

Morphological, Palynological and Ecological Features of *Dianthus engleri* Hausskn. & Bornm.

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Abstract

In this study, morphological, palynological and ecological features of *Dianthus engleri* Hausskn. & Bornm. were investigated. *D. engleri* is a local endemic species for Turkey and its type specimen was collected from Karababa Mountain (Sivas) in 1889 by Bornmüller. This species is very different from other *Dianthus* species in terms of taxonomy. In the result part of this study, the description of species was enlarged and a new treath category was proposed. Besides, a pollen description was composed for *D. engleri* according to scanning electron microscopy (SEM) and light microscopy (LM) studies.

Key Words

Dianthus engleri,
Taxonomy,
Palynology,
Thread category

INTRODUCTION

There exist 72 species, 2 subspecies and 12 varieties of the genus *Dianthus* L. (Caryophyllaceae) in Turkey. 34 species of them (47.2%) are endemic for Turkey [1-6]. While most of these endemic species are very local, 12 of them are identified only via type locality and 5 by two collections. They are more frequent on the territory within the Toros Mountain range, particularly in grid C4 and C5 except for the few local endemic species such as *D. engleri* which are observed out of this range.

Dianthus engleri is cushion-forming species which has spectacular flowers (Figure 1). The type locality of species is Karababa Mountain [1]. The second collection after Bornmueller's type specimen is from Akdağ by Siehe in 1911 which is near Karababa. The description of the species was based on these two collections, therefore we thought that the description is may be inadequate. Therefore, in this study it is aimed to expand the description of the species.

Some authors studied the pollen morphology of different genera of Caryophyllaceae at worldwide level [6-20]. The pollen morphology of *D. engleri* was observed in detail using LM and SEM. The purpose of the present investigation is to provide palynological information of *D. engleri* (Sileneae) pertaining to the family of Caryophyllaceae which

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would be helpful to establish a classification and a phylogenetic relationship with Caryophyllaceae.

MATERIALS AND METHODS

The research material are based on ca. 30 samples collected from the research area in 2007-2008 and the pollen slides belong to these samples. The specimens were dried and prepared as herbarium specimen to deposit at HUB. The voucher number Ekim 4132 was also investigated morphologically

beside our collections. Flora of Turkey [1] was used for identification. The different and enlarged characters were given in Table 1. The habitat information was obtained from the field studies. The threat category of the species was given according to Red Data Book for the vascular plants of Turkey [21] and World Conservation Union (IUCN) categorization and a new status has been proposed for the species [22]. The locality information with the coordinates and the coexisting plants were given as well.

