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Short Communication: Photogrammetric analysis of the number and pattern of dorsal cranium scale of juvenile green iguana (*Iguana iguana*)

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[4]Division of Veterinary Reproduction, Faculty of Veterinary Medicine, Universitas Airlangga. Kampus C, Jl. Dr. Ir. H. Soekarno, Mulyorejo, Mulyorejo, Surabaya 60115, East Java, Indonesia
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Abstract. *Ramadhani BF, Yuliani MGA, Hendarti GA, Palupi TDW, Rosyada ZNA, Soeharsono, Luqman EM, Srianto P, Dhamayanti Y, Setiawan B. 2024. Short Communication: Photogrammetric analysis of the number and pattern of dorsal cranium scale of juvenile green iguana (*Iguana iguana*). Biodiversitas 25: 264-268.* Pet animals can significantly positively impact mental health and reduce feelings of loneliness. Due to the large number of pets under care, there is a need for an efficient and effective method of pet identification. Thus, this study aims to identify changes in the dorsal cranium scale of juvenile green iguana (*Iguana iguana* (Linnaeus, 1758)) less than one year old. Dorsal cranium scales of juvenile green iguanas identified the number and pattern. Photo identification was examined for 18 green iguanas four times from the Faculty of Veterinary Medicine, Universitas Airlangga, Indonesia, at 12 weeks old, 14 weeks old, 16 weeks old, and 18 weeks old. The photo was taken on a studio set, focusing on the cranium of the green iguana to get the scale pattern correctly. Photo identification was taken to find scale number and pattern determinants by analyzing the app I^3S. We collated and analyzed the weekly data to test hypotheses using repeated measure ANOVA analysis in IBM SPSS 23. The data showed that the number of scales of the dorsal cranium was stable during the four photos taken, and each individual could be the same in the number of scales. The pattern of dorsal cranium scales has a stagnant pattern for each individual, and each individual is different at scale patterns, so photo identification as individual identification is possible. However, it is not possible to use it to identify the age of the iguana.

Keywords: Biometric, dorsal cranium, *Iguana iguana*, mental health, pattern

INTRODUCTION

The green iguana, often known as the American iguana (*Iguana iguana* (Linnaeus, 1758)), is indigenous to South and Central America. This iguana has been brought to multiple nations (Thomas et al. 2013; van den Burg et al. 2022). Approximately 17,000 islands with diverse sizes, geological origins, and distinct flora and fauna make up the archipelagic republic of Indonesia. One of the Earth's megadiversity centers is thought to be Indonesia. According to the Biodiversity Action Plan for Indonesia, around 1,100 species, or sixteen percent of all amphibian and reptile species, are found in Indonesia. The green iguana is one of the reptiles found in Indonesia. The green iguana has a huge number, but it also proposed measures for better long-term conservation (Iskandar and Erdelen 2006). Indeed, throughout the past 20 years, the number of descriptions for reptile species has expanded dramatically (Uetz et al. 2022).

Pet reptiles are popular in Indonesia. Their unique traits make reptiles like the green iguana popular. In metropolitan neighborhoods, most households have green iguanas as pets. Companion animals can improve mental health and reduce isolation (Ratschen et al. 2020). The pet trade has expanded beyond domesticated animals such as dogs (*Canis lupus* subsp. *familiaris* (Linnaeus, 1758)) and cats (*Felis catus* (Linnaeus, 1758)), encompassing the sale of wild animals to keep them as pets. Although the green iguana may be intimidating, it is a herbivorous reptile that mostly consumes plant matter, including vegetables and fruits. The distinctive characteristics of green iguanas make them a popular choice for pet owners (Putranto et al. 2017).

The rising number of animal caretakers makes it necessary to collect pet identity data to help owners recognize their pets. This is done via marks. Tattoos, ear clips, and ear tags can harm tissue and cause animal misery. Ear tags can break or corrode, causing illness at the attachment site (Norton et al. 2014). Biometrics on animals is another technique that can be employed in marking. Animal biometrics is a method used to categorize animals in data by analyzing their physical characteristics or identifying features, such as through photographs or visual records. Animal biometrics is a non-intrusive technique that does not induce discomfort or alter the physical look of the animal.

