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## CULTURE PERFORMANCE AND ECONOMIC PROFITABILITY OF CANTANG HYBRID GROUPER (*Epinephelus fuscoguttatus* f x *Epinephelus lanceolatus* m) FINGERLINGS REARED AT DIFFERENT INITIAL STOCKING SIZES AND NURSERY PERIODS

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### ABSTRACT

High production costs in grouper nursery can be caused by the use of large fingerlings size and long rearing times. The purposes of this study were to evaluate the culture performance and economic profitability of "cantang" hybrid grouper juveniles reared at different initial stocking sizes and nursery periods. This research lasted from September to December 2017 in one of small scale hatcheries in Buleleng, Bali, Indonesia. This study consisted of two experimental treatments; the first treatment was different initial stocking sizes (body weight and total length) of  $0.50 \pm 0.07$  g and  $3.0 \pm 2.1$  cm;  $3.50 \pm 0.67$  g and  $5.0 \pm 1.9$  cm; and  $6.10 \pm 0.91$  g and  $7.0 \pm 2.3$  cm. The second treatment was different nursery periods with the following arrangement: 15, 30, and 45 days (initial body weight and length of  $0.54 \pm 0.067$  g and  $3.0 \pm 0.09$  cm, respectively). The stocking density in all treatments was 1,000 fish reared in a 2 m x 2 m x 1 m concrete tank. The observed culture performance parameters consisted of survival rate (SR, %), daily growth rate (DGR, g/day), and feed conversion ratio (FCR). The calculated economic profitability parameters were net profit, return-on-investment (ROI, %), and return cost ratio (R/C). The highest culture performance was achieved by the juveniles reared using the largest initial stocking size and longest nursery period. This was in contrast with the economic profitability, in which smaller initial stocking size and middle nursery period had resulted in the highest profit. Based on the culture performance and profitability considerations, the suggested combination of initial stocking size and nursery period for cantang fingerlings is  $3.0 \pm 2.1$  cm initial stocking size and 30 days rearing times.

**KEYWORDS:** growth; production; return; profit, cantang, fingerlings

### INTRODUCTION

Groupers (*Epinephelus* spp.) are highly valued mariculture fish in the market, particularly when sold alive. Due to its economic profitability, the grouper industry has increased rapidly in the past decade and many grouper species have been widely cultured in China and South-East Asian countries (Guo *et al.*, 2015; Pierre *et al.*, 2008). The development of grouper culture has reached the level where hybridization technology using artificial spawning is used as one of the efforts to

increase farming productivity (Sun *et al.*, 2016). The Borneo Marine Research Institute in Sabah (Malaysia) had successfully developed a grouper hybrid from the female of *Epinephelus fuscoguttatus* and male of *Epinephelus lanceolatus* in 2006 (Ch'ng & Senoo, 2008), which probably makes up most of the Indonesian grouper production (Rimmer & Glamuzina, 2017). This hybrid is known in Indonesia as "cantang" hybrid grouper. Despite being one of the main grouper species cultured in Indonesia, cantang hybrid grouper culture still requires improvements in production efficiency.

Indonesia is one of the primary sources of grouper fingerlings for the Asia-Pacific region. Many grouper farmings have been developed in Indonesia, such as in the coasts of East Java, Northern Bali, Southern Sumatra, Northern Sumatra, and other areas (Rimmer & Glamuzina, 2017). Some of the grouper farms form

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an integrated industry with segmented grouper production systems. The segmentation divides the grouper industry into hatchery, nursery and grow out which are, in many cases, widely separated in terms of geographical locations (Komarudin *et al.*, 2004; Rimmer & Glamuzina, 2017). After transported out of a hatchery (2-3 cm in length), an intermediate rearing stage called nursing has to be undertaken before the fingerlings are ready (7-10 cm in length) to be stocked in a sea cage (Ismi *et al.*, 2012; Komarudin *et al.*, 2004). Grouper nursing can be carried out in on-shore tanks to prevent high mortality, which is usually located close to the hatchery of origin (Ismi *et al.*, 2012).

