls (33% in distilled water and 32% in control) (Fig-1).

Percentage of larvae spun the cocoons on the mountages

50.0 and 25.0% concentrations of eucalyptus and 50.0% concentration of neem were effective in eliciting significant improvement on percentage of larvae climbed on the mountages (93.1, 92.7 & 91.5% respectively) as compared to controls (89.4% in distilled water and 88.7% in control) (Fig - 2).

Percentage of larvae spun the cocoons in the rearing bed

The data with regard to percentage of larvae spun the cocoons in the rearing bed was significantly reduced in 50.0% concentration (6.9%), 25.0% concentration (7.2%) of cold green extrication of Eucalyptus and in 50.0% concentration of *neem (8.4%)* when compared to the controls (10.7% in distilled water and 11.2% in control) (Fig-3).

Percentage of good cocoons

Similarly, the results pertaining to percentage of good cocoons after treatment with eucalyptus and neem based

repellent revealed significant improvement in 50.0%, 25.0 & 50.0% concentrations of cold green extraction (92.6, 92.0 & 91.1% respectively) over the controls (88.8% in distilled water and 88.1% in control) (Fig-4).

Percentage of defective cocoons

The significant difference was observed on percentage of defective cocoons in 25.0 & 50.0% concentrations of cold green extraction of eucalyptus (7.3 & 7.9% respectively) and also in 50.0% concentration of *neem (8.8%)* when compared to controls (11.1% in distilled water and 11.8% in control) (Fig-5).

Single cocoon weight

Single cocoon weight did not reveal any significant improvement in the treated batches listed. Highest single cocoon weight (1.82g) was recorded in 50.0% concentration of n*eem* and lowest value was seen 50.0% concentration of eucalyptus (1.78g) (Fig - 6).

Single shell weight

Non-significance difference was noticed in single shell weight. This trait remained almost at par with that of the controls. However, maximum single shell weight was observed in 50.0% concentration of neem (0.395g), whereas minimum was found in 50.0% concentration of eucalyptus (0.387g) (Fig - 6).

Shell percentage

Highest shell percentage was recorded in distilled water (21.77%) and lowest value was observed in 25.0% concentration of eucalyptus treatment (21.66%). However, there was no significance difference between the treatments and the controls (Fig-6).

Floss percentage

Similar trend was observed in this trait also in the treated batches (Fig - 6).

Filament Length

The Fig - 7 revealed that filament length did not exhibit any significant change. However, the highest value (1065m) was recorded in 50.0% concentration of eucalyptus and lowest value (1048m) was observed in control.

Non- Breakable Filament Length

The data with regard to non-breakable filament length also revealed non-significance difference. Highest value (930m) was recorded in 50.0% concentration of neem and lowest value (919m) was observed in distilled water *(Fig-7).*

Denier

Statistical analysis on denier revealed that there was non-significant difference between the treatments and the control. Highest value (2.72) was recorded in distilled water and lowest was found in *control (2.63)* (Fig - 7).

Renditta

No significant improvement was also observed in this trait when compared to controls. However, the maximum renditta was observed in distilled water (5.78) and lowest was seen in 25.0% concentration of eucalyptus (5.65) (Fig -7).

Raw Silk Recovery Percentage

Non-significant difference was observed between the treatments and the controls. However, highest value (79.91%) was recorded in Eucalyptus plant based repellent and lowest value (78.85%) was recorded in distilled water (Fig -7).

Reelability

The Fig-7 revealed that the data pertaining to reelability non-significance difference was observed between the treatments and the controls. The maximum reelability (87%) was noticed in 50.0% concentration of eucalyptus, neem *and control.*

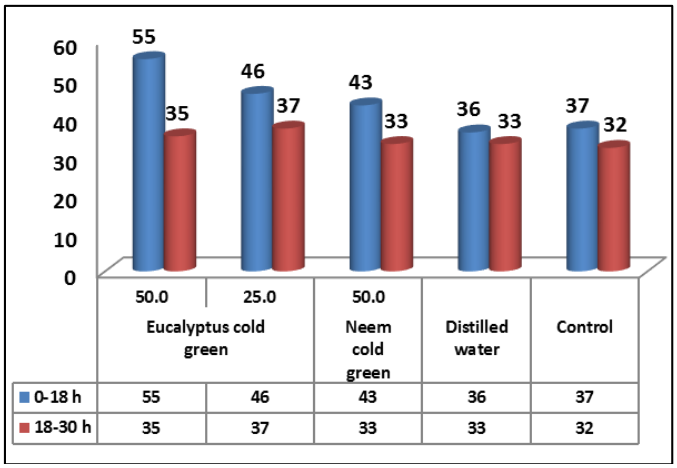


Fig 1: Effect of plants based repellent on the parentage of larvae climbed on the mountages in different durations (h).

