

RESEARCH ARTICLE



Community Perspectives in Ethogram for Komodo Dragon (*Varanus komodoensis*) in the Wild

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Abstract

The Komodo dragon (*Varanus komodoensis*) of East Nusa Tenggara, Indonesia, is an endemic species protected by Indonesian law, mostly due to its population size and limited distribution. The natural distribution of the Komodo dragon is limited to Komodo National Park and several areas on the island of Flores and its surroundings. However, increasing population and tourism in its natural habitat might increase the conflict between the Komodo dragon and humans. To study the impact of human activities on the behavior of the Komodo dragon, we constructed an ethogram to catalog the behavioral inventories of the Komodo to enable future quantitative comparison. The Komodo dragon ethogram was obtained from observations in Loh Buaya and Loh Baru Resorts, Rinca Island, Komodo National Park. Observations were made on 10 adult males, 13 adult females, 12 juveniles, and 3 hatchlings Komodo dragons. Data were collected during July-September 2019, February-March 2020, and June-September 2020. Based on observations, observed behavior was grouped into 9 categories based on their function. Among them are sexual behavior, parental behavior, antagonistic behavior, ingestion/egestion, maintenance, movement, resting, and investigative.

Keywords: behavior, catalog, Varanidae

1. Introduction

The Komodo dragon (*Varanus komodoensis*) is an endemic and protected species from East Nusa Tenggara, Indonesia. The natural distribution of Komodo dragon is currently limited to the islands in Komodo National Park and several areas on the island of Flores and its surroundings islands [1–3]. The largest population of Komodo dragons is found on Rinca Island and Komodo Island [1]. As a giant lizard, the Komodo dragon has an essential ecological role as an apex predator [4–7]. In its natural distribution, Komodo dragons are found not only in areas devoid of any humans but also in proximity to human settlements and tourist areas [8]. However, the increase in population and tourism in its natural habitat might increase the conflict between Komodo dragons and humans, leading to wildlife and human conflicts [9].

The populations and ecology of Komodo dragons in the wild, especially in the Komodo National Park, have been studied extensively. Population monitoring of the Komodo dragon, and its main prey has been conducted continuously [1,10]. Study on the behavior of Komodo, especially related to movement and breeding behaviors, has been studied in nature and zoos [2,11]. Despite the intensive study, no comprehensive report catalogs the behavior of the Komodo dragon. This research aims to construct an ethogram categorizing the behavior of Komodo dragons. The result can be used to develop management strategies to reduce the risk of conflict between humans and animals [12] and as quantitative future comparisons.

2. Research Methodology

Observation was conducted at the Loh Baru and Loh Buaya resorts on Rinca Island, Komodo National Park (Figure 1). Observations made on 38 Komodo dragons, which consisted of 10 adult males, 13 adult females, 12 juveniles, and 3 hatchlings. Observations of the adult and juvenile behavior were carried out in July-September 2019 and June-September 2020, respectively, during the mating and nesting season. Meanwhile, observation of the behavior

of the hatchlings of Komodo dragons was carried out in February-March 2020 during the hatching period, carried out at the Loh Buaya Resort only. Most individuals observed usually reside in the nearby guard post of each resort. Behavioral observations were conducted directly following the Komodo dragons in nature, using the focal animal sampling method based on Altmann [13].

