INTRODUCTION

In Bali Island, there are two types of cattle breeds known, Bali cattle and Taro White cattle. The Bali cattle is cattle breed from Indonesia with potential as meat producer. While the Taro White cattle is a unique group cattle with a very small number of population and only can be found at Taro village, Gianyar Regency, Bali Province. They are kept by farmers in conservation management system (Sarini et al., 2020). Until now, the origin of this cattle is unknown, but the people of Taro believed that Taro White cattle calf they brought originally from India by the great Rishi Markandeya (Heryani et al., 2016).

Recently, the phenotype and genotype of Taro White cattle are subject to several research projects. Taro white cattle breed is least known cattle breed in Indonesia. Taro white cattle possess special features in their appearance and body characteristics. The Taro white calves are born with clear white coat colour that tends to change to a permanent pinky white and ivory white at six months of age. The white coat is the characteristic colour of Taro white cattle.
The Taro white cattle start grow horns at the first time at 3 to 4 months of ages. Males have more developed horn than females. The horns are warp and straight orientation. Based on the orientation there are 8 variation of horn types (Sarini et al., 2020). Calves born having eyes with pale irises around the pupil.

Taro white cattle are important cattle in Bali because their function in social culture roles for the Balinese people and in Bali Hindu ceremony. The Balinese people considered that Taro white cattle are sacred cattle (Pujaastawa and Suwena, 2013). All Taro white cattle regardless their sex, teeth dentition, or physiological status were treated well like human beings from the day of their births until deaths whether due to too old or newly born calves’ mortality or other reasons. Like a newborn in the beliefs of Balinese Hinduism, newborn calf or dead cattle are also made birth and death ceremonies under Balinese Hindu beliefs. In social culture roles, the people particularly at Taro Kaja Village considered that the animals were had roles in religious ceremonies and non-medical healing. Taro white cattle are not kept for consumption, so they have never been killed, slaughtered, sold, and not used as draught animals. Although the treatment of cattle is considered irrational, it is believed that this treatment will bring economic benefits and provides benefits for the environment. For instance, the community earns from wages obtained as compensation for maintenance as well as income in the form of donations from tourists visiting the place.

The Taro white cattle breeds in Bali have been subjected for a long process of natural selection, and they are tropically well adapted. However, these breeds are not well characterized adequately. Very little research has been done in uncovering on this breed. Perhaps of ignorance or not interesting to be investigated because these cattle cannot be utilized as meat production. Several documented scientific information have been written by some experts in the context of local wisdom behind the Taro white cattle myths (Pujaastawa and Suwena, 2013); morphometric characteristics (Heryani et al., 2016); challenge, and improvement of Taro white cattle (Yasa et al., 2015); forage management in supporting Taro white cattle conservation (Suarna et al., 2013); morphometric characters which included body weight, chest circumferences, body length, height at withers of animals. Body weight (kg) estimated and measured before morning feeding by using digital scale that had accuracy to 0.1 kg. Chest circumferences (cm): was a circumferential measurement taken around the chest just behind the front legs and behind the scapula. Body length (cm): was measured from scapula to the tuber ischii, by using stick measure that had accuracy to 0.1 cm. Height of withers is vertical distance from the surface of plane to the highest point in of the shoulder between withers (Vanvanhossou et al., 2018). The measurements were made using a cattle measuring stick.

The present study covered different morphological characters which included body weight, chest circumferences, body length, height at withers of animals. Body weight (kg) estimated and measured before morning feeding by using digital scale that had accuracy to 0.1 kg. Chest circumferences (cm): was a circumferential measurement taken around the chest just behind the front legs and behind the scapula. Body length (cm): was measured from scapula to the tuber ischii, by using stick measure that had accuracy to 0.1 cm. Height of withers is vertical distance from the surface of plane to the highest point in of the shoulder between withers (Vanvanhossou et al., 2018). The measurements were made using a cattle measuring stick.
RESULTS AND DISCUSSION