The growth and enlargement of the green iguana's body weight and size will result in a significant change in scale for this reptile. The frequency of scale changes in adult green iguanas is approximately every 4-6 weeks. However, in juvenile iguanas under 3, this interval can be shorter, ranging from 2 to 3 weeks (Kaplan 2014). There is no specific age requirement for biometric identification. As long as there are no changes in the number and pattern of the observable parts used for identification, individuals of any age can be identified (Kumar and Singh 2017). Previous research has yet to investigate the process of identifying the age of juvenile green iguanas by examining their scales. Hence, it is imperative to conduct a comprehensive analysis to ascertain and distinguish the growth and variations in the quantity and arrangement of dorsal scales on the cranium of juvenile green iguanas. Developmental identification is conducted to assess any variations in the quantity and arrangement of green iguana scales over time, using a two-week interval for scale changes. Additionally, this study aims to determine if there are discrepancies in the quantity and arrangement of scales among individual iguanas. Variations in the quantity and arrangement of each person will generate a biometric identity that is valuable for individual recognition.

MATERIALS AND METHODS

Materials

The material used in this study was green iguana juveniles at the Faculty of Veterinary Medicine, Universitas Airlangga, Kampus C Mulyorejo, Surabaya, Indonesia. The study used a group of twelve green iguana juveniles obtained from the same parent aged between 12 and 18 weeks. During the study, green iguana seedlings were fed with kale and sprouts ad libitum. Green iguana juveniles are given time to bask in the sun in the morning. This study utilized measurement tools such as a camera with a 90mm macro lens (Sony α90, Tokyo, Japan), supporting equipment like a tripod, cloth for the background, and additional lighting such as a flashlight.

Data acquisition

The study was conducted by taking photos of the dorsal part of the cranium of the iguana juveniles with previous handling. Handling was done by pinching the front legs of green iguana juveniles with their hands and then placing the part to be photographed on the photo table. The position of the camera when shooting is done right above the cranium of the juvenile green iguanas at a distance of 30 cm. The head scales were chosen for research due to the unique skin growth pattern and plate-shaped morphology, which make them easier to examine. Each iguana sapling's number and pattern dorsal cranium scale were measured by taking a photo from the dorsal cranium, including the boundary between the snout on the cranial side and the caudal nuchal, as shown in Figure 1. The number of scales is on the dorsal part of the cranium of the juvenile green iguanas. At the same time, the scale pattern is the pattern of the arrangement of scales on the dorsal aspect of the cranium of the juvenile green iguanas.

This research is observational, with direct observation of the location determined by purposive sampling. Data were collected by taking pictures of the dorsal cranium of green iguana juveniles and repeated shots every two weeks from 12 weeks, 14 weeks, 16 weeks, and 18 weeks. Pictures were taken by handling and fixing the green iguana juveniles first. Taking pictures using the camera. The collected images are processed with software to determine the pattern of green iguana juveniles' cranium scales. Thus, ethical clearance is not required for this study because this study does not harm the animals used and is minimally invasive.

Data analysis

To determine the difference in the pattern of the cranium scales of green iguana juveniles using the Interactive Individual Identification System Software (I3S) GNU public license v2. At the same time, the data achieved from the anatomy observation was analyzed descriptively. The Kolmogorov-Smirnov test was used to determine whether the study's data were normally distributed ($P>0.05$). The differences in pattern scores at each age were tested using repeated measures and analyzed using One-way ANOVA statistics. If there was a significant difference ($P<0.05$), this analysis proceeded to a Post Hoc test for group comparison.

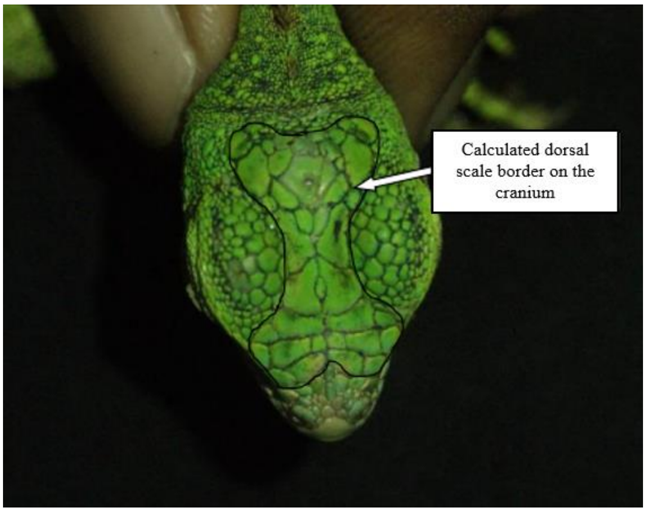

Figure 1. The measured border of the number and pattern dorsal cranium scale of each juvenile green iguana (*I. iguana*) from the dorsal cranium, including the boundary between the snout on the cranial side to the caudal nuchal