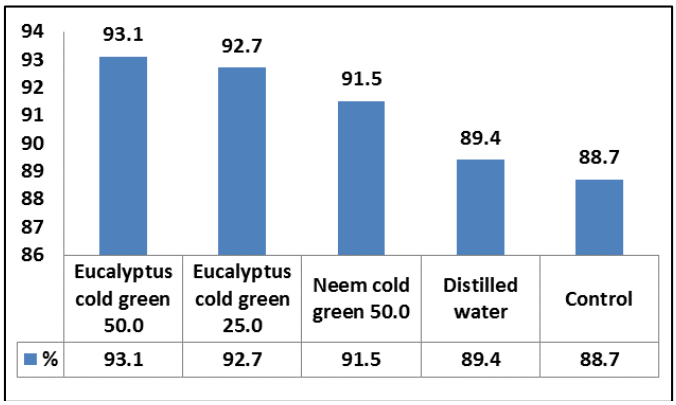


Fig 2: Effect of plants based repellent on the parentage of larvae climbed on the mountages.

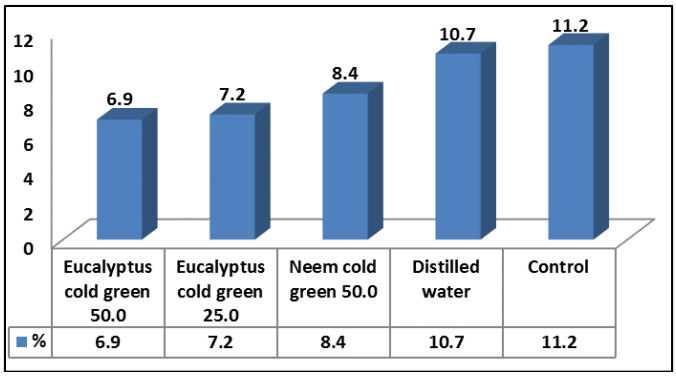


Fig 3: Effect of plants based repellent on the parentage of larvae spun the cocoons in the rearing bed.

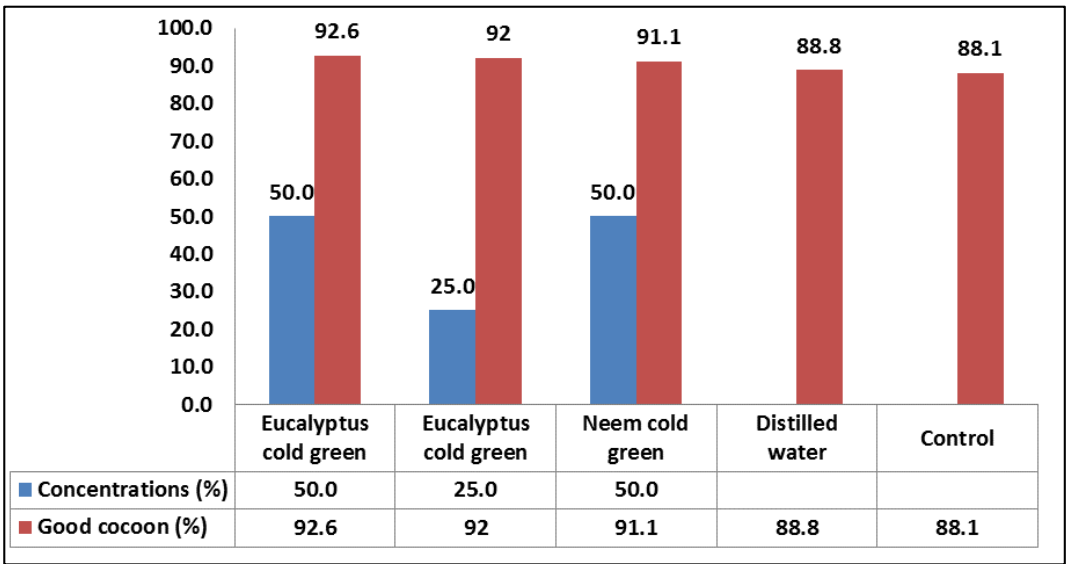


Fig 4: Effect of plants based repellent on good cocoons percentage.