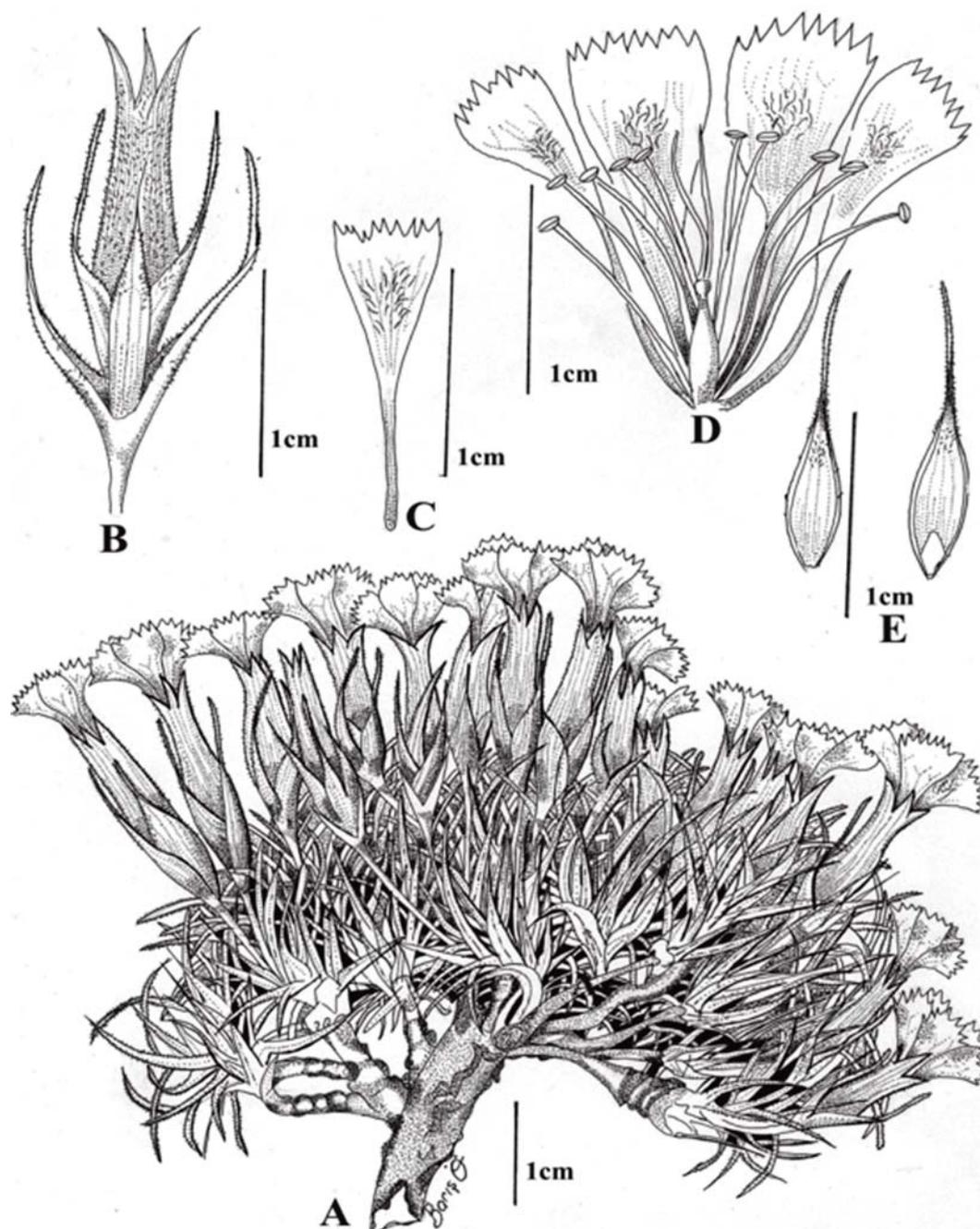


Figure 1. *Dianthus engleri* (a) Habitus, (b) Calyx tube, epicalyx scales and leaves, (c) Petal, (d) Flowers, (e) Epicalyx scales.

The LM observations with their measurements were made on pollen from mature anthers which had been prepared according to the acetolysis method as described by Erdtman [23]. The measurements of different parts of the pollen such as the size of the pollen, the pore diameter, the distance between the two pores and the exine thickness were taken using an immersion object-lens (x100) and a scale ocular (10x). These measurements were repeated on about 30 pollens for *D. engleri*. In addition, the ornamentation and the structure were established. All the statistical analyses of the palynological characters were calculated by the SPSS package program. In the SEM studies, the pollen grains taken from the anther were placed directly on the stubs and were covered with gold. The detailed surface ornamentation and the aperture characteristics were examined with a SEM and the microphotographs were taken. The terminology used is after Erdtman [24] and Punt et. al. [25].

RESULTS AND DISCUSSION

Species Description

Perennial, 2-4.5 cm, cushion-forming, all parts densely pubescent. Leaves acicular, 8-25 x 0.3-0.6 (0.8) mm, mostly at the base. Flowers usually solitary, rarely in pairs, sessile. Epicalyx scales four, 10-14 mm, shorter, equal or longer than and calyx tube, lanceolate to ovate-lanceolate, purplish, ciliate, narrowed gradually into a green aristate or caudate apex. Calyx not verruculose, 8-16 x 2-3.5 mm, subcylindrical, widest about the middle, purplish or purplish at the base and middle, greenish to apex, teeth 3.5-5.5 mm, acuminate, margin scariose, ciliate. Petal 15-16 mm, limb pink, 4-6 mm, ovate, barbate, dentate. Stamen 10, anthers ca. 1.25 mm, filament 11-12 mm, style 2, ca. 5 mm, capsule dehiscing by 4 teeth. *Fl. 7. Calcerous steppe 2000-2200 m.*

Type: [Turkey A5 Amasya] in sumo cacumine 'Kara baba' montis Ak – dagh, 2700 m, 1 vii 1889, *Bornm.*984.(Holo JE Photo !)

