



Study of *dogania subplana* acclimatization in the turtle learning center university of bengkulu



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ABSTRACT

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The forest softshell turtle (*Dogania subplana*) is a species increasingly threatened by habitat destruction and overexploitation. This study aims to identify the acclimatization process of *D. subplana* in an artificial environment, specifically, an aquarium at the Turtle Learning Center (TLC). The research was conducted over 30 days from July to August 2024. Observations were made on daily behavior, body temperature, and health condition, individual biometric measurements, and environmental (abiotic) parameters. The results showed that daily behaviors such as feeding, basking, and hiding occurred regularly, indicating the species' ability to adapt to a new environment. The turtles experienced an increase in body weight, while growth in carapace length and width was very slow. The body temperature of *D. subplana* varied in accordance with the surrounding environmental temperature, reflecting its dependence on ambient conditions. Some individuals experienced minor health issues, such as fungal infections, but the majority remained active and healthy. Environmental factors such as temperature, humidity, pH, dissolved oxygen, total dissolved solids, and light intensity were within ranges conducive to acclimatization. These findings suggest that the aquarium at the TLC is quite effective as an ex situ conservation facility in supporting the adaptation process of *D. subplana* outside its natural habitat.

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INTRODUCTION

The softshell turtle is a type of freshwater turtle from the family Trionychidae, which is widely distributed across Asia, Africa, and North America. Trionychidae consists of two

subfamilies: Trionychinae, which includes 11 genera with 21 species, and Cyclanorbinae, which includes 3 genera with 6 species (Munawaroh, 2021). A study by Raid & Arya (2022) states that there are five Trionychidae species found in Indonesia: the painted batagur (*Chitra chitra*), the forest softshell turtle (*Dogania subplana*), the New Guinea giant softshell turtle (*Pelochelys bibroni*), the Cantor's giant softshell turtle (*Pelochelys cantorii*), and the Asiatic softshell turtle (*Amyda cartilaginea*). Trionychidae are known for their soft shells, flattened bodies, and tube-shaped noses that facilitate breathing at the water's surface (Nugroho et al., 2020). These turtles are commonly found in calm waters such as rivers, lakes, or swamps, and they play an essential role in maintaining the balance of aquatic ecosystems.

One of the species from this family is *Dogania subplana*, which belongs to the Cyclanorbinae subfamily and is native to Southeast Asia (Munawaroh et al., 2021). *Dogania subplana* can be found in the Sumatra region, including in Pal Tujuh Village, Rejang Lebong Regency. This species has distinct morphological features such as an oval and flat carapace, a large head with a small snout, and a short nasal stalk pointing downward. Other characteristics include two to three pairs of black spots on the carapace, a longitudinal black stripe on the dorsal side, and reddish coloration on the cheeks and neck. The carapace can grow up to 30 cm long and has a pale brown or yellowish-green hue, while the plastron is cream or gray in color (Suryawinata et al., 2025). Its natural habitat includes calm water bodies such as slow-flowing forest streams in mountainous areas. This omnivorous species mainly feeds on fish, shrimp, other aquatic organisms, algae, and fallen fruits. The female *D. subplana* lays between 3 to 7 eggs per year, with egg diameters ranging from 22 to 31 mm (Irham et al., 2011).

The presence of *D. subplana* in the wild is vital to aquatic ecosystems as it helps regulate insect and small fish populations and contributes to organic decomposition through its opportunistic feeding behavior. This species supports the balance of the food chain and helps maintain water quality. However, *D. subplana* is increasingly threatened by human activities such as habitat destruction, river pollution, and overharvesting for consumption and trade. *D. subplana* is listed in Appendix III of CITES and is categorized as Vulnerable by the IUCN (Raid & Arya, 2022). These circumstances raise serious concerns about its survival in the wild, underscoring the need for appropriate protection and conservation measures to prevent extinction.

One such effort is ex situ conservation, which involves maintaining wildlife outside their natural habitats. The University of Bengkulu, through TLC, supports ex situ conservation by providing educational and research facilities for various Sumatran turtle species, including *D. subplana*. TLC is equipped with four aquarium units designed to mimic natural habitats, complete with sand, rocks, and aquatic plants to support the adaptation and survival of *D. subplana* in artificial environments.