Dynamic flock size and composition of Taro white cattle
The present study counts the total population of 57 Taro white cattle being conserved at Taro Kaja Village (Table 1). This population indicated that there were increased from 30 cattle in 2010 reported by Dharmawan et al. (2010), then it increased by 15 cattle over the seven years (Suarna et al., 2017) then increase until 57 cattle in 2020. However, this population is still smaller compared to the population in 2001. Suarna et al. (2016) reported the population was 150 cattle in 2001. In December 2018, there were 52 Taro white cattle and in December 2019, there two old females were dead and seven calves were born. Based on current data, there are 15 productive females, it will be projected that in 2025 the cattle population will become 202 cattle. Within this population 65 productive female cattle are predicted. It means at the end of 2025 the Taro white cattle will be still considered as endangered species (Table 2).

The projection of the total number of productive cows is very important in the context of conservation of Taro White cattle. By analyzing the potential of productive females under conservation management system in the village of Taro Kaja, it will be estimated succeeded producing at least 100 productive females of Taro white cattle by 2027. This projection is different from the projections reported by Yasa et al. (2015). In year 2027, Yasa et al. (2015) estimated that the projection productive females of Taro white cattle were 104.

PRODUCTIVE POTENCY OF TARO WHITE CATTLE
No data were available on productive and reproductive performance of Taro white cattle. At the beginning of this study, data relating to productive potency were recorded. During the data collection, seven dams gave birth to seven calves with the average birth weight of 11.7 ± 0.18 kg (Table 3). The birth weight of this cattle in this study were found to be lower than the result of other studies of Bali cattle. In Bali cattle measurement average for birth weight were reported to be 18.0 ± 1.4 kg for male Bali calves and 17.9 ± 1.3 kg for female (Gunawan and Jakaria, 2011), 18.0± 1.4 kg for male Bali calves and 17.9 ± 1.3 kg for female (Setiyabudi et al.,2016) and 17.28 ± 0.93 kg in Bali cattle that raised in mountainous areas and 16.46 ± 0.40 kg in Bali cattle that raised in the lowlands (Pemayun et al., 2020) respectively. Suryani et al. (2017) also reported that provision higher level of energy ration fed to seven months of pregnancy of Bali cows improved birth weight of their calves ranging from 17.3 ± 0.8 kg to 18.0 ± 0.8 kg. The average of chest circumferences, body length, and height at withers of Taro white calves were 58.4 ± 2.25 cm, 63.0 ± 2.16 cm, and 55.9 ± 1.47 cm, respectively, and these measures were higher than Bali calves (Nugraha et al., 2016).

The productive potency in adult Taro white cattle compared to other indigenous cattle of Bali were lower might be due to differences of genetic make up of growth traits of different breeds. The morphometric measurements in adult cattle were variation existed might be due to differences of genetic make up of growth traits of different breeds or types and different feeding and management systems (Hadiuzzaman et al., 2010).

The average body weight for Taro white cattle dams was 206.5 ± 13.45 kg. In this study it was observed that size of

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Table 1: Dynamic flock size and composition of Taro white cattle from 2001 to 2020.

| Year | Total population (Head) | Composition of flock size |
|------|-------------------------|---------------------------|
| 2001 | 150                     | --                        |
| 2010 | 30                      | --                        |
| 2011 | 25                      | --                        |
| 2013 | 34                      | Productive females = 12   |
|      |                         | Bulls = 16                |
|      |                         | Female calves = 3         |
|      |                         | Male calves = 3           |
| 2014 | 34                      | --                        |
| 2015 | 42                      | Female calves (<1 year) = 6|
|      |                         | Productive female (1-2 year)|= 2   |
|      |                         | Productive females (2-3 year)| =3   |
|      |                         | Productive females (>4 year)|= 6   |
|      |                         | Male calves (<1 year) = 8  |
|      |                         | Bucks (>4 year) = 17       |
| 2016 | 33                      | Productive females = 16    |
|      |                         | Bulls = 8                 |
|      |                         | Young cattle = 9           |
| 2017 | 45                      | White bulls = 21           |
|      |                         | Black bulls = 4            |
|      |                         | Red bulls = 3              |
|      |                         | White females = 16         |
|      |                         | Red female = 1             |
| 2018 | 33                      | Productive females = 16    |
|      |                         | Bulls = 8                 |
|      |                         | Young cattle = 9           |
| 2019 | 57                      | --                        |
| 2020 | 57                      | Female calves (<1 year) = 6|
|      |                         | Young females (1-2 year) = 8|
|      |                         | Productive female (2 year) = 1|
|      |                         | Productive females (3-4 year)| = 3   |
|      |                         | Productive females (4-5 year)| = 11 |
|      |                         | Young male (1 year) = 1    |
|      |                         | Bulls (2-3 year) = 6       |
|      |                         | Bulls (3-4 year) = 6       |
|      |                         | Bulls (>4 year) = 15       |
Table 2: Projection of composition and flock size of Taro white cattle in 2025