Grouper nursery requires appropriate and efficient rearing systems to maintain an optimal culture performance of the fingerlings. The combination of efficient production and good culture performance will generate high economic profitability for fish farmers who are involved in the nursery segmentation business. The initial stocking size and nursery times of fingerlings are the essential factors that affect production efficiency. For example, several studies on the influence of initial stocking size on the growth and production of marine fish have been reported such as on spotted rose snapper (*Lutjanus guttatus*) (Castillo-Vargasmachuca *et al.*, 2007) and pike-perch (*Sander lucioperca*) (Molnár *et al.*, 2004). The findings from both studies implied that the use of larger fingerlings and longer rearing period could lead to an increased production cost as well as other associated risks. Therefore, this study was carried out to evaluate the culture performance and economic profitability cantang hybrid grouper juveniles reared at different initial stocking sizes and nursery periods.

## MATERIALS AND METHODS

### Fish Origin and Husbandry

This research was conducted from September to December 2017 in one of small scale hatcheries in Kaliasem Village, Banjar District, Buleleng Regency, Bali Province, Indonesia. Cantang fingerlings with an average weight range of 0.5-6 g and length range of 3-7 cm were obtained from the Institute for Mariculture Research and Fisheries Extension Gondol, Bali, Indonesia; and reared in a 2 m x 2 m x 1 m concrete tank. Water salinity, temperature, and dissolved oxygen were kept between 33-34 g/L, 28.3°C-31.3°C, and 5.1-5.6 mg/L, respectively. A commercial fish feed (Otohime™, Japan) was used to feed the fish at satiation.

## Research Design

This study was arranged into two experimental activities. The first experiment consisted of different treatments of initial stocking sizes (weight and length) with three replicate for each treatment as follows: 0.50 ± 0.07 g and 3.0 ± 2.1 cm (treatment A), 3.50 ± 0.67 g and 5.0 ± 1.9 cm (treatment B), and 6.10 ± 0.91 g and 7.0 ± 2.3 cm (treatment C). The nursery period of the first study lasted for 30 days. The second experiment consisted of different rearing time treatments (three replicate in each treatment) as follows: 15 days, 30 days, and 45 days of nursery periods. The initial stocking sizes (weight and length) for the second experiment were 0.54 ± 0.067 g and 3.05 ± 0.09 cm. The stocking density for all treatments was set at 1,000 fish/tank.

## Observed Research Parameters

The observed parameters were culture performance and economic profitability parameters. The culture performance parameters consisted of survival rate (SR, %), daily growth rate (DGR, g/day), and feed conversion ratio (FCR) calculated based on the following formulas:

$$SR (\%) = 100 \times (\text{Final population} - \text{Initial population})$$

$$AGR (\text{g day}^{-1}) = \frac{(W_t - W_o)}{t}$$

$$FCR = \frac{\text{Total weight of feed consumption}}{(\text{Final biomass} - \text{Initial biomass})}$$

where:

$W_t$  is the mean final body weight,

$W_o$  is the mean initial body weight, and  $t$  is the mean of the nursery period

The economic profitability was calculated using the retail fish price in Bali, Indonesia, in 2017. The economic profitability parameters were net profit, return-on-investment (ROI, %), and return cost ratio (R/C) calculated based on the following formulas:

$$\text{Net profit} = \text{Total return} - \text{Total cost}$$

$$ROI (\%) = 100 \frac{\text{Net profit}}{\text{Total cost}}$$

$$R/C \text{ ratio} = \frac{\text{Total return}}{\text{Total cost}}$$

The obtained data were analyzed using variance analysis (ANOVA) with a 95% confidence level. Significance between applied treatments was identified using Duncan's test and statistical analyzes were performed using SPSS (version 17.0). The results were presented as means  $\pm$  SD (standard deviation).

**RESULTS AND DISCUSSION**

The treatments (initial stocking size sand nursery period) had significantly increased the survival rate, daily growth rate, and feed conversion ratio ( $P < 0.05$ ) of cantang hybrid grouper. The fish with larger initial stocking sizes had higher survival rates (Figure 1) and daily growth rate (Figure 2) but lower feed conversion ratio (Figure 3). Conversely, the fish reared in shorter nursery periods had higher growth rate (Figure 5) and feed conversion ratio (Figure 6) but lower survival rate (Figure 4).

