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The Eating Behaviour, Feed Consumption, and Nutrient Digestibility of Sumatran Elephant (Elephas maximus sumatrensis)

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Keywords

consumption;
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Abstract

This study aims to determine the consumption, digestibility of feed nutrients that are given to support the activities of the Sumatran elephant at the Bali zoo, to determine the feeding duration and eating behavior of the Sumatran elephant at the Bali zoo. It has been carried out for 1 month at the Bali zoo, Singapadu Village, Sukawati, Gianyar. , Bali and at the Laboratory of Nutrition and Animal Feed, Udayana University. The method of collecting data on feeding time was carried out using the focal animal sampling method, namely the method of collecting behavioral observation data using four individual animals as objects of observation and using the technique of recording the behavior of these animals at certain time intervals. Consumption of feed nutrients can be determined by calculating the dry matter consumption per day times the nutrient content of the feed consumed. Nutrient digestibility can be determined by calculating the nutrients consumed minus the nutrients in the feces divided by the nutrients consumed. Nutrient content of feed can be known by proximate analysis. The observed variables were feeding behavior, duration of eating, nutrient consumption and nutrient digestibility. The results showed that the most frequent eating behavior of the Sumatran elephant was taking food with its trunk as much as 54.26% and the lowest behavior was putting food on its back as much as 0.77%.

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1 Introduction

The Sumatran elephant (Elephas maximus sumateranus) is a protected animal based on Government Regulation no. 7 of 1999. The population of Sumatran elephants is decreasing from year to year due to changes and shifts in the habitat of Fadillah et al. (2014). One of the efforts to slow the rate of extinction of elephants is to maintain their population in the wild (in-situ conservation), and maintain part of the population in captivity (captivity) or ex-situ conservation. Bali zoo is an ex-situ conservation institution that contains 13 Sumatran elephants imported from Sumatra. The Bali zoo is a suitable place for elephants because there are components that meet the requirements of elephants living in nature such as shelter, food, water, and mineral salt. zoos, pets are not fed strictly according to their food choices in natural conditions, often due to logistical and financial constraints. This is especially true for captive elephants (Crandall, 1964), with reports showing that some facilities feed their elephants a low diversity of diet throughout the year and that some captive animals are fed inadequately (Vanitha et al., 2011). (Zahrah, 2002). Therefore, to maintain the condition of a healthy elephant population, factors that affect the elephant's quality of life must be considered, namely life necessities such as feed, water, and mineral salts. Elephants need to feed with high species diversity (Fadhli, 2012). The diversity of feed types is to meet the nutritional needs of elephants in carrying out their activities Abdullah et al. (2009). Data related to feeding behavior, consumption, and digestibility of feed nutrients in elephants in Sumatra is still very few and even no related research results have been reported. Therefore, the authors are interested in conducting research on the duration of eating, consumption, and digestibility of feed nutrients in Sumatran elephants (Elephas maximus sumatrensis) at the Bali Zoo.

2 Materials and Methods

Cattle

The animals used in this study were 4 Sumatran elephants (Elephas maximus sumatrensis), aged ± 10 years with an average body weight of 4,100 kg.

Cages and equipment

The cages used were individual cages consisting of 4 plots of length, width, and height (7 m, 5 m, 4 m). The cage is made of steel and has cavities on the walls of the cage so that the elephant can see his friend next to him. The floor is made of cement concrete, while the roof of the cage is made of zinc. The feeder is not provided because the feed is only placed on the floor of the cage. The drinking water container is made of a buss which is made permanently on the floor of the cage with a volume of 30 liter

Feeding and drinking water

The feed provided consisted of coconut fronds, bamboo leaves, banana leaves, and king grass. Coconut fronds are obtained from suppliers from the country, and banana leaves, banyan leaves, and king grass are imported from the village of Taro. Feeding was given 2 times (morning and evening) with different compositions. The

composition of elephant food ingredients is presented in table 1. Table 1 The composition of elephant food ingredients and the nutrient content of the ration

Research Location and Time

This research was conducted at the Bali Zoo, Singapadu Village, Sukawati District, Gianyar Regency, Bali. As well as Lab. Nutrition and Animal Feed Udayana University for 1 month starting in October 2021.