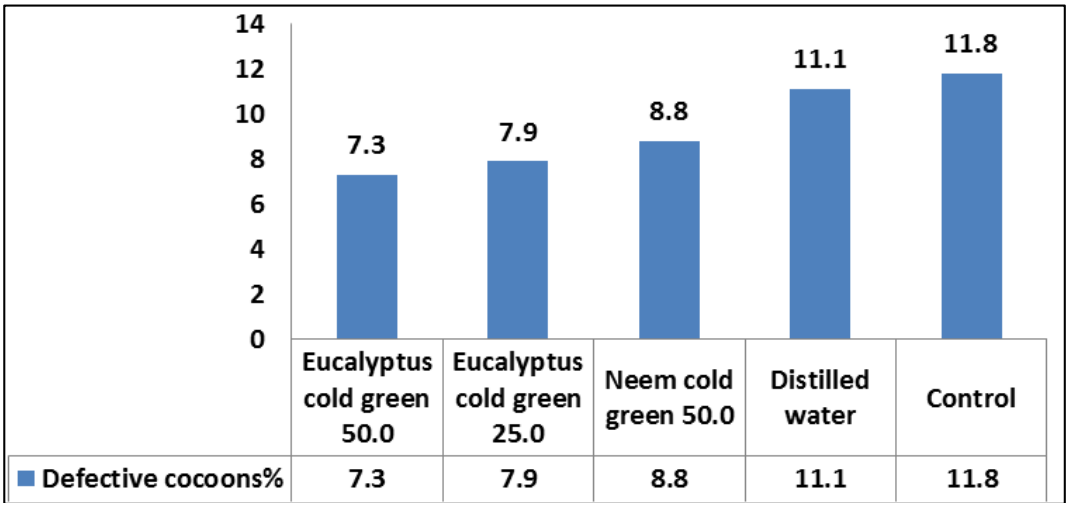


Fig 5: Effect of plants based repellent on defective cocoons percentage.

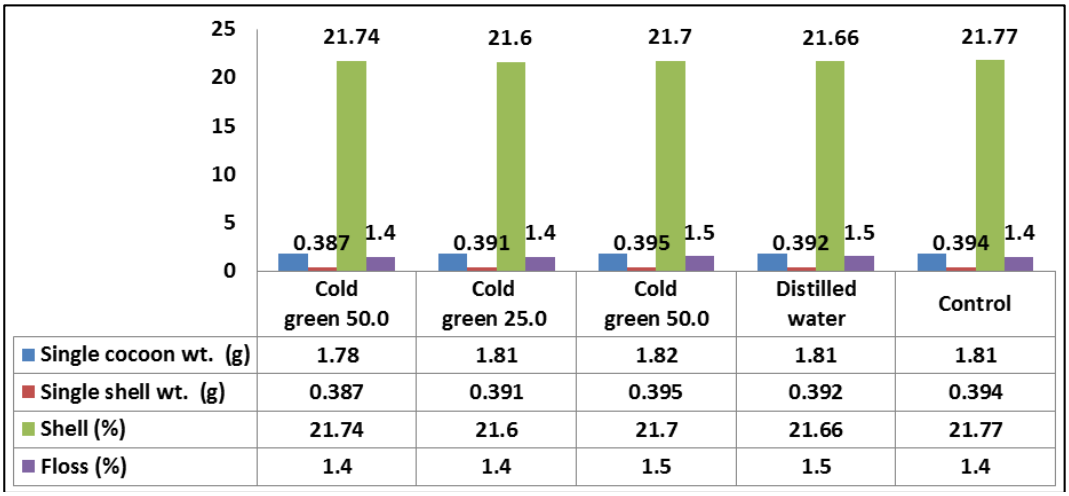
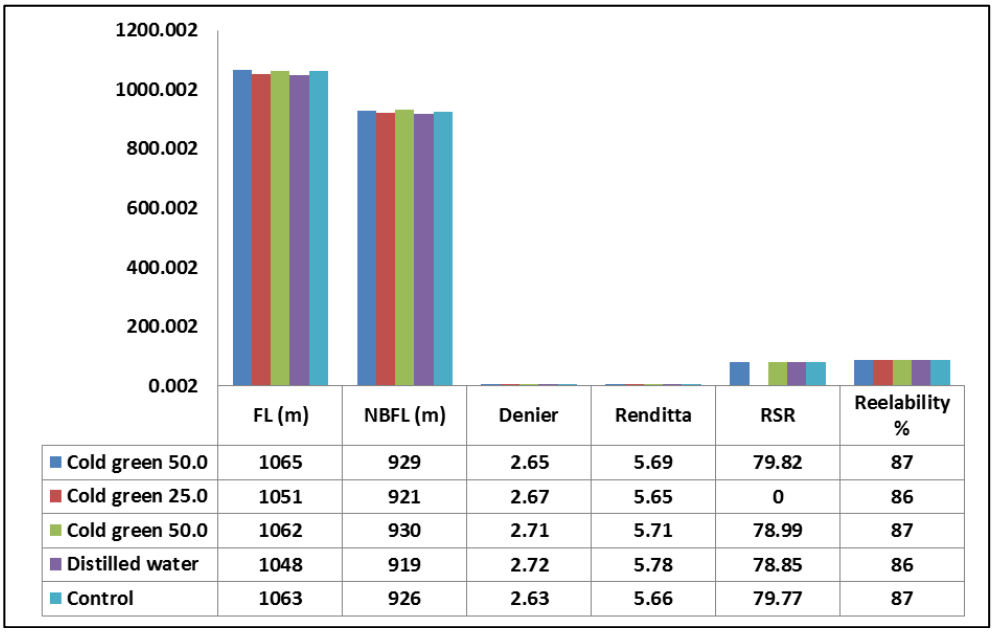