Several studies have indicated that the acclimatization process in aquatic reptiles can affect fundamental behaviors such as feeding patterns, locomotor activity, and shelter preferences (Wilson et al., 2019). Acclimatization is not only influenced by temperature factors but also by lighting, noise levels, substrate types, and spatial limitations in artificial environments (Chen et al., 2022). Adjustment to aquarium conditions is often accompanied by physiological changes, such as fluctuations in body weight, alterations in carapace coloration, and respiratory disorders, especially in sensitive species (Kusrini et al., 2021). Semi-aquatic reptiles like *D. subplana* are highly dependent on stable temperatures and water quality, so artificial environments must be carefully regulated to support optimal adaptation (Rahman et al., 2020). Failure in acclimatization can lead to chronic stress, marked by decreased activity, loss of appetite, and even death (Putra & Widodo, 2023).

In ex situ conservation efforts, acclimatization is a crucial phase that must be properly managed. Acclimatization refers to the process of animals adjusting to environmental changes,

especially when being transferred from the wild to artificial settings like aquariums. *D. subplana* is known to be sensitive to changes in temperature, pH, and habitat structure, making this adjustment process essential for maintaining its physiological and behavioral stability. If done improperly, sudden changes can cause stress, bodily dysfunction, or even death. Therefore, acclimatization is a key step to minimize such risks and support the species' successful adaptation to new environments (Arif et al., 2020). This study aims to identify the acclimatization of *D. subplana* in an artificial aquarium environment at the TLC, University of Bengkulu, as part of an ex situ conservation initiative.

RESEARCH METHODS

Research Design

This research is a quantitative descriptive study conducted over a period of 30 days, from July to August 2024, at the TLC, University of Bengkulu. The tools used in this research included various instruments for measuring abiotic parameters as well as documentation equipment. These instruments comprised a digital scale, caliper, lux meter, thermometer, hygrometer, Dissolved Oxygen (DO) meter, Total Dissolved Solids (TDS) meter, and a digital infrared thermometer. In addition, a camera and writing tools were used for recording and documentation purposes. The materials used consisted of eight *D. subplana* individuals, freshwater, and aquariums of various sizes as maintenance media.

Procedures

The research was carried out through three main stages: the preparation of the aquariums and *D. subplana* individuals, maintenance, and observation of daily behaviors, biometric data, body temperature, and health conditions of *D. subplana*, as well as environmental (*abiotic*) parameters. The first stage was the preparation of the aquariums and the *D. subplana* individuals. Four aquariums of different sizes were prepared: Aquarium 1 (76.3 × 41.3 × 46 cm), Aquarium 2 (99.3 × 41.4 × 45.3 cm), and Aquariums 3 and 4 (each measuring 90.1 × 36.1–36.2 × 35 cm). Each aquarium was checked for leaks and sterilized using natural materials such as papaya leaves and banana stems (Hidayati et al., 2022). Substrate arrangement using river sand and rocks was done to mimic the natural habitat, while aquatic vegetation was added sufficiently to support the ecological needs of the species (Suardita et al., 2018). Each aquarium was covered with 70% paranet to maintain appropriate light intensity and stable temperature.

Once the aquarium environments were ready, the next step involved the collection and grouping of *D. subplana* individuals from their natural habitat in Pal Tujuh Village, Rejang Lebong Regency. Individuals were collected by hand-catching and placed into plastic boxes lined with damp cloth to retain moisture during transport. Air circulation was maintained by opening the boxes every 10–20 minutes. Upon arrival at TLC, the *D. subplana* individuals were gradually acclimatized by keeping them in the boxes for an hour before transferring them to the prepared aquariums.

The initial setup involved placing ten *D. subplana* individuals into four aquariums at the TLC, University of Bengkulu. Aquariums 1, 2, and 3 each contained two individuals, while Aquarium 4 housed four individuals. During the pre-treatment phase (July 15–25, 2024), preliminary observations were made on water temperature, pH, and adaptive behaviors. However, on the 10th day, two individuals in Aquarium 2 were found dead, allegedly due to stress from relocation, excessively high temperatures, and low food intake. Therefore, the main research continued with the remaining eight individuals. Redistribution was conducted evenly across three aquariums according to the size of each space, and acclimatization observations were continued for

30 days starting from July 26, 2024. The final distribution of individuals across the aquariums is presented in Table I.