Cost and return analysis based on the data of initial stocking sizes and nursery periods treatments are presented in Table 1 and 2. The major expenditures were accounted for fingerlings and feed of up to 70% of the total costs for each treatment. In the rearing experiment using different initial stocking

sizes, treatment A ( $0.50 \pm 0.07$  g size of fish) had yielded the highest net profit, return on investment (ROI), and R/C ratio compared to the other treatments. In the experiment using different nursery periods, treatment R2 (30 days of nursery period) yielded the highest net profit, return on investment (ROI), and R/C ratio compared to the other treatments.

Cantang hybrid grouper fingerlings reared at the largest initial stocking size had the highest survival rate (Figure 1). It is suspected that the low survival rate in the smaller stocking sizes of grouper fingerlings was caused by the high rate of cannibalism within this size group, a similar finding reported by Hseu (2002). In population dynamics, stadia or life cycle is one of the influential aspects responsible for fish cannibalism (Claessen *et al.*, 2004). Cannibalism increases during the early fish life then decreases when fish reach certain older ages forming a parabolic curve (Hecht & Pienaar, 1993). The higher survival in larger fish can also be attributed to the increase of the fish's body resistance to diseases and environmental fluctuations (Breuil, *et al.*, 1997; Magnadóttir *et al.*, 1999).

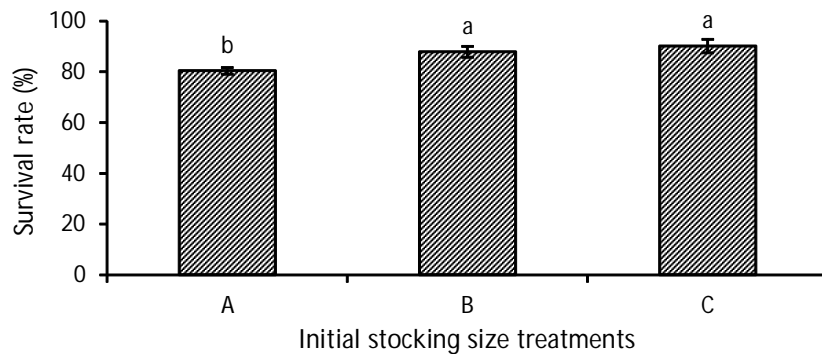


Figure 1. Survival rate of cantang hybrid grouper fingerlings reared at different initial stocking sizes for 30 days; (A)  $0.50 \pm 0.07$  g, (B)  $3.50 \pm 0.67$  g, and (C)  $6.10 \pm 0.91$  g size of fish treatment.

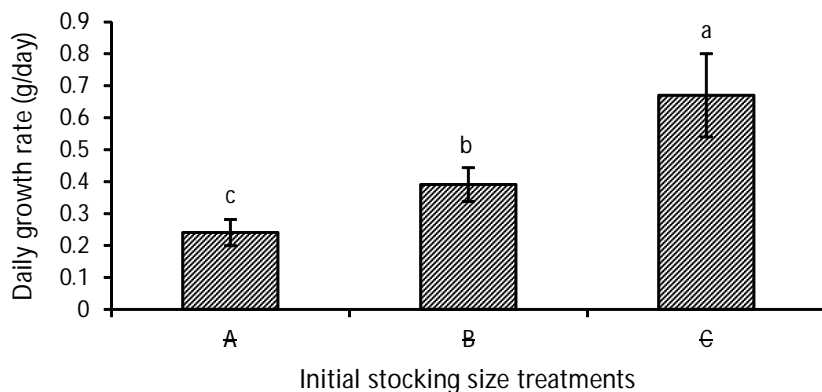


Figure 2. Daily growth rate of cantang hybrid grouper fingerlings reared at different initial stocking sizes for 30 days; (A)  $0.50 \pm 0.07$  g, (B)  $3.50 \pm 0.67$  g, and (C)  $6.10 \pm 0.91$  g size of fish treatment.