Research design

The research design used was the Latin Square Design (BSL). Placement of Sumatran elephants in cages and without special treatment between animals Table 1

Table 1
Research chart for Sumatran Elephants

Days	Sumatran Elephants			
	1	2	3	4
I	P1,OB	P1	P1	P1
II	P1	P1,OB	P1	P1
III	P1	P1	P1,OB	P1
IV	P1	P1	P1	P1,OB
V	P1	P1	P1	P1

Information:
P1 = 40 kg Coconut frond + 20 kg Bamboo Leaf + 20 kg King Grass + 20 kg Banana Leaf
OB = Observation of Eating Behavior

Observed Variables
Eating behavior and eating time

Behavioral data was collected and collected using the "focal animal sampling" method, where each individual animal's behavior was observed while the animal was being fed by recording the eating behavior and duration of eating when the animal was eating (Martin and Bateson, 1993).

Nutrient consumption

Calculation of BK ration consumption per day (KBK/day) (g BK) and nutrient consumption using the formula:
BK consumption (g/h) =∑ feed consumption x % of feed BK
Cons. Nutrient (g/h) = CBC/day (g BK) x ration nutrient content (%BK)
Sampling of feed as much as 200 g per / sample, then the feed sample in the oven to determine the dry weight, then a proximate analysis was carried out to determine the nutritional content of the feed sample.

Nutrient Digestibility

Determination of digestibility was carried out by the total collection method. Stool samples were taken as much as 1 kg, then dried in the sun and weighed again to determine the air dry weight (BKU). Stool samples were taken as much as 10% BKU/day to be mashed using a blender. Next, a proximate analysis was carried out.

$$\text{Nutrient digestibility coefficient} = \frac{\text{nutrient consumed} - \text{nutrients in feces}}{\text{nutrient consumed}} \times 100\%$$

3 Results and Discussions

Sumatran Elephant feeding behavior

The results of observations of the eating behavior of Sumatran elephants kept at the Bali Zoo show the behavior that is often done by Sumatran elephants is taking food with the trunk as much as 285 times/day, this is because elephants have a large body size and are also quite high so that the distance between the mouths and the food is far enough away that the elephant needs the help of its trunk to pick up food and put food into its mouth. According to Mckay (1973), Asian elephants eat grass by wrapping their trunks and then pulling them and putting them in their mouths. Abdulah et al, (2009), explained that the trunk is used to reach food by moving it lengthwise, circularly or coiled. The elephant will stick out its trunk and it will be wrapped around the food to be taken and then put into its mouth.

The behavior of eating elephants which is quite often done is to separate the leaves from the stems as much as 105 times/day. Usually, elephants do this when the elephant wants to eat the leaves first before eating the stems, such as bamboo leaves, banana leaves, king grass, and banyan leaves, this is because elephants prefer to eat soft food or easy-to-chew like leaves on plants. , therefore elephants separate the leaves and stems when eating hard-trunked plants. The way the elephant separates the leaves and the trunk is of course with the help of the trunk and also its big legs (LaDue et al., 2022; Zhang & Wang, 2003; Arvidsson et al., 2012)

The elephant's next eating behavior is peeling food with its trunk as much as 45 times/day, this behavior of peeling food with the trunk is quite often observed when elephants eat coconut fronds. As is well known, the coconut frond has skin that is quite hard but has an inside that is quite oxen, so the elephant has to peel the skin first to eat the inside of the coconut frond. The elephant's way of peeling the skin of the coconut midrib is by biting the coconut midrib and then wrapping it around the coconut midrib with its trunk and then pulling the skin of the coconut midrib until you can see the inside of the coconut midrib. The behavior of peeling the skin of food in adult elephants is greatest when the elephants eat coconut fronds. The eating behavior of elephants is like hitting their food against their body 27 times/day, and shaking their food with their trunk 21 times/day. This behavior has the same purpose elephants do this usually when the food to be eaten contains insects (ants) and the food is dirty. In line with the research of Berliani et al. (2018) that in managing their food the elephant will first clean the dirt on the feed by shaking the feed using its trunk.