RESULTS AND DISCUSSION

Number of dorsal cranium scales of juvenile green iguana

The dorsal scales of the heads of juvenile green iguana across various age groups were observed for this study (Table 1). The processes of calculation and juvenile green iguana scale counting are performed manually using the photographs that have been captured. 47, 46, 52, 48, 45, 45, 47, 55, 51, 46, 47, and 48 were the respective number of scales on the cranium of juvenile green iguana (*I. iguana*) juveniles 1 through 12. The result of the number of dorsal cranium scales of juvenile green iguanas was sound in Table 1. The quantity of scales remains constant from 12 weeks to 18 weeks of age. This finding indicated that the green iguana's cranium does not develop more dorsal scales as it ages.

The scale patterns of the dorsal cranium of juvenile green iguana (*I. iguana*)

A comparative analysis of two photographs of the juvenile green iguana cranium was conducted to examine its dorsal scale pattern. The photographs in question are of the same iguana, specifically iguana 1 and iguana 1'. This method is utilized to ascertain the degree of disparity in scores between the two photographs of the identical individual. Then, the photographs of green iguanas at ages 12 to 18 were compared to photos of iguanas at age 12 using I^{3}S software. The difference score results were produced by utilizing the I3S program. This was achieved by comparing patterns on the same individual utilizing 2 distinct pictures and then individual green iguanas each week compared to week 12, as shown in Table 2. Moreover, the dorsal scale arrangement alterations of the Iguana juvenile's cranium from 12 to 18 weeks of age were examined by comparing photographs of iguanas at 12 weeks using I^{3}S software, as shown in Table 2. A repeated measure ANOVA test was conducted to analyze the variation in scale patterns between the ages of 12 and 18 weeks. Prior to the test, normality was assessed as a precondition. If the data passed the sphericity test, it was then used to determine whether the null hypothesis (H0) or the alternative hypothesis (HA) should be accepted. The available data demonstrated normality with statistical significance levels of 0.321, 0.261, and 0.802 ($P>0.05$). The examined data satisfies the assumption of sphericity, which is important in making the decision. The sphericity assumption has a significance value of 0.125, which is larger than the threshold of 0.05. The analysis utilized repeated measures ANOVA, preceded by a normality test as a requirement. The findings indicated no significant alteration in the number of scales ($P>0.05$) but only in size when the shooting time changed, specifically in relation to the dorsal scale pattern of the green iguana juvenile's cranium.

Discussion

According to Sacchi et al. (2010), the photographic identification technique marks and measures amphibians and reptiles. This low-cost and minimally invasive approach enables the identification of individuals over longer periods. The scales present on the surface of reptiles are leveraged for photographic identification. While the quantity and shape of scales may vary between individuals, the count and distribution of scales in certain body areas can be accurately ascertained, such as the abdominal scales in lizards and the cranium scales in saurians and ophidians.

The head scales of lizards were chosen as the research object because their skin does not follow the growth of their body. Additionally, the plate-shaped scales on the head make calculating and examining their morphology easier (Rutland et al. 2019). The difference in the number of scales on the dorsal cranium of juvenile green iguanas varies due to two main factors: bilateral asymmetry and fragmentation of the scales. Bilateral asymmetry refers to a condition where the number of scales on each side of the cranium of a young iguana is different, while fragmentation is a condition where the scales are broken into several small parts. This asymmetry is common among reptiles (Brown et al. 2017). The findings of this study showed that the number of scales on the cranium of a green iguana does not increase as it ages.

Table 1. The number of dorsal scales on the cranium of juvenile green iguana from 12-18 weeks of age

Age (weeks)	12	14	16	18
Iguana 1st	47	47	47	47
Iguana 2nd	46	46	46	46
Iguana 3rd	52	52	52	52
Iguana 4th	48	48	48	48
Iguana 5th	45	45	45	45
Iguana 6th	45	45	45	45
Iguana 7th	47	47	47	47
Iguana 8th	55	55	55	55
Iguana 9th	51	51	51	51
Iguana 10th	46	46	46	46
Iguana 11th	47	47	47	47
Iguana 12th	48	48	48	48

Table 2. I3S score data juvenile green iguana cranium dorsal scales pattern for each age