Table I. Arrangement of Eight *D. subplana* Individuals

Aquarium	<i>D. subplana</i>	Description
I	L1	Softshell turtle number 1
	L2	Softshell turtle number 2
II	L3	Softshell turtle number 3
	L4	Softshell turtle number 4
	L5	Softshell turtle number 5
III	L6	Softshell turtle number 6
	L7	Softshell turtle number 7
	L8	Softshell turtle number 8

The second stage was the maintenance phase, which was carried out routinely throughout the acclimatization period, as shown in Figure 1. The individuals were fed twice a week (on Mondays and Fridays) with juvenile catfish (*Clarias batrachus*) and freshwater shrimp (*Palaemon paucidens*) at four feeding times: 08:00, 12:00, 16:00, and 19:00. Water changes were performed regularly to maintain the quality of the aquarium environment. In addition, leftover food, dried leaves, and animal carcasses that could contaminate the water were also removed during cleaning.

Observations were conducted to measure several key indicators during the acclimatization process. The observed indicators included daily behaviors such as the frequency of feeding, basking, and hiding during morning, noon, afternoon, and night. Additionally, the depth at which individuals buried themselves in the aquarium substrate was observed as a response to environmental conditions. The body temperature and health condition of *D. subplana* were recorded using an infrared thermometer, along with visual observations of physical symptoms such as fungal infections and reactions to environmental stimuli. Biometric indicators measured included body weight, carapace length, and carapace width to monitor physical development throughout the adaptation process. Meanwhile, environmental parameters measured included air and water temperature, humidity, light intensity, water pH, dissolved oxygen (DO), and total dissolved solids (TDS), as external factors that may affect acclimatization success. All collected data were systematically recorded and analyzed descriptively to provide a comprehensive overview of *D. subplana*'s responses to the aquarium environment during the 30-day research period.



Figure 1. Maintenance of *D. subplana*: (A) Feeding, (B) Water Replacement, (C) Aquarium Cleaning

The third stage involved the observation of daily behavior and hiding depth of *D. subplana*, body temperature, and health condition, as well as environmental parameters. These observations

were conducted simultaneously every week over the 30-day research period. The behavioral aspects observed included feeding activity, basking, and hiding. Additionally, the depth to which individuals dived or buried themselves in the aquarium substrate was recorded to understand *D. subplana*'s responses to environmental conditions.

Biometric measurements of *D. subplana* individuals were carried out at the end of the acclimatization process to assess their development over the four-week period, with the measured parameters including body weight, carapace length, and carapace width. All data obtained from behavioral observations, body temperature and health assessments, environmental parameters, and biometric measurements were systematically recorded on observation sheets, then analyzed descriptively to provide a general overview of the acclimatization period.

Data Analysis

The data were analyzed using a quantitative descriptive approach, presenting the results in the form of graphs, tables, and narratives. The averages, value ranges, and trends of each parameter were observed to provide a comprehensive overview of the acclimatization process of *D. subplana*. Behavioral data, body temperature, and growth were analyzed to identify adaptation patterns in the artificial environment.

RESULTS

Daily Behavior of *D. subplana*

Observations of the daily behavior of *D. subplana* during acclimatization in the artificial aquarium habitat were conducted over a 30-day period at the TLC, University of Bengkulu. The observations focused on three main behavioral aspects: feeding, basking, and hiding. These three behaviors were monitored to understand how *D. subplana* adjusted to its new environment while maintaining its basic physiological functions. Visualizations of the observation results for the three daily behaviors are shown in **Figure 2**, and the average daily behaviors are presented in **Figure 3**.