The elephant's next eating behavior is cutting food using the trunk 17 times/day and cutting with the legs 15 times/day. Both of these behaviors have the same goal, namely to reduce the size of the food to make it easier for food to enter the elephant's mouth. An elephant cuts food with its trunk by wrapping it with its trunk and then cutting it, the same as cutting with the feet of an elephant stepping on its food with its feet and then raising it with its trunk, usually elephants do it with their feet when the size and texture of the food is so hard that the elephant has to use its feet by being stepped on. This is in line with the research of Berliani et al. (2018), which explains that in processing elephant feed, they will remove plant parts that are not palatable or break and split the feed into smaller ones using the trunk, as well as one of its forelegs.

The last eating behavior is to put food on the back 5 times/day. Usually, elephants do this when the elephant feels hot so the elephant puts its food on its back. The food that is usually placed on the back is banana leaves and king grass. According to Lekagul & Mcnelly (1977) elephants when the weather is hot, elephants usually wallow in the form of bathing in water or mud, spraying water on their bodies and if there is no water and mud, elephants usually put plants that have a lot of water on their backs.

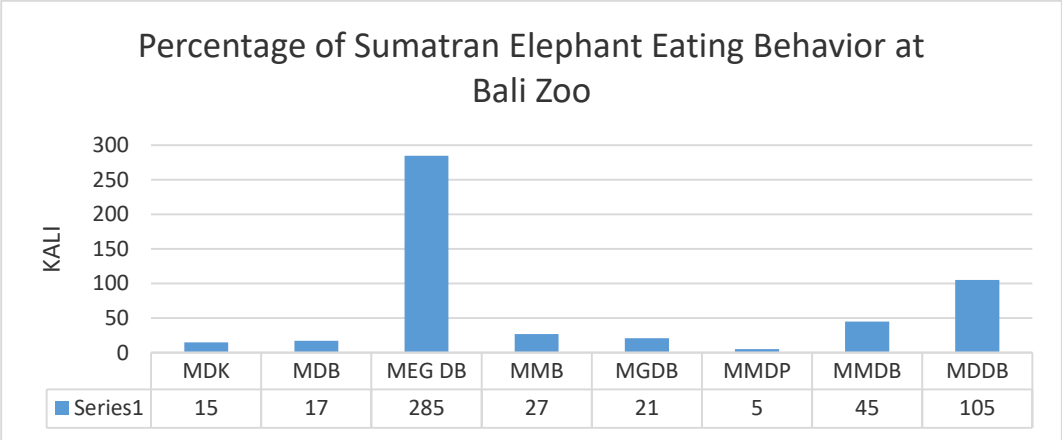

Figure 1. The eating behavior of Sumatran elephants kept at the Bali Zoo

Description: MDK=Cuts With Feet, MDB = Cuts With Trunk, MEG DB = Takes Food With Trunk MMB = Hits Food Into Body MGDB = Shakes Food With Trunk MMDP = Puts Food on Back MMDB = Peels Food With Proboscis MDDB = Separates Leaves With the Stem

Feeding duration of Bali Zoo's Sumatran Elephant

Calculation of the Sumatran elephant feeding duration in the morning by giving 20 kg of midrib at 10:00 WITA with the duration of eating the Sumatran elephant around 51-54 minutes. The coconut frond given to the Sumatran elephant has a length of about one meter with a total of 8 coconut fronds / 20 kg with an average weight of 2-2.5 kg per coconut frond. Sumatran elephants require a longer feeding process than animals seen from the size of the elephant's food and the texture of the elephant's food which is quite hard, causing the elephant to cut the midrib using its trunk and legs. According to Kurt (2002), if the food to be eaten is hard, the elephant uses its trunk to peel and cut its food to make it easier to eat. After the coconut midrib is broken, it is peeled using its trunk to get the middle of the coconut midrib, after eating the middle of the coconut midrib, the elephant immediately eats the skin of the midrib.

Calculation of the duration of eating in the afternoon by feeding at 15:00 WITA with a food composition of 20 kg of king grass, 20 kg of banana leaves, 20 kg of coconut midrib, and 20 kg of bamboo leaves, with the duration of time needed to spend the afternoon feed for 285-305 minutes. According to Ofrinaldi et al. (2016), Sumatran elephants carry out feeding activities for 16 hours on land or in the forest. Sumatran elephants kept at the Bali Zoo take 5 hours to finish their food, this is because the Sumatran elephant's feed at the Bali Zoo for the composition of the food has been set by the Bali Zoo feed officer and when feeding, the feed has been collected into one so that the elephants are only used for feeding. eat them directly without the need to find or choose food like in their natural habitat, this is what causes the duration of eating elephants in captivity to run out faster than in their natural habitat (LaDue & Schulte, 2021; Aryani & Rahayuni, 2016).