B6 Sivas: Ak Da., 2800 m, Siehe,1911 : 328, B6 Sivas, Gemerek, Karababa mountain, South-east slopes of Karasivri Hill, K 39° 28'23.9", D 36° 06' 05.1", 2000 – 2050 m, 04/07/2007, B. Özüdoğru 1344! (HUB), B6 Sivas: Şarkışla, Karababa mountain, Demirkaya Hill, 2000 – 2200 m, 20/07/1979, T. Ekim 4132! – A. Düzenli (ANK), B6 Sivas:Yıldızeli, Tümbül Hill, northern slopes, steppe, 1800 m, 30.VI.2005, DAG 1507 (Photo!), B6 Yozgat, South of Kızılcaova Village, 39° 30' 01" K, 36° 01' 17" D, 2000 m, 02/07/2008, B. Özüdoğru 2105!- B. Tarıkahya, D. Töre & Ö. Öztürk (HUB).

Irano – Turanien element

The type specimen deposited herbarium is not specified in Flora of Turkey. With our research it is recorded that the type specimen is at the Herbarium Jena (JE) (Figure 2). In addition, we found some morphological differences and new characteristics which are not mentioned in the Flora (Table 1).

Palynology

The pollen grains of *D. engleri* are radially symmetrical, apolar, pantoporate and prolate-

Table 1. The enlarged character of species.

Flora of Turkey	Added
Plant 1-2 cm long	Plant 2-4.5 cm long
Leaves 8-12 x 0.3-0.6 mm	Leaves 8-12 x 0.3-0.6 (0.8) mm
Bracteol (epicalyx scale) equalling or longer than calyx	Bracteol (epicalyx scale) shorter, equalling or longer than calyx
Calyx 8-15 x 3 mm	Calyx 8-16 x 2-3.5 mm.
Petal length not indicate	Petal 15-16 mm long
Calyx teeth 4.5-5.5 mm	Calyx teeth 3.5-5.5 mm
Calyx purplish at the base and middle, greenish to apex	Calyx purplish or purplish at the base and middle, greenish to apex