Age (weeks)	12	14	16	18
Iguana 1st	0	19.04	19.03	10.04
Iguana 2nd	0	15.37	09.46	19.67
Iguana 3rd	0	16.88	18.87	19.14
Iguana 4th	0	14.67	08.43	25.70
Iguana 5th	0	11.43	22.54	20.87
Iguana 6th	0	1.76	21.05	25.99
Iguana 7th	0	1.88	22.23	29.77
Iguana 8th	0	09.23	10.04	25.44
Iguana 9th	0	10.06	13.24	22.49
Iguana 10th	0	20.89	19.38	18.42
Iguana 11th	0	22.29	15.54	16.94
Iguana 12th	0	18.45	14.07	21.22

Notes: Significance = $P>0.05$

However, the size or pattern of the scales does increase. Similar to Chang et al. (2009), the arrangement and number of scales in reptiles are specific and stable, so they are not often used as characteristics to determine species classification. The number of scales on the green iguana remains consistent throughout its life, providing hope that the pattern and scales on the dorsal cranium of the iguana will not change much as it ages. This consistency makes it possible to use the pattern and scales on the dorsal cranium as a recognition mark to identify individual iguanas. Such identification can be used as a fingerprint for the green iguana species, making identifying specific individuals easier.

The arrangement and number of scales in reptiles are distinct and consistent, making them helpful in identifying and classifying different species (Chang et al. 2009). The pattern of dorsal cranium scales in each iguana sapling is unique, similar to the pectoral scales found in the European Lizard (*Podarcis muralis* (Laurenti, 1768)). These scales can be used to identify individuals, much like fingerprints. Since the pectoral side of the European lizard does not have many unique shapes, such as dangling or wavy, it is easier to take stable photos of it (Sacchi et al. 2010; Rocha et al 2013). Tomke and Kellner (2020) have proposed that asymmetrical dorsal scales in lizards could be an alternative to fingerprints for individual identification. This technique can be extended to other species, such as phynosomatids, iguanas, liolaemids, lacertids, and other Short-tail Lizards (*Phrynosoma braconnieri* (Bocourt, 1870)) by using the dorsal part as a distinguishing feature.

The I3S software is used for identification processing. It produces consistent and reliable results by comparing different photos of an individual. The I3SS application is user-friendly and can be used by both experienced individuals and beginners. The I3S software is recommended for identifying unique reptile scale patterns (Treilibs et al. 2016). In line with this study, I3S software generates scores that indicate a match or high similarity between the photos of the cranium dorsal scale of a juvenile green iguana. The differences are slight or insignificant even when comparing photos of the same individual taken at different times. Therefore, it can be concluded that the individual scale number remains the same over time except for the pattern size of the scale, even though it does not differ significantly. This indicates that the dorsal scale pattern of the green iguana cranium can be used to recognize individuals within the species.

To determine if the pattern of dorsal scales on the craniums of juvenile green iguanas changes over time, a thorough analysis and examination of any differences in the pattern as it develops need to be conducted. A repeated measures ANOVA, preceded by a normality test, was used for this. The results showed no significant changes in the pattern of dorsal scales on the craniums of juvenile green iguanas during their growth. This finding was also in line with the study conducted on European Vipers (*Vipera berus* (Linnaeus, 1758)), which found that their cranium scale pattern did not change after being observed and identified for 2-3 years (Bauwens et al. 2018). Furthermore, during the growth process, Iguana scales only gain in thickness and length but not in the number of scales (Breuil et al. 2020; Antonini et al. 2023). Yang et al. (2019) also propose no discernible variations in scale attributes, as evidenced by the scales' size and position being relatively unobtrusive in *Dracaena guianensis* Daudin, 1801. Since most juvenile scales blend in with the appearance of adjacent scales, it is improbable that conspecifics will notice differences.

Moreover, the dorsal cranium scales of the green iguana can be used as a means of individual identification because the cranium scales of juvenile green iguanas tend to be stable like fingerprints in humans, and the turtle version of the I^{3}S application can be used as an identification of the pattern of the dorsal cranium of the green iguana. Thus, it could be concluded that the number of dorsal scales on the cranium of juvenile green iguanas is always the same at each age. The pattern of the dorsal scales of the green iguana's cranium did not have a significant difference in each age growth of the juvenile green iguanas, and it can be concluded that the scale pattern tends to be the same at each age. The number of dorsal scales of juvenile green iguanas varies; some individuals have the same number of dorsal scales and can differ from other juvenile green iguanas. The pattern of the dorsal scales of the cranium of the juvenile green iguanas differs in each individual.

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