Table 2
Feeding duration of Bali Zoo's Elephants

Elephant's Name	Morning Feeding Duration	Afternoon Feeding Duration	Duration Total/days
A	52 minute	285 minute	337 minute/days
B	51 minute	297 minute	348 minute/days
C	52 minute	305 minute	362 minute/days
D	54 minute	295 minute	349 minute/days
Average duration	52,25 minute	295,5 minute	349 minute/days

Description:A=Lola B = Laras C = Tongkun D = Handayani

The duration of each type of feed for Sumatran elephants kept at the Bali zoo with the same feed weight was 20 kg. Elephants need a shorter time when elephants eat banana leaves with a duration of 34 minutes then when consuming king elephant grass it takes 43 minutes, almost the same time when elephants consume banana leaves. This is because banana leaves and king grass are one of the elephants' favorite foods because they are soft and also contain quite a lot of water which is very easy to chew and eat. more time to eat banana leaves and elephant grass. According to Muir et al. (2021), in their research, Sumatran elephants do not take long to consume grass and banana leaves, because elephants only need to clean the feed from the soil or mud before eating it, besides that the structure of grass and banana leaves is also quite soft so it doesn't need to be eaten. long time to eat it (Hedges et al., 2005; Arnold et al., 2017).

The duration of eating the Sumatran elephant when eating coconut midrib and bamboo leaf is 52 minutes and bamboo leaves 62 minutes Sumatran elephants need a longer time when eating coconut midrib and bamboo leaves because coconut midrib and bamboo leaves have a fairly hard texture so that elephants need to break and peel the coconut midrib before eating. eat it while the elephant bamboo leaves need to separate the bamboo leaves from the stems before eating because the hard bamboo stems make the elephants take longer to eat. Because it has a hard texture when chewing elephant food takes longer before swallowing it.

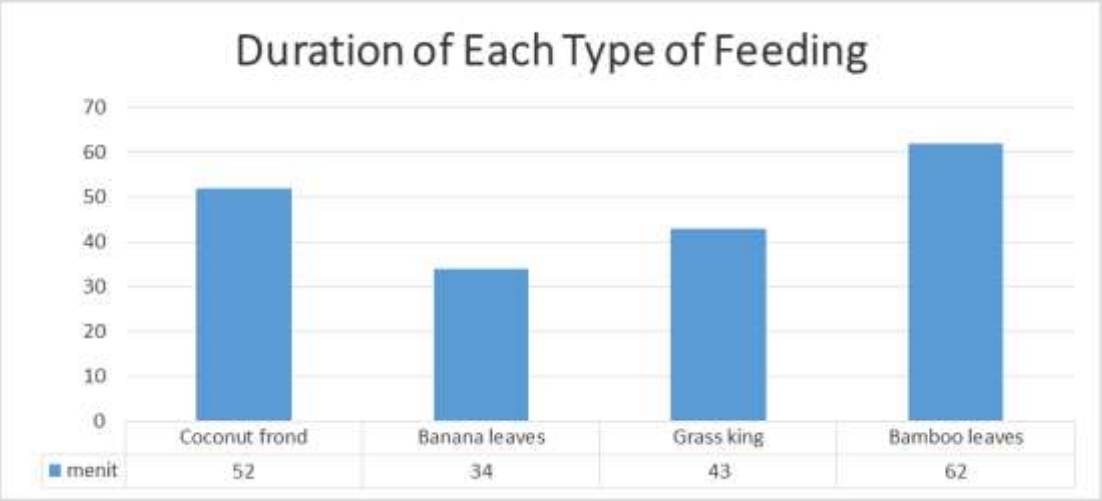

Figure 2. Feeding duration of each type of feed for Sumatran elephants kept at Bali Zoo