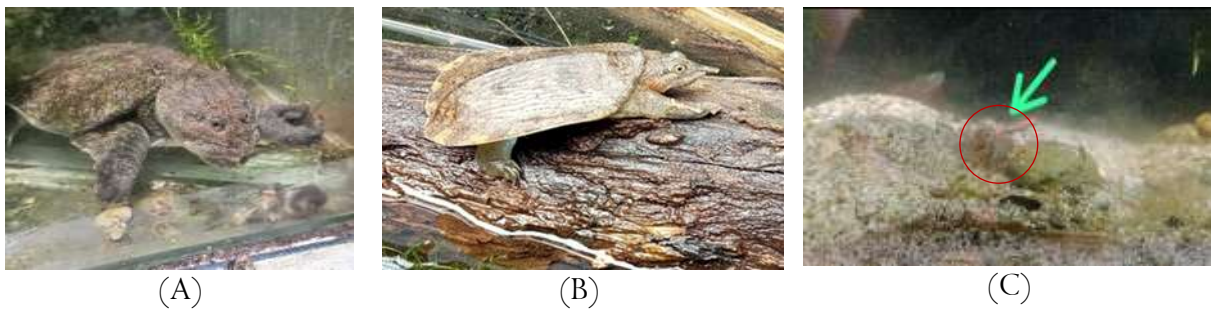


Figure 2. Daily Behavior of *D. subplana*: (A) Feeding, (B) Basking, (C) Hiding

Figure 3 illustrates the average daily behavior of *D. subplana*, including feeding, basking, and hiding activities. The frequency of feeding behavior ranged from 7 to 12 times per observation session, with peak activity occurring in the morning and the lowest activity at night. Basking behavior was much less frequent, only 1–2 times per session, most commonly observed in the morning (average of 2 times) and least during midday (average of 1 time). Meanwhile, hiding behaviour where the turtles stayed under substrate or vegetation was observed nearly all day with high frequency, consistently ranging from 26–27 times per session. This indicates that *D. subplana* heavily relies on environmental shelter in artificial habitats to feel secure.

The frequent hiding behavior observed in *D. subplana* throughout the study reflects its natural instinct for self-protection. As a softshell turtle, *D. subplana* is more vulnerable to threats and therefore tends to rely on shelter such as sand, wooden crevices, and aquatic plants to feel safe.

This behavior also serves as a strategy to avoid stress caused by excessive temperature or lighting, and provides an ideal position to ambush prey silently. Despite being in a predator-free aquarium environment, this instinct remains strongly evident. According to Berry Patch Farms (2023), softshell turtles often bury themselves to camouflage and reduce stress in unfamiliar settings. Therefore, the high frequency of hiding behavior signifies that access to hiding spots is crucial for the comfort and adaptation of *D. subplana* in artificial habitats.

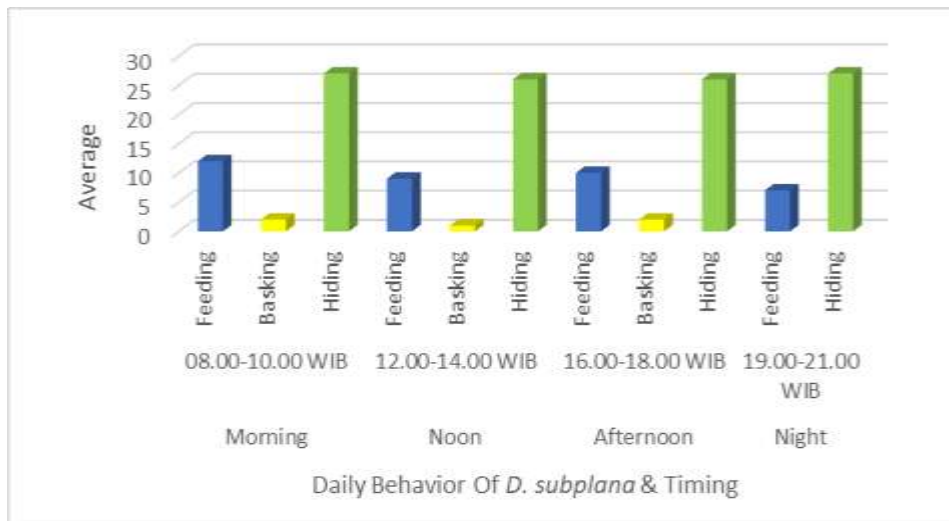


Figure 3. Average Daily Behavior

Hiding Depth of *D. subplana*

Observations of hiding behavior revealed variations in both the frequency and depth chosen by each *D. subplana* individual in their respective aquariums. In general, the most frequently used hiding depths ranged from 18 mm to 40 mm. The complete data on hiding depth and its frequency is presented in Table 2 below. One individual, labeled L5 (in Aquarium III), exhibited distinct behavior, rarely hiding and only being observed at very shallow depths (1–2 mm).