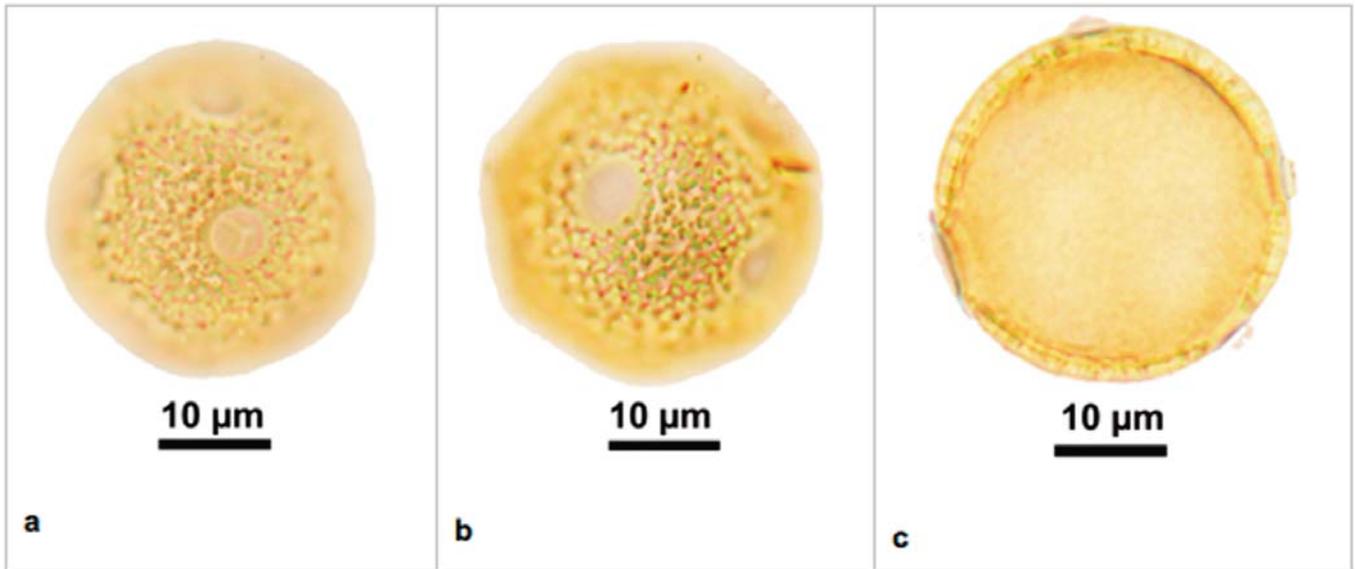


Figure 3. Microphotographs of pollen grains of *Dianthus engleri* (LM): a-b. pore and exine ornamentation (low focus), c. exine structure (high focus).

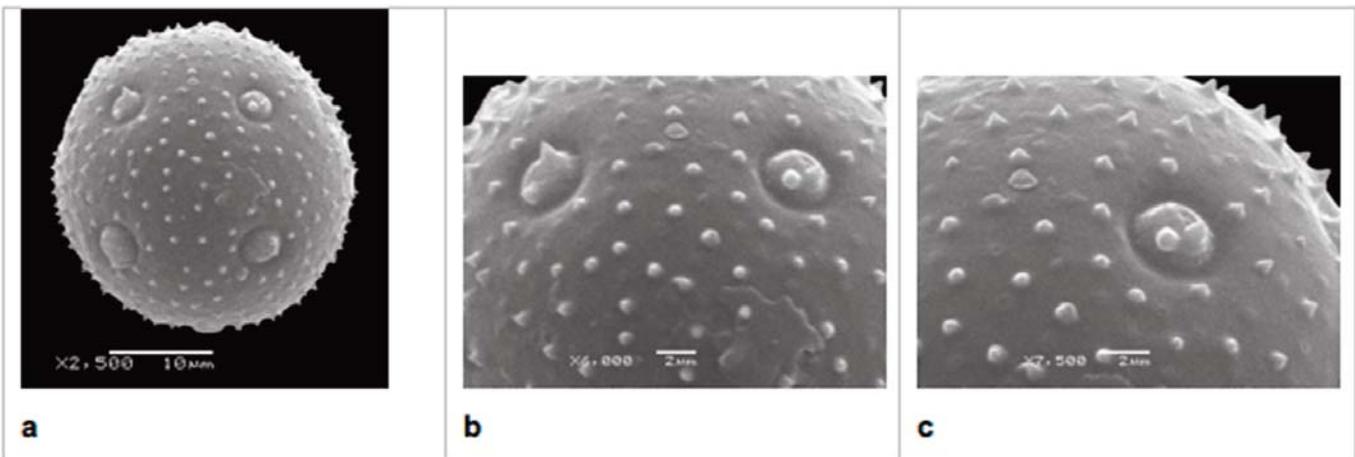


Figure 4. Microphotographs of pollen grains of *Dianthus engleri* (SEM): a. general view of a pollen grain, b-c. Detailed view of pore and exine ornamentation.

Table 2. Pollen morphological features of *Dianthus engleri* (Silenae- Caryophyllaceae)

(A axis, B axis, Plg: Pore length, Plt: por breadth, t: apoporium).

Species	<i>D. engleri</i>				
Pollen shape	prolate-spheroidal	Aperture number and type	Pantoporate, 7-11 pores		
A/B	1.05	Plg/Plt	1.22		
A (µm)	M 34.77	Plg	M	6.15	
	S ± 1.16		S	± 0.68	
	Var. 33.32-37.24		Var.	4.90-6.86	
B (µm)	M 33.12	Plt	M	5.06	
	S ± 1.17		S	± 0.55	
	Var. 29.40-36.26		Var.	3.92-5.88	
Exine thickness (µm)	M 2.38	t (µm)	M	9.67	
	S ± 0.48		S	± 0.88	
	Var. 1.96-2.94		Var.	8.82-11.76	

spheroidal (Figure 3-4). The pollen length (A) is 34.77 µm, breadth (B) is 33.12 µm. The distance between the two pores is 9.55 µm.