Fig 6: Effect of plants based repellents on cocoons characters and floss percentage.



	FL (m)	NBFL (m)	Denier	Renditta	RSR	Reelability %
Cold green 50.0	1065	929	2.65	5.69	79.82	87
Cold green 25.0	1051	921	2.67	5.65	0	86
Cold green 50.0	1062	930	2.71	5.71	78.99	87
Distilled water	1048	919	2.72	5.78	78.85	86
Control	1063	926	2.63	5.66	79.77	87

Fig 7: Effect of *plants based* repellents on post cocoon parameters.

Economics of plant based repellents for self-mounting

On the other hand, the economics in respect of plant based repellent on CSR_2 x CSR_4 hybrid, indicated that, an amount of Rs.165.00 towards total additional costs for 100 dfls. An amount of Rs. 736.00 was accrued in terms of extra good cocoon yield over the control and Rs.360.00 was the reduced cost because of labour saving. Spraying of crude extract of plant based repellent gain a net income of Rs.931.00 for 100 dfls and the cost benefit ratio was 1:5.64 (Table-1).

Table 1: Economics of plant based repellent in self mounting (CSR_2 x CSR_4).

Additional costs:	Amount:	Additional returns:	Amount:
Distilled water cost (20ltr. @6.84/ltr.)	136.8	Improvement in good cocoon yield over control (4.6Kg @ Rs. 160/Kg)	736.00
Labour cost (2.3hrs @ Rs.100/8hrs)	29.00	--	
Reduced returns:	--	**Reduced costs:**	
		Labour saving (3.6 mandays @ Rs.100/manday)	360.00
A. Total additional costs:	165.00	**B. Total additional returns and reduced costs:**	1096.00
Net change in income (B minus A):	931.00		
Cost benefit ratio	1:5.64		

Discussion

Adopting self-mounting method can effectively bring down the labour requirement at the time of mounting by utilizing the negative geotaxis of the silkworm at the wandering stage, but mounting rate is generally low [8]. In the past many workers made an attempts to overcome this problem by using repellents to improve the efficiency of mounting by orienting silkworms out of the rearing bed to the cocooning frame [2, 9, 13, 10] and also in India [16, 6]. However, the results of the current investigation when tested on CSR_2 x CSR_4 silkworm breed revealed that there was significant improvement observed in percentage of larvae climbed on the mountages and reduction in bed cocoons percentage was noticed. The investigation of the present study also revealed that cocoons characters and post cocoons parameter were not affected in the treated batches after spraying plant based repellents over silkworm breed CSR_2 x CSR_4. This results was in conformity with the findings of [6, 12].

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