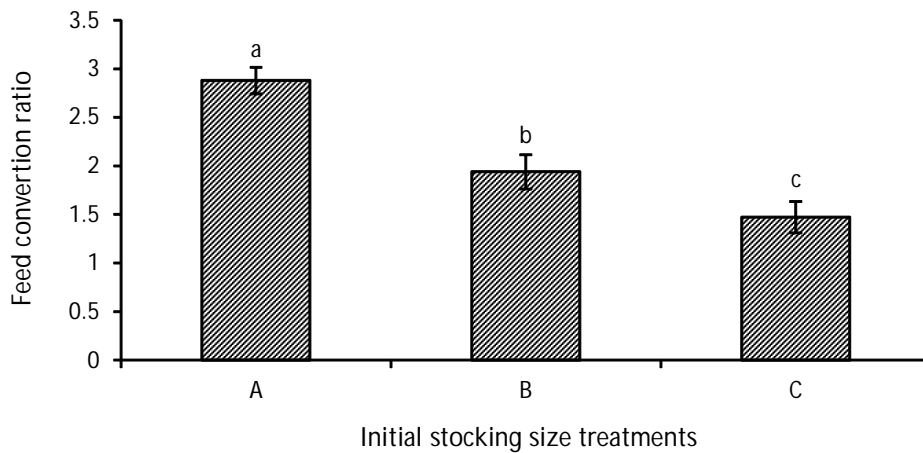


Figure 3. Feed conversion ratio of cantang hybrid grouper fingerlings reared at different initial stocking sizes for 30 days; (A)  $0.50 \pm 0.07$  g, (B)  $3.50 \pm 0.67$  g, and (C)  $6.10 \pm 0.91$  g size of fish treatment.

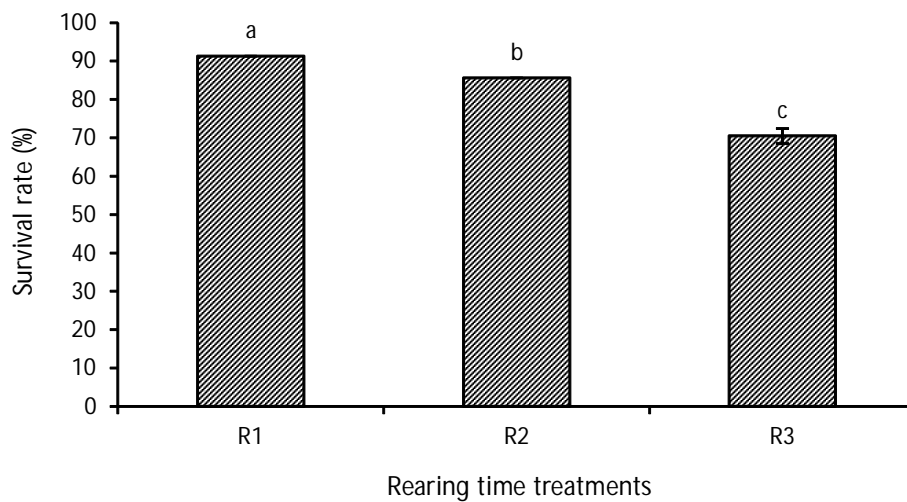


Figure 4. Survival rate of cantang hybrid grouper fingerlings reared with different periods; R1 = 15 days; R2 = 30 days; R3 = 45 days.

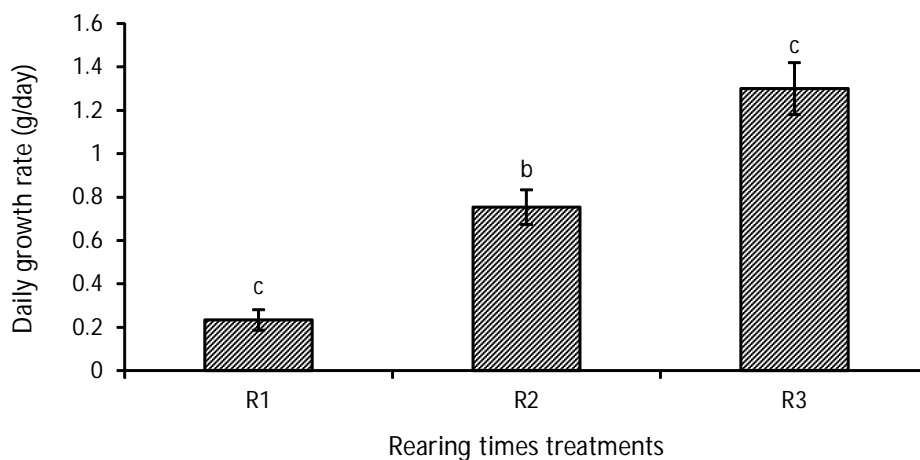


Figure 5. Daily growth rate of cantang hybrid grouper fingerlings reared with different periods; R1 = 15 days; R2 = 30 days; R3 = 45 days.