The pores are circular, with distinct margin and operculate. The pore length (Plg) is 6.15 µm, pore breadth is (Plt) 5.06 µm. The pore number is between 7-11.

The exine ornamentation is scabrate-punctate (Figure 4). The puncta are sparse.

The exine thickness is 2.38 µm. The sexine and the nexine are not distinctly distinguished.

Ecology

Habitat

Dianthus engleri is found in all the determined localities between 2000 and 2200 m, although in Flora of Turkey the habitat in which it grows as 2800 m. *D. engleri* is a chasmophytic plant which grows on the upper layer of the Paleozoic-Mesozoic old marble bedrock, a metamorphic unit called Akdağmadeni formation. The flowering period starts in early July.

According to the meteorological data from Şarkışla and Gemerek meteorological stations which are the closest meteorological stations to the research area [26], the average annual temperature is 9.4°C in Şarkışla and 9.5°C in Gemerek. In Şarkışla and Gemerek the average annual precipitation is 325.5 mm and 400.8 mm respectively. The distribution of precipitation according to season is SWAS (spring, winter, autumn, summer) and the precipitation regime is "East Mediterranean Rain Regime Type 1" in Şarkışla and Gemerek [27].

Communities

Aspleniata rupestris Br-BI.1934

Silenetalia odontopetalae Quezel, 1973

Onosmium mutabile Quezel, 1973

Dianthus engleri-Helichrysetum chinopyllii

KURT

The floristic structure of the *D. engleri* habitat belongs to the class **Aspleniata rupestris** Br-BI.1934 and the order **Silenetalia odontopetalea** Quezel 1973. The Class **Aspleniata rupestris** is the characteristic for more humid rocks in the northern hemisphere. The floristic structure of the research area is very complex because of having low inclination and soil layer. Therefore, the species is found within class **Daphno-Festucetales** [28].

The following chasmophytic species are coexisted with *D. engleri*.

Helichrysum chionophilum Boiss. & Balansa, *Centaurea drabifolia* Sm subsp. *detonsa* (Bornm.) Wagenitz, *C. mucronifera* DC., *Dianthus zederbaueri* Vierh., *Asperula nitida* Sm. subsp. *subcapitellata* Ehrend., *Bromus tectorum* L., *Sedum subulatum* (C. A. Mey.) Boiss., *Allium scarodoprassum* L. subsp. *rotundum* (L.) Stearn, *Arenaria ledeboriana* Fenzl. var. *ledeboriana*, *Silene caryophylloides* (Poiret) Otth subsp. *caryophylloides*.

CONCLUSION

The distribution area of *D. engleri* is ca. 100 km² in the Karababa Mountain and the adjacent mountain range called İncebel Mountain (previously name is Akdağlar). The second record excluding this range have been reported by Dağ from Yıldızeli-Tümbül Hill [29]. Bornmueller collected plants from both Amasya-Akdağ and Sivas-Akdağ at the same period, the type locality of *D. engleri* was given as A5 Amasya-Akdağ in Flora of Turkey most probably by mistake. Because it was labelled as "in sumo cacumine 'Kara baba' montis Ak-dagh" in the type specimen. Though this species is not present in the floristic study of Akdağ in Amasya [30].

In Red List this species has been proposed as NT due to the type location was given in Amasya [21]. However the real distribution of the plant is at Sivas-Yozgat border. Animal husbandry is a very important economical activity in this region. The population of *D. engleri* is under threat because of trampling by animals. For the rest, there are two dormant marble quarries. If these quarries begin to operate, the habitat of on marble stones growing *D. engleri* will be completely destroyed. In addition, because its occupancy is less than 20000 km² and it is severely fragmented and known to exist at no more than 10 locations, according to World Conservation Union (IUCN, 2001) categorization [criterion B1ab(ii) +

2ab(ii)] it is proposed for Vulnerable (VU) status.