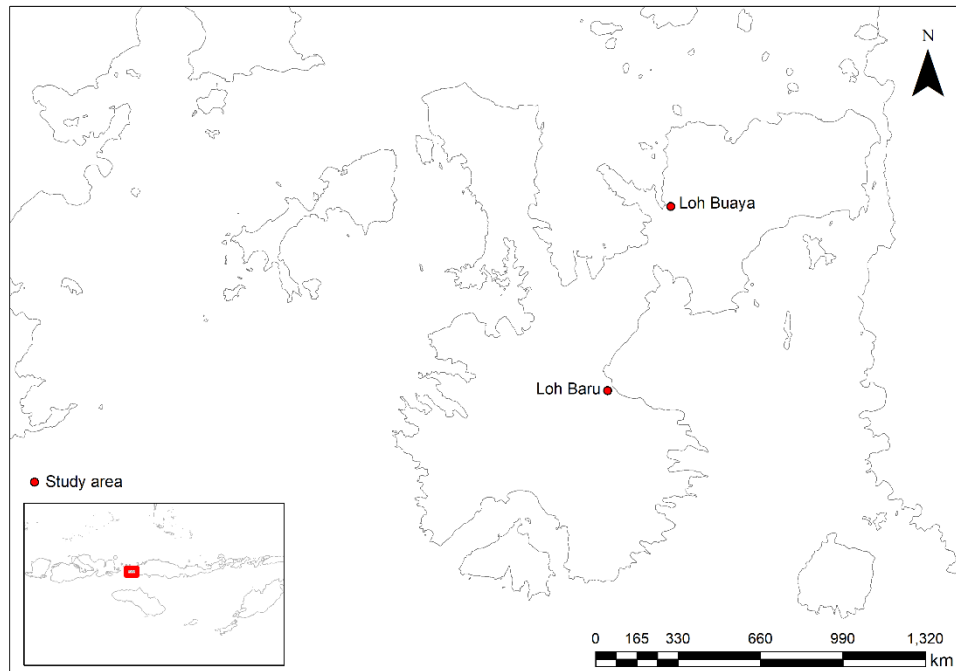


Figure 1. Study area in Rinca Island, Komodo National Park.

Observations were conducted hidden from the animal vision by 2-3 persons. The distance between the observer and the Komodo dragon ranges from 2 to 15 m. The land cover influences the variation in the observation distance. In a savanna, where the grass is relatively high and dense, the distance between the observer and the Komodo dragon is closer than in open habitat. In any observation, observers will remain as still as possible to avoid disturbing the natural behavior of the Komodo dragon. In addition, camera traps were set up in the nearby nest to help investigate nesting behaviors. We use binoculars during observation, especially when the position of the Komodo dragon is far from the observer. Behavioral observations were conducted from 6:00 to 18:00 because Komodo dragons are mostly active during the day. The behaviors are recorded in detail and then categorized according to their function.

3. Results

We recorded 23 types of Komodo dragon behavior, which divided the behavior into 9 categories based on their function. The general functions are maintenance, ingestion/egestion, investigative, self-defense, agonistic, movement, and rest, which means all Komodo dragons can show the behavior. The sexual and parental behavior is only shown by adult Komodo dragons.

3.1. Maintenance

This is a very general behavior, which means this behavior is shown by all Komodo dragons. They showed this behavior every day as part of their routines or basic needs. The maintenance behavior is divided into 2 activities, basking, and taking shelter (Figure 2).

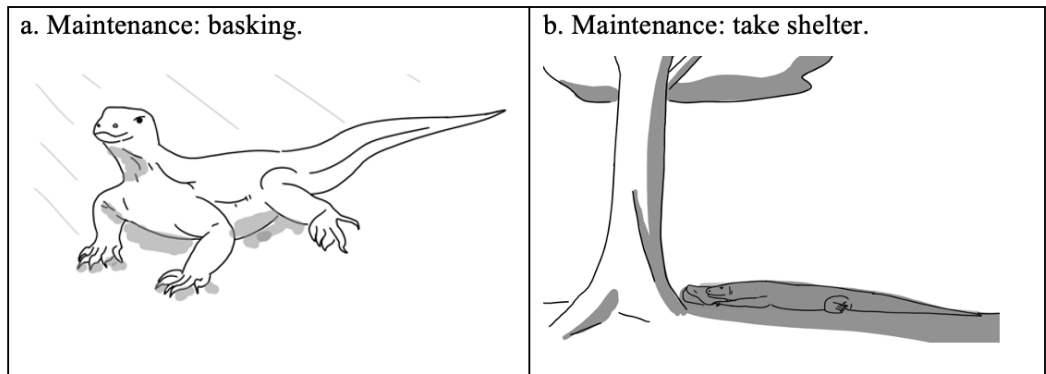


Figure 2. Illustration for maintenance behavior of Komodo dragons.