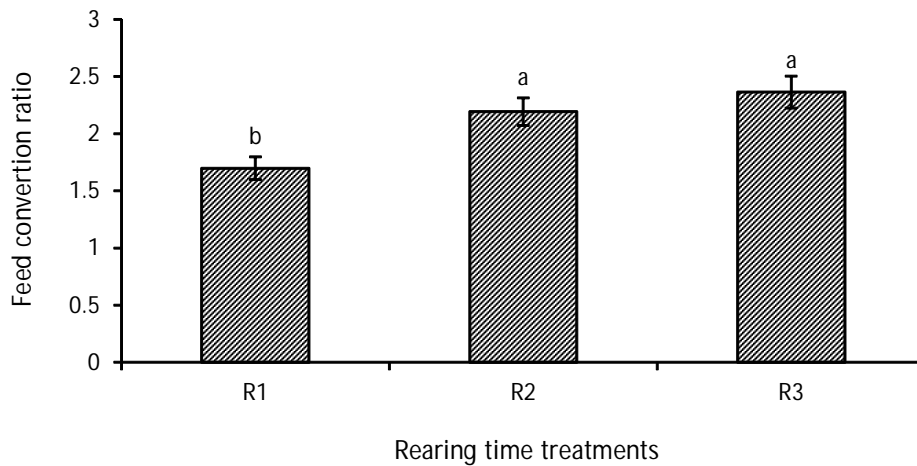


Figure 6. Feed conversion ratio of cantang hybrid grouper fingerlings reared with different periods; R1= 15 days; R2= 30 days; R3= 45 days.

Table 1. Comparison of economic advantages of cantang hybrid grouper (*Epinephelus fuscoguttatus* f x *Epinephelus lanceolatus* m) fingerlings reared at different initial stocking sizes for 30 days

Items	Price (x10 <sup>3</sup> IDR/unit)	Quantity			Unit	Total price (x10 <sup>6</sup> IDR)		
		A	B	C		A	B	C
<b>Costs</b>								
Fingerlings size A	2.10	9,700.00	-	-	fish	20.37	-	-
Fingerlings size B	3.25	-	9,700.00	-	fish	-	31.52	-
Fingerlings size C	4.55	-	-	9,700.00	fish	-	-	44.13
Feed: EP1	80.00	10.00	-	-	kg	0.80	-	-
Feed: EP2	60.00	20.00	20.00	-	kg	1.20	1.20	-
Feed: EP3	55.00	20.00	20.00	20.00	kg	1.20	1.10	1.10
Feed: EP4	45.00	-	20.00	30.00	kg	-	90.00	1.35
Feed: Skreting6	33.00	-	-	30.00	kg	-	-	0.99
Electric charge	2.00	500.00	500.00	500.00	kwh	1.00	1.00	1.00
Labor	1,500.00	1.00	1.00	1.00	work	1.50	1.50	1.50
Other costs	500.00	1.00	1.00	1.00	-	0.50	0.50	0.50
<b>Total costs</b>						<b>25.97</b>	<b>37.22</b>	<b>50.07</b>
<b>Return</b>								
Treatment A	4.55	7,799.00			fish	35.49	-	-
Treatment B	5.20		8,526.00		fish	-	44.33	-
Treatment C	6.50			8,817.00	fish	-	-	57.31
<b>Total return</b>						<b>35.49</b>	<b>44.33</b>	<b>57.31</b>
<b>Net Profit (x10<sup>6</sup> IDR)</b>						<b>9.51</b>	<b>7.11</b>	<b>7.23</b>
<b>Return-on-investment (ROI, %)</b>						<b>36.64</b>	<b>19.10</b>	<b>14.45</b>
<b>R/C Ratio</b>						<b>1.37</b>	<b>1.19</b>	<b>1.14</b>

Remarks: (A) 0.50 ± 0.07 g size of fish treatment; (B) 3.50 ± 0.67 g size of fish treatment; (C) 6.10 ± 0.91 g size of fish treatment

The larger initial stocking size was observed to have a higher absolute growth rate (Figure 2). For many fish species, growth is the continuous increase in the average body weight, which can be represented with an asymptotic sigmoid curve (Hopkins, 1992). The growth of fish in this recent experiment was very fast, particularly in treatment C (6.10 ± 0.91 g

size), which followed an exponential line compared to the other treatments.