Table 2. Observational Results of *D. subplana* Hiding Frequency and Depth

Aquarium	Individual	Depth (mm)	Frequency
I	L1	30	30
	L2	19	19
	L3	22	22
II	L4	18	18
	L5	1-2	-
III	L6	9	9
	L7	3	3
	L8	11	11

Biometric of *D. subplana*

Figure 4 displays the comparison of average biometric growth of *D. subplana* over a four-week period, including body weight, carapace length, and carapace width. In general, individuals with larger initial body sizes (L1–L4) exhibited higher body weights, but with a slower growth rate compared to smaller-sized individuals (L5–L8). Conversely, individuals L5–L8, which started with lower initial weights, showed more significant weight gains week by week, indicating a positive adaptive response to the aquarium environment.

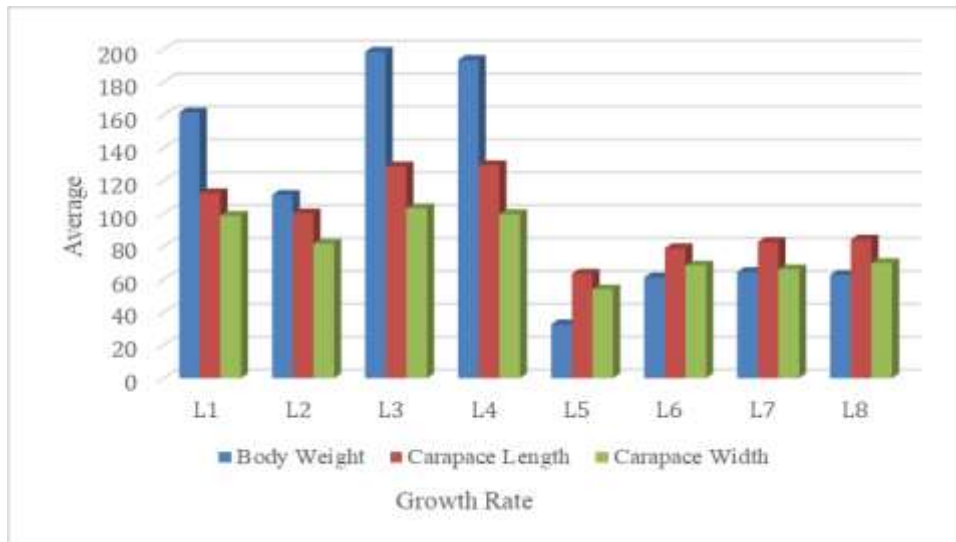


Figure 4. Average Biometric Measurements of *D. subplana*

Carapace length increased very gradually. Individuals with greater initial lengths showed minimal change, while smaller individuals such as L5 to L8 experienced steady, although minor, increases. This suggests that carapace length growth tends to be slow over a short period. Carapace width growth followed a similar pattern, with relatively small increases. In fact, some individuals, such as L5, showed no change at all throughout the observation period. Nonetheless, individuals L6 to L8 did exhibit slight increases toward the final week.

Overall, these data suggest that during the acclimatization process, *D. subplana* concentrated more of its energy on increasing body mass (weight) rather than on carapace size growth within a short timeframe.

Body Temperature and Health Condition of *D. subplana*

The observational results presented in Table 4 show the body temperatures of eight *D. subplana* individuals measured at four different times of day: morning, noon, afternoon, and night. The average body temperature tended to rise during the daytime (approximately 31.4°C–32.3°C) and decreased again at night (approximately 29.0°C–29.6°C). These temperature fluctuations reflect the physiological response of *D. subplana* to the surrounding environmental temperatures.

Table 4. Body Temperature Measurements of *D. subplana*

Aquarium	Individual of <i>D. subplana</i>	Average (°C)			
		Morning	Evening	Afternoon	Night
I	L1	26,7	32,3	31,7	29,6
	L2	27,6	32,2	31,7	29,4
II	L3	27,8	32,1	31,2	29,3
	L4	27,9	32,1	31,2	29,4
III	L5	28,0	31,5	31,0	29,0
	L6	27,8	31,5	31,0	29,2
	L7	27,7	31,4	30,9	29,2
	L8	27,8	31,4	30,9	29,3

In addition, observations of physical conditions revealed that several individuals experienced health issues in the form of fungal infections, particularly on the carapace and plastron. The

infected areas appeared discolored, turning whitish, and were covered with a powder-like layer suspected to be fungal colonies. These symptoms were accompanied by reduced activity and responsiveness to stimuli, as shown in Figure 7 below.