| Year | Total population (Head) | Composition of flock size |
|------|-------------------------|---------------------------|
| 2025 | 202.5                   | Female calves (<1 year) = 21  
|      |                         | Young females (1-2 year) = 18.25  
|      |                         | Productive female (2-3 year) = 14.50  
|      |                         | Productive females (3-4) = 11.50  
|      |                         | Productive females (>4 year) = 7.5  
|      |                         | Productive females (5 year) = 6  
|      |                         | Productive females (6 year) = 8  
|      |                         | Productive females (7 year) = 1  
|      |                         | Productive females (8 year) = 3  
|      |                         | Productive females (9 year) = 11  
|      |                         | Male calves (10 year) = 21  
|      |                         | Young males (1-2 year) = 18.25  
|      |                         | Bucks (2-3 year) = 14.50  
|      |                         | Bucks (3-4) = 11.50  
|      |                         | Bucks (>4 year) = 7.5  
|      |                         | Bull (6 year) = 1  
|      |                         | Bulls (7 year) = 6  
|      |                         | Bulls (8 year) = 6  
|      |                         | Bulls (9 year) = 15  
| 2025 | 306                     | Productive females = 104  

Table 3: Morphometric measurements of calf and dam of Taro white cattle

| Physiological status | Parameters          | N  | Mean ± SEM | Min. | Max. |
|----------------------|---------------------|----|------------|------|------|
| Born calf            | Body weight (kg)    | 7  | 11.7 ± 0.18| 11.0 | 12.5 |
|                      | Chest circumferences (cm) | 7  | 58.4 ± 2.25| 53.0 | 69.0 |
|                      | Body length (cm)    | 7  | 63.0 ± 2.16| 58.0 | 72.0 |
|                      | Height at withers (cm) | 7  | 55.9 ± 1.47| 52.0 | 62.0 |
| Dam                  | Body weight (kg)    | 7  | 206.5 ± 13.45| 150.7 | 267.3 |
|                      | Chest circumferences (cm) | 7  | 152.0 ± 5.00| 138.0 | 179.0 |
|                      | Body length (cm)    | 7  | 114.1 ± 2.99| 104.0 | 124.0 |
|                      | Height at withers (cm) | 7  | 109.3 ± 1.87| 102.0 | 115.0 |

Table 4: The body morphometric measurements of Taro white cattle

| Parameters            | N    | Mean ± SEM | Range | Min.  | Max.  |
|-----------------------|------|------------|-------|-------|-------|
| Body weight (kg)      | 42   | 242.4 ± 12.2| 262.1 | 120.1 | 382.2 |
| Chest circumferences (cm) | 42  | 156.2 ± 2.7 | 73.6  | 114.8 | 188.4 |
| Body length (cm)      | 42   | 119.2 ± 2.1 | 50.0  | 89.4  | 139.4 |
| Height at withers (cm) | 42   | 115.2 ± 1.4 | 37.0  | 99.4  | 136.4 |

Table 5: Morphometric measurements of Taro white cattle for different sex and age.