The high growth rate in C treatment was also followed by a low FCR value, which means that fish in treatment C had a good feed conversion. This indicates that feed efficiency increases with increasing

Table 2. Comparison of economic advantages of cantang hybrid grouper (*Epinephelus fuscoguttatus* f x *Epinephelus lanceolatus* m) fingerlings reared with different nursery periods

Items	Price (x10 <sup>3</sup> IDR/unit)	Quantity			Unit	Total price (x10 <sup>6</sup> IDR)		
		A	B	C		A	B	C
Fingerlings size A	2.10	9,700.00			fish	20.37	20.37	20.37
Feed: EP1	80.00	10.00	10.00	10.00	kg	0.80	0.80	0.80
Feed: EP2	60.00	10.00	20.00	30.00	kg	0.60	1.20	1.80
Feed: EP3	55.00		20.00	20.00	kg	0	1.10	1.10
Feed: EP4	45.00			20.00	kg	0	0	0.90
Electric charge	2.00	250.00	500.00	750.00	kwh	0.50	1.00	1.50
Labor	1,000.00	1.00	1.50	2.50	work	1.00	1.50	2.50
Other costs	200.00	1.00	2.50	3.50	-	0.20	0.50	0.70
<b>Total costs</b>						<b>23.47</b>	<b>26.47</b>	<b>29.67</b>
<b>Return</b>								
R1 treatment	3.25	9,130.00			fish	29.67	0	0
R2 treatment	4.55		8,560.00		fish	0	38.95	0
R3 treatment	5.85			7,050.00	fish	0	0	41.24
<b>Total return</b>						<b>29.67</b>	<b>38.95</b>	<b>41.24</b>
<b>Net Profit (x10<sup>6</sup>IDR)</b>						<b>6.20</b>	<b>12.48</b>	<b>11.57</b>
<b>Return-on-Investment (ROI, %)</b>						<b>26.42</b>	<b>47.15</b>	<b>38.99</b>
<b>R/C Ratio</b>						<b>1.26</b>	<b>1.47</b>	<b>1.38</b>

Remarks: R1 = 15 days nursery period; R2 = 30 days nursery period; R3 = 45 days nursery period

fish's body size. Previous research on the relationship between body size and feed efficiency in channel catfish (*Ictalurus punctatus*) showed that feed efficiency increased to a certain size and then decreased with increasing size following a parabolic curve (Cacho *et al.*, 1990).

In general, the culture performance of cantang hybrid grouper reared with different initial stocking sizes showed better results in fish with a larger initial stocking size. However, the economic analysis shows contrasting results. The smaller initial stocking size resulted in higher profitability, which is evident in net profit, ROI, and R/C ratio values (Table 1). Even though the total economic return in the smaller initial stocking sizes is lower, the net profit is higher due to the lower total culture cost compared to the other treatments.

Long nursery periods produced a large final fish size, which means the price of the fish seeds is higher. However, the risk accompanied is high due to longer rearing time. For example, the survival rate of fish had dropped in the longer rearing time treatment (Figure 4) despite larger sizes mean that cannibalism decreases and fish immunity increases (Breuil *et al.*, 1997).

The longer nursery periods has resulted in a higher daily growth rate and feed conversion ratio (FCR) (Figure 5 and Figure 6). This means that growth increase is negatively correlated to the utilization of feed decreases, thus deem the practice is not economically profitable. The most profitable treatment is the medium nursery period treatment (30 days rearing times), which is indicated by the highest net profit, ROI, and R/C ratio (Table 2).

### CONCLUSIONS

The culture performance of cantang hybrid grouper nursing with the different initial stocking size and rearing periods was higher in the larger initial stocking size treatment and longer rearing time treatments. On the contrary, the smaller initial stocking size treatment and medium rearing period treatments have higher economic profitability in terms of return of profit. This research recommends that the best combination between initial stocking size and rearing periods is 3.0 ± 2.1 cm and 30 days rearing period, respectively.

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