3.1.1. Basking

Adult stays still while exposed to direct sunlight, sometimes with dorsoventral touch the substrate; head and forebody raised off with limbs straight or lying on the substrate; head raised and forebody and limbs touched the substrate; often in the morning and late afternoon. Juveniles and hatchlings sit still in the tree trunk or twig, exposed to the sun. Komodo dragon usually do this in the morning and afternoon (sometimes).

3.1.2. Take shelter

Komodo dragons stay in shaded areas, not exposed to direct sunlight, the position of the head, and forebody are raised or lying on the ground with limbs outstretched. Komodo dragon will take shelter when the body temperature is too hot, so they take shelter to cooling down their temperature.

3.2. Ingestion/egestion

Ingestion is a general behavior too. There are five activities that are grouped into ingestion/egestion behavior, foraging, eating, drinking, defecation, and vomiting (Figure 3).

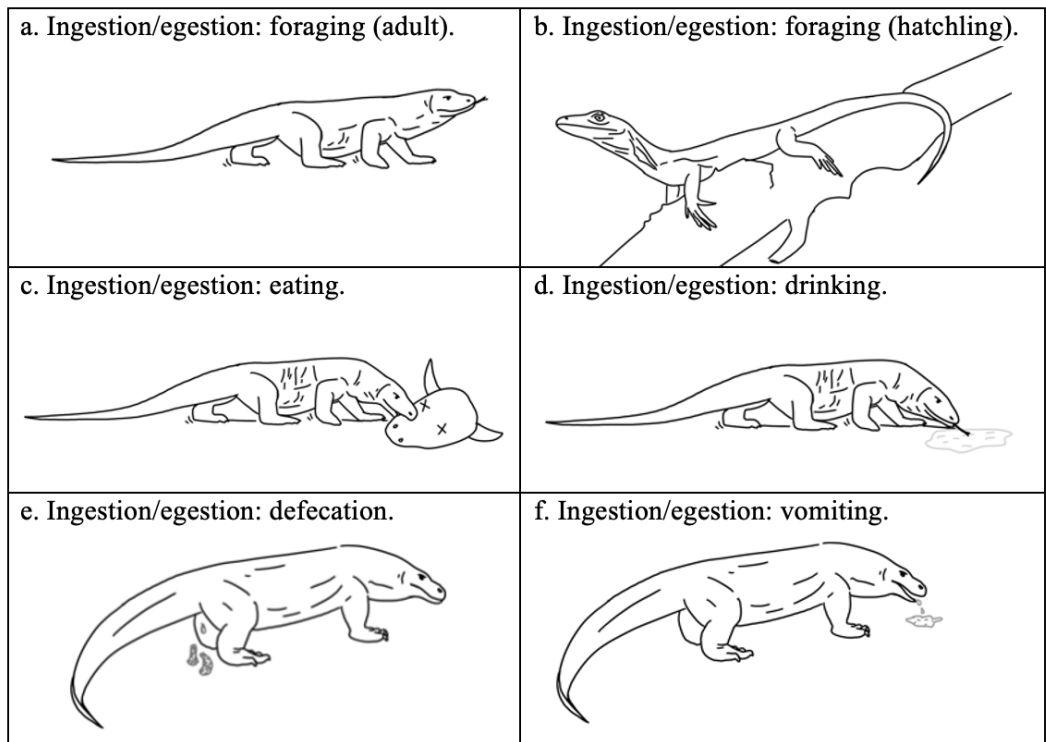


Figure 3. Illustration for ingestion/egestion behavior of Komodo dragons.

3.2.1. Foraging

Komodo dragon is on alert mode, legs are straight, head up with occasional movement to the side. Tongue flicks are apparent, sometimes drooling. Komodo can be stationary or walking back and forth at a point on the ground looking for prey. The foraging behavior is often seen in the morning and evening. This behavior is not always followed by eating behavior.