| Parameter             | Sex | Body measurements (mean ± SE) by sex and age |
|-----------------------|-----|---------------------------------------------|
|                       |     | 1.5-2.0 year | 2.0-2.5 year | 2.5-3.5 year | >3.5 year |
| Bodyweight (kg)       | M   | 63.5      | 139.9 ± 23.5 | 227.4 ± 66.2| 318.4 ± 37.6|
|                       | F   | 144.1 ± 43.1| 150.7         | 174.4 ± 31.3| 229.6 ± 60.8|
| Chest circumferences (cm) | M   | 99.2       | 132.4 ± 10.7 | 154.4 ± 20.4| 170.5 ± 8.1|
|                       | F   | 130.4 ± 13.6| 138.6         | 138.5 ± 10.2| 157.1 ± 12.0|
| Body length (cm)      | M   | 67.2       | 97.8 ± 7.1   | 113.8 ± 12.7| 131.8 ± 4.3|
|                       | F   | 101.2 ± 10.9| 104.8         | 113.1 ± 4.8| 119.7 ± 9.1|
Height at withers (cm) M 80.4 104.7 114.8 ± 5.9a 124.2 ± 5.7b F 101.5 ± 5.6 106.4 105.6 ± 5.8a 112.4 ± 5.7a

Note: Different superscripts in the same row show a significant difference in order of 5% (P <0.05).

dams affects the calf birth weight. These results are in line with the results of research on the productive potential of cattle reported by Suryani et al. (2017). Productive potency in cattle is usually related to the size and age of the dams. The larger dams usually produce larger calves (Suryani et al., 2017).

**Body Linear Measurement of Taro White Cattle**

The descriptive analysis of the body morphometric measurements 42 individuals of Taro white cattle is presented in Table 4. The average of the body weight, chest circumferences, body length, height at withers of animals was 242.4 ± 12.2 kg, 156.2 ± 2.7 cm, 119.2 ± 2.1 cm, and 115.2 ± 1.4 cm, respectively.

The average of body linear measurement of males Taro white cattle was higher than of females Taro white cattle. This result was comparable to data that found in cow (Polak and Frynta, 2010). In this study, the age category not influenced the body linear measurements (p>0.05). There was no significant difference (p>0.05) in body weight, chest circumferences, body length and height at withers for different ages in female cattle (Table 5). However, ages of cattle showed significant effect on body weight, chest circumferences, body length and height at withers in male cattle (p<0.05). This difference of the body linear measurements was occurred due to females had complex functions than of males. This study was confirmed by Daza et al. (2014) who reported the average daily gain were higher in males than females.

There is a close relationship between body weight and body linear measurements. In this study it was revealed that Taro white cattle had strong positive correlations between chest circumferences with body weights and had the highest value of R² = 0.9749 (Figure 1). The correlation between chest circumferences with body weights in this study showed that same result was reported by Sahu et al. (2017). Generally, heart girth accepted as the most satisfactory single predictor of live weight in cattle (Lukuyu et al., 2016; Tebug et al., 2016; Ashwini et al., 2019). The correlations reported above are similar to other studies that found a correlation between body weight and chest circumferences of 0.75–0.88 (Doloksaribu et al., 2010; Zuraehmah and Enos, 2011; Dhanny et al., 2015). To ensure high prediction accuracy, it was necessary to include chest circumferences traits for body weight estimation.

**CONCLUSION**

The present study provides the first prominent published body linear measurements of Taro white cattle. From the results, it was clear that all body linear measurements of Taro white cattle significantly increased with the advancement of age in male. However, there were no significant differences in body linear measurement in female cattle. The average of body linear measurement of males Taro white cattle was higher than of females Taro white cattle. The chest circumferences measurement can be used to predict the live body weight of Taro white cattle.

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**CONFLICT OF INTEREST**

The authors declare that there is no conflict of interest.

**AUTHORS CONTRIBUTION**

All the authors contributed significantly to the paper. Anak
Agung Oka designed the study, analyzed and interpreted the data, and drafted the manuscript. I Gusti Agung Arta Putra, I Wayan Suarna, Lindawati Doloksaribu, I Ketut Puja, collected the data and also contributed to manuscript preparation.

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December 2020 | Volume 8 | Issue 4 | Page 198