Nutrient Consumption of Sumatran Elephant

The results showed that the consumption of BK Sumatran elephants kept at the Bali zoo was 30.848 kg/head/day with a fresh weight consumption of 100 kg/head/day, the results of this study were lower than the results of the study by Koirala (2017), calm Asian elephants in the zoo. Auckland, New Zealand, which resulted in the consumption of Asian elephant BK in New Zealand was 83.3 kg/head/day with a fresh weight consumption of 200 kg/head/day. When compared with goats whose weight is much different from that of Sumatran elephants, the dry matter needs of goats with a body weight of 40 kg range from 910-1,050 g/head/day. This difference occurs because they have different body weights. This phenomenon indicates that the consumption of BK is influenced by body weight of livestock. Supported by the statement of Mathius et al. (2002), that livestock body weight significantly affects dry matter consumption. According to Kurt (2002), that dry matter consumption of feed is influenced by body weight, ambient temperature, and feed characteristics which include digestibility, palatability, and nutrient balance in the ration.

The results showed that the consumption of CP in Sumatran elephants kept at the Bali zoo was 3,642 kg/head/day. The results of this study are lower than the study by Koirala (2017), on Asian elephants in New Zealand zoos with CP consumption of 4.53 kg/head/day, because Asian elephants target to consume 11-15% protein/day to support their basic life. In line with the opinion of McDonald et al. (2002), that the increasing consumption of protein is caused by the consumption of dry matter, this greatly affects protein consumption.

The same thing was conveyed by Purbowati et al. (2007), that the factors that influence protein consumption are dry matter consumption and feed protein content. Kamal (1994), added that the amount of feed consumed can affect the amount of other nutrients consumed, so the more feed consumed will increase the consumption of other nutrients in the feed.

The results showed that the consumption of SK on the Sumatran elephant's feed kept at the Bali Zoo was 9.578 kg/head/day. The high consumption of SK was caused by the high content of SK in each of the Sumatran elephant feed ingredients kept at the Bali Zoo, such as banana leaves 27.08%, bamboo leaves 32.24%, coconut fronds 31.89% and king grass 27.29%. The higher the SK content in the ration, the higher the consumption of crude fiber. Khammesri et al. (2022), suggested that elephants need high crude fiber in their feed because elephants have a fermentative digestive system of the cecum and colon.

The results showed that the consumption of LK Sumatran elephants kept at the Bali zoo was 1.744 kg/head/day. This result is lower than the results of Koirala's (2017), Asian elephants at the Auckland Zoo, New Zealand, which obtained a yield of 2,953 kg/head/day of LK consumption, this is because the Sumatran elephants that are kept in the Bali Zoo are only fed forage with LK content in each feed ingredient such as banana leaf 10.34%, bamboo leaf 5.64%, coconut frond 3.35%, and king grass 5.04%. In contrast to the elephant feed that is kept in New Zealand, they add their forage feed with special commercial elephant pellets as elephant feed

Table 3
Nutrient consumption in Sumatran Elephants kept at Bali Zoo

Nutrient	Consumption(kg)
Dry feed	30,848
Rough protein	3,642
Rough fiber	9,578
Fat	1,744

Sumatran Elephant nutrient digestibility

The results showed that dry matter digestibility of Sumatran elephants (KCBK) reared at the Bali zoo was 67.64%-57.49% by feeding bamboo leaves, banana leaves, coconut midribs, and king grass. the research of Clauss et al. (2003), and Auckland Zoo, Koirala et al. (2016), which obtained dry matter digestibility ranging from 67.1-72.8% by feeding high-fiber feeds such as grass, leaves, wheat straw and grass straw. In his research, when elephants were only given wheat straw, the dry matter digestibility was reduced by only 35.0%. This shows that the diversity of feed on elephants greatly affects the dry matter digestibility of a given feed. According to Joshi & Singh (2008), states that elephants are able to compensate for the decline in feed quality by eating more food so that elephants are able to maintain their nutritional needs.

The results showed that the coefficient of organic matter digestibility (KCBO) of Sumatran elephants kept at the Bali zoo was 57.65 – 66.42% (Table 5.2). Digestibility of organic matter follows the dry matter digestibility pattern. This agrees with the statement of Siti et al. (2013), that organic matter is part of dry matter, so that the digestibility of organic matter follows the dry matter digestibility pattern. This is also explained by Muhtarudin & Liman (2006), who stated that the higher the digestibility of organic matter in the feed, the higher the dry matter digestibility and the higher the opportunity for nutrients that can be utilized by livestock for production.