3.2.2. Foraging (hatchlings)

Hatchling Komodo dragon foraging position is similar to adults. Hatchlings live on the trees, so they chase insects or other small animals in the trees.

3.2.3. Eating

Komodo opens its mouth and grabs the food by its mouth. Prey is immediately swallowed if the size is sufficient for its mouth cavity. Large food will be continuously pulled and torn by the teeth and then swallowed.

3.2.4. Drinking

Komodo inserts the tip of its snout into the surface of the water to drink; its mouth is opened, sometimes with its tongue sticking out into the water.

3.2.5. Defecation

Komodo stays still, stands on all fours, and then excretes feces from its anus, either in liquid or solid form.

3.2.6. Vomiting

The change of movement, where the head and front legs were initially erect, to suddenly the head and front legs lowered while opening its mouth. The body was then jerked while spewing something out of its mouth.

3.3. Investigative

Investigative behavior is shown when Komodo dragons feel disturbed. They will show investigative behavior until they feel safe enough or it can turn into another behavior like self-defense, agonistic, or aggressive behavior. There are two activities grouped into this behavior, alert, and tongue flicks (Figure 4).

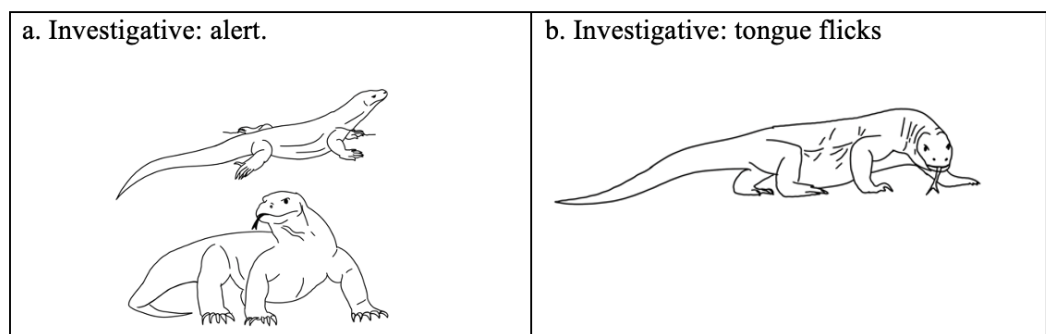


Figure 4. Illustration for investigative behavior of Komodo dragons.

3.3.1. Alert

Komodo Dragon lifts its head and occasionally looks left or right. The forelegs are in the starting position and are raised when alertness is increased.

3.3.2. Tongue flicks

The tongue sticks out of the mouth, sometimes quickly in and out of the mouth. This activity is conducted by all Komodo dragons. The frequency of the tongue flicks increases in a state of alert or searching.

3.4. Self-defense

Self-defense is shown when the Komodo dragon feels in danger. The threat can be from other Komodo dragons, other animals, or humans. First, Komodo dragons will show aggression to their threat, but if the threats are stronger, they are fleeing/moving away (Figure 5).

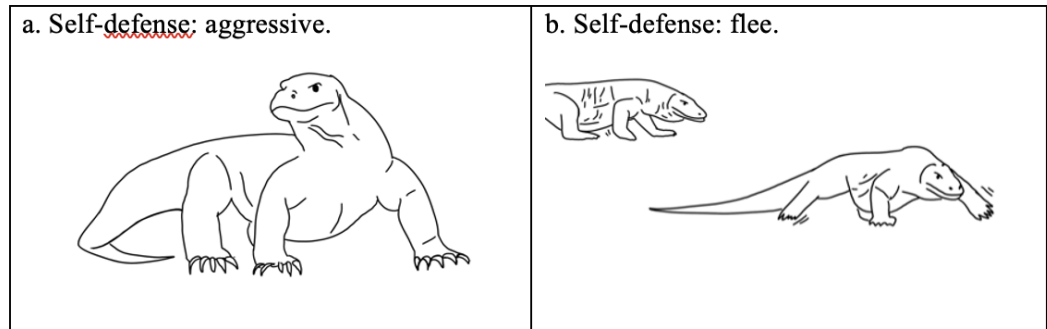


Figure 5. Illustration for self-defense behavior of Komodo dragon.