Pollen morphology can be useful in supporting taxonomic suggestions [31]. It provides useful taxonomic characters for the identification and the classification of the taxa of the family Caryophyllaceae. The pollen morphological characters are of significance in the species delimitation. These are considered supplementary to the general plant morphology and play a critical role in the taxonomic and the evolutionary debate.

Perveen & Quaiser [17] have examined the pollen morphology of the 74 species belonging to the 23 genera of the family Caryophyllaceae from Pakistan by light and scanning electron microscope. In this study, on the basis of apertural type three distinct pollen types are recognized: *Silene indica*-type, *Spergula arvensis*-type and *Stellaria media*-type. *Stellaria media*-type pollen grains have been identified as pantoporate, spheroidal, pore more or less circular, spinulose-punctate or scabrate-punctate. Perveen & Quaiser have included *Dianthus anatolicus* Boiss, *D. crinitus* Sm, *D. orientalis* Adams., *D. angulatus* Royle ex Benth., *D. cachmericus* Edgew. and *D. Jacquemontii* Edgew. ex Hook.f. in *Stellaria media*-type.

Yıldız [15] has studied pollen morphology of the 45 species belonging to the 15 genera of Caryophyllaceae by LM and SEM. On the basis of exine structure, ornamentation and morphological data, 10 distinct types viz., 1. *Arenaria* type, 2. *Stellaria holostea* L., 3. *Cerastium* type, 4. *Dianthus* type, 5. *Gypsophila repens* type, 6. *Lychnis viscaria* type, 7. *Silene vulgaris* type, 8. *Silene caryophylloides* subsp. *subulata* (Poiret) Otth, 9. *Silene conica* type and 10. *Agrostemma githago* L., were recognized. In the study, Yıldız has examined the pollen grains of *Dianthus eldivenus*, *D. balansae*, *D. crinitus* var. *crinitus*, *D. orientalis*, *D. masmenaus* var. *glabrascens*, *D. erinaceus* var. *alpinus*, *D. carmelitarum*. According to Yıldız [15]

Dianthus type pollen grains are microperforate or reticulate. Grains with 11-20 (generally 11-16) pori. Grain size ranges from 20.68 ± 2.42 μm to 45.35 ± 3.57 μm .

Vural investigated *D. aytachii* and *D. zederbaueri* under light and electron microscope [6]. He has pointed out that the size difference between the pollen grains of these species. Also, he has found out the pollen grains of both species are periporate, oblate-spheroidal and echinate.

Our palynological results are concordant to the previous researches about Caryophyllaceae and *Dianthus* pollen investigations. The pollen grains belong to *D. engleri* are radially symmetrical, pantoporate, apolar, prolate-spheroidal, scabrate-punctate and the pores are circular. According to these features pollen grains of *D. engleri* should be in *Stellaria media*-type of Perveen & Quaiser [17]. Yıldız [15] has defined *Dianthus* type pollen grains as microperforate or reticulate. However, SEM micrographs of these species have shown that the pollen grains had ornamentation elements less than 1 μm and puncta between these elements [15]. According to Punt et. al. [25], the elements of ornamentation, of any shape, smaller than 1 μm in all directions are scabrae and its ornamentation type is scabrate. Because of these, the exine ornamentation of *Dianthus* type pollen grains should be identified as scabrate-punctate and should be evaluated in the *Stellaria media*-type of Perveen & Quaiser [17]. Also, Vural [6] has identified the pollen grains of *D. aytachii* and *D. zederbaueri* as periporate and echinate. The term of periporate is synonym of pantoporate. Moreover, he has declared that the length of echinae has been 0.5 μm . Also in the SEM micrographs of the pollen grains belonging to *D. aytachii* and *D. zederbaueri* are seen as clearly, there are puncta between scabrae [6]. For these reasons the exine ornamentation of the pollen grains belonging to *D. aytachii* and *D. zederbaueri*

should be scabrate-punctate. In terms of the apertures and the exine ornamentation the pollen grains of *D. engleri*, *D. aytachii* and *D. zederbaueri* resemble each other.

In the results of all these studies we can say that in generally the pollen grains of genus *Dianthus* are pantoporate, spheroidal (prolate- or oblate-spheroidal) and spinulose- or scabrate-punctate.

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