Figure 5. *Ichthyophthirius multifiliis* Parasite

Environmental Parameters

The results of environmental (abiotic) parameter measurements, presented in Table 5, show that the average air temperature in each aquarium ranged between 29.49°C and 29.75°C. Air humidity (relative humidity) was recorded between 70.22% and 71.48%, while water temperature measurements using a thermometer showed values ranging from 29.03°C to 29.13°C.

Light intensity across all aquariums ranged from 332.97 to 412.20 lux. Other water quality parameters, such as pH, were in the range of 6.96 to 7.35. The TDS (Total Dissolved Solids) values ranged from 0.380 to 0.406 ppm, and DO (Dissolved Oxygen) levels ranged from 4.38 to 4.87 mg/L, meeting the minimum requirement of >4 mg/L necessary for respiration and metabolism in freshwater animals (Yunita et al., 2020).

Overall, all measured environmental parameters were within appropriate ranges and supported the survival and health of *D. subplana* in the aquarium environment used during the observation period.

Table 5. Environmental (Abiotic) Parameter Data

Parameters	Average		
	I	II	III
Air Temperature (°C)	29,72	29,75	29,49
Temperature (%)	70,63	70,22	71,48
Light intensity	340,86	412,20	332,97
Water pH	6,96	7,33	7,35
Termometer (°C)	29,13	29,11	29,03
TDS (ppm)	0,380	0,406	0,400
Do (Mg/L)	4,38	4,87	4,54

DISCUSSION

Daily Behavior of *D. subplana*

Figure 2(A) shows observations of *D. subplana*'s feeding behavior, conducted twice a week (Monday and Friday) at four different times: 08.00, 12.00, 16.00, and 19.00. The diet consisted of 30 individuals of *Palaemon paucidens* and 40 juvenile *Clarias batrachus* per session. All individuals showed a stronger feeding preference for *Clarias batrachus* over *Palaemon*

paucidens (Santoso et al., 2023). This is likely due to the higher protein and fat content in *C. batrachus*, which provides energy and supports growth, especially during the acclimatization phase in a new environment (Rahmawati et al., 2021). From week to week, feeding responses improved, particularly in the morning, indicated by faster and more active prey capture (Akmal et al., 2015).

Figure 2(B) illustrates basking behavior, observed as individuals remaining still under sunlight exposure. This activity was most frequent in the morning for about 15 minutes, decreased during midday due to high temperatures, and reappeared in the late afternoon. Basking is essential for *D. subplana* to aid digestion, warm the body, and absorb sunlight necessary for developing strong bones and shells (Prayogo et al., 2024).

Figure 2(C) represents hiding behavior, a frequent activity during which *D. subplana* utilized various parts of the aquarium to seek shelter digging into sand, slipping between wood crevices, or hiding behind aquatic plants like *Hydrilla*. In the morning, *D. subplana* tends to burrow into the sand to warm up slowly after a cold night (Aspita & Jimi, 2020). In the afternoon, hiding increases due to higher environmental temperatures, which can lead to stress and dehydration. Wood crevices provide sturdy, dark shelter for safety and stable temperatures, while aquatic plants and sand offer humidity and comfortable hidden spots. The primary purpose of this behavior is to protect from heat stress, stabilize body temperature, avoid disturbances, and gain a sense of security (Khairuman & Amri, 2022; Barua & Sharma, 2022).

Hiding Depth

Observations on hiding depth revealed that *D. subplana* actively selected specific depths they perceived as most comfortable or safe. Depths varied between individuals and aquariums but generally ranged from 18–40 mm, indicating the species' ability to select microhabitats to stabilize body temperature. Shallower depths observed in some individuals (especially in Aquarium III) may be linked to substrate conditions or individual characteristics, such as sex and body size (Ernst, 2020).

Biometric of *D. subplana*

D. subplana showed a more rapid increase in body weight compared to the growth in carapace length and width. Weight gain occurred mainly between the first and second weeks, especially in lighter individuals. This is likely due to initial adaptation to the aquarium environment, which provided regular feeding and stable water conditions (Corgos & Freire, 2023). After the second week, weight gain stabilized, indicating individuals had reached a balance between food intake and metabolic needs.

Carapace length growth was slow in all individuals. Those with smaller initial lengths showed slight increases, but overall the changes were minimal. This is consistent with typical reptilian growth patterns, where body length increases gradually after reaching a certain size. A study by Plummer et al. (2021) on other softshell turtles showed a similar growth trend, with little change in carapace length over a short period.