The results showed that the crude protein digestibility coefficient (KCPK) in Sumatran elephants kept in the Bali zoo was 52.43% - 81.95% (Table 5.2). The results of this study are also in line with the results of Clauss et al. (2003) and Auckland Zoo, Koirala et al. (2016), which obtained crude protein digestibility in the range of 51.2-81.8% with the provision of high-fiber feeds such as grass, leaves, wheat straw and grass straw. Nutritional imbalance in elephants can make elephants obese and obese. poor health in elephants if elephants overeat foods containing low protein, and low energy intake (Raubenheimer, 2011). KCPK According to Vancuylenberg (1977), high and low protein digestibility is influenced by the protein content of the ration material and the amount of protein that enters the digestive tract.

The results showed that the crude fiber digestibility coefficient (KCSK) in Sumatran elephants kept in the Bali zoo was between 50.56% - 59.61% (Table 5.2). seen from the crude fiber content of the feed eaten by Sumatran elephants kept at the Bali zoo, including banana leaves 27.01%, raja grass 32.24%, coconut fronds 31.89%, and bamboo leaves 27.29%. The crude fiber content of the feed for elephants in Bali Zoo is high because the feed given contains quite a lot of fiber. The digestive strategy of elephants is to pass large amounts of low quality feed such as crude fiber through the GI (Gastrointestinal) tract in a short time. The transit time of feed in the GI tract depends on the type of feed consumed. When compared with horses which have a digestive system that is almost the same as elephants, with field grass feeding, the digestibility of horse crude fiber is 61.67% (Kristina et al., 2019).

The results showed that the crude fat digestibility coefficient (KCPK) in Sumatran elephants kept in the Bali zoo was 54.63% - 70.63% (Table 5.2). The results of this study are also in line with the results of the study of Clauss et al. (2003) and Auckland Zoo, Koirala et al. (2016), which obtained crude fat digestibility of 69.2%. According to Fowler & Mikota (2006), a diet consisting only of grass and commercial food may have less fat content but this deficiency is not important because captive elephants are limited to activities and therefore captive elephants require less fat like other animals to migrate. The recommended level of crude fat content in captive elephant diets is 30.2% - 51.8% (BIAZA, 2006), while the crude fat content required for wild elephants is 75.5%, this is very much in line with the activity level of wild elephants. (Chen et al., 2006). Crude fat appears to play an important role in reproductive physiology (Abdullah, 2009; McDonald et al., 2002; Franz et al., 2011).

Table 4
Nutrient digestibility coefficients for Sumatran elephants kept at Bali Zoo

Elephant Code	BK (%)	BO(%)	CP(%)	SK(%)	Lemak (%)	BETN (%)	TDN (%)
A	67,64	66,42	81,93	59,61	70,63	66,96	51,19
B	59,56	59,90	78,31	50,56	68,46	60,03	50,43
C	64,39	64,69	67,50	57,25	61,04	70,62	54,38
D	57,49	57,65	52,43	53,09	54,63	71,22	41,42
Average	62,27	62,17	70,04	55,13	56,19	67,21	49,35

Information: A= Lola B =Laras C = Tongkun D = Handayani

4 Conclusion

The conclusions of this study are the eating behavior of Sumatran elephants kept at the Bali zoo more often using the trunk to take and cutting food and occasionally cutting food using their forelegs. Elephants kept at the Bali zoo are fed twice a day, 20 kg in the morning and 80 kg. The average length of feeding in the morning is 53 minutes / day and the average length of eating in the afternoon is 366 minutes (5 hours) a day. Consumption of nutrients for Sumatran elephants kept in the Bali zoo is good, BK 30,848, CP 3,642, SK 9,578, LK 1,744 , The coefficient of nutrient digestibility of Sumatran elephants kept in Bali zoo is high, BK 62.27%, BO 62.17%, CP 70.04%, SK 55.13%, LK 56.19%. It can be suggested that further research is needed on the consumption and digestibility of Sumatran elephants by adding treatments among elephants to determine the effect of each treatment on Sumatran elephants.

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