3.4.1. Aggressive

The legs and head of the Komodo dragon were upright and alert. Komodo will move closer by walking or running towards other Komodo, animals or humans.

3.4.2. Flee

Moving away action by walking or running from humans or other animals when they feel threatened. Sometimes the tail is folded to the side and wagged. This behavior usually showed by younger komodo.

3.5. Agonistic

Agonistic is a behavior when Komodo dragons feel threatened, this is a form of defense or resistance against other Komodo dragons. This behavior usually shows when they defend their territory, nest/eggs, or their mating partner (Figure 6).

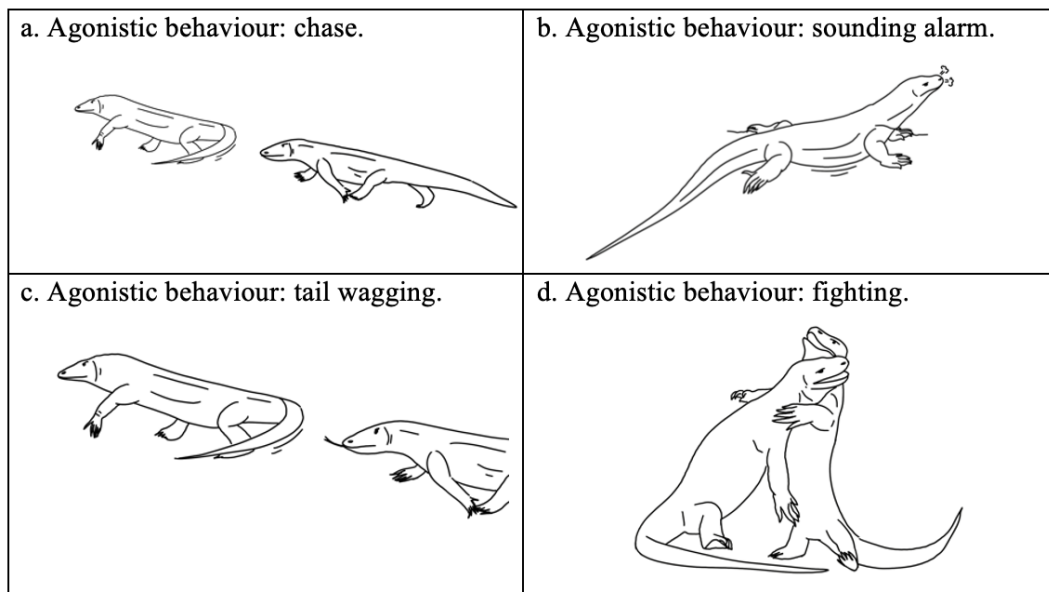


Figure 6. Illustration for agonistic behavior of Komodo dragons.

3.5.1. Chase

The position of the Komodo dragon is ready, with straight legs, then walk or run towards the opponent.

3.5.2. Sounding alarm

Komodo makes a sound (hissing) that comes from the air in its stomach that is exhaled through its nostrils. Sound is usually produced to repel other approaching Komodo dragons.

3.5.3. Tail-wagging

Komodo dragon lifts its tail and folds it to the side, then once the target is within reach, it will wag its tail. The tail-wagging behavior is carried out as a form of attack on the chasing dragons.

3.5.4. Fighting

Legs upright, head up, with body alert. The Komodo dragons will move closer to the opponent while making a sound. The Komodo dragon then jumps, both forelegs resting on the opponent as if to stand up on two legs, both hind legs and tail resting on the ground to maintain balance. The two Komodo dragons collide and sometimes bite each other's. The one that falls, and its head squeezed by the body of the opponent's dragon is the loser.

3.6. Movement

This behavior divided into 2 activities. Walking/running performed by juvenile and adult Komodo dragon, while