Carapace width also increased slowly. Some individuals, such as the fifth, showed no change in width throughout the observation period. Factors such as calcium needs for shell growth and limited movement space in the aquarium may affect growth rate. According to Hamid et al. (2018), carapace width growth can be influenced by habitat quality and nutrient availability, which may also apply to *D. subplana*. Overall, the results suggest that during acclimatization, *D. subplana* focused more energy on gaining body mass rather than shell growth—a possible adaptive strategy to build energy reserves and strengthen physical condition for the new environment.

Body Temperature and Health *D. subplana*

Observations revealed that *D. subplana*'s body temperature fluctuated with the surrounding environment, indicating that the species is ectothermic—it cannot regulate its own body

temperature and relies on ambient conditions. This pattern is common in aquatic reptiles, whose body temperatures tend to align with the water temperature (Seebacher & Franklin, 2017). Tan et al. (2015) also noted that *D. subplana* adjusts its body temperature according to environmental temperatures, especially at night, although the methods may vary depending on daily fluctuations.

Physical observations revealed differences in individual health conditions. Some showed signs of fungal infections on the carapace and plastron, characterized by whitening and powder-like layers, accompanied by decreased activity and stimulus response. These infections were primarily found in all individuals in Aquarium III, as well as individual 5 in Aquarium II and individual 2 in Aquarium I. This may be due to suboptimal conditions such as high humidity and lack of direct sunlight. Health status was also linked to body weight and activity levels. The lightest individuals, such as individual 5 (32.75 g) and individual 7 (64.5 g), showed signs of poor health and smaller body size. Conversely, heavier individuals such as individual 3 (206.25 g) and 4 (210 g) appeared healthier and more active. This suggests that body weight and daily behavior may serve as early indicators of *D. subplana*'s health in aquarium environments. The fluctuation in body temperature and infection symptoms highlight the importance of maintaining stable aquarium conditions. Temperature, lighting, and habitat hygiene must be well-managed, and routine monitoring of body weight and activity is essential to prevent health issues (Deem et al., 2023).

Abiotic Environmental Parameters

Measurements showed that environmental conditions in the aquarium were within ranges supportive of *D. subplana*'s survival. Air and water temperatures close to 30°C are ideal for tropical reptiles like *D. subplana*, as they enable normal daily activity without heat or cold stress (Puspitasari et al., 2021). High humidity is also important to prevent excessive water loss, especially since *D. subplana* is a semi-aquatic species (Suprihatin & Anjarwati, 2019). Light levels in the aquarium were within optimal ranges for activity such as feeding and basking (Fauziah & Priyono, 2017). Adequate light helps maintain good body condition and stable water temperatures, supporting *D. subplana*'s thermoregulation since it relies on the environment for body temperature control (Wicaksono et al., 2019).

Water quality was also appropriate. Near-neutral pH supports internal organ function and digestion (Sari et al., 2022). Sufficient dissolved oxygen indicates good water flow and air circulation, facilitating respiration and movement (Yunita et al., 2020). Low levels of dissolved solids are important to avoid disturbing fluid balance in the body. Overall, the aquarium conditions were conducive to *D. subplana*'s acclimatization, helping them remain active, healthy, and well-adjusted to their new environment.

CONCLUSION

The results of this study show that the relocation of *D. subplana* to the TLC at the University of Bengkulu was part of an ex situ conservation effort to protect the species from habitat destruction and overexploitation in the wild. Of the 10 individuals transferred to the TLC aquarium, two did not survive the initial adjustment phase, while the remaining eight (80%) successfully underwent a 30-day acclimatization period. Success was indicated by consistent daily behaviors such as feeding, basking, and hiding, along with the ability to adjust body temperature to the environment. Most individuals remained in stable health, despite some showing mild symptoms of infection. Biometric measurements revealed faster weight gain compared to carapace size growth. Environmental parameters such as temperature, humidity, pH, DO, and TDS were within acceptable ranges to support life. These findings suggest that aquariums designed to mimic natural habitats can serve as effective mediums to support the adaptation and survival of *D. subplana* outside its native habitat. The results can be used as a reference for planning ex situ conservation programs for other aquatic reptile species with similar characteristics. Moreover,



insights into behavioral and physiological responses during acclimatization may inform technical improvements in care, health monitoring of *D. subplana*, and the development of experience-based conservation education at learning centers like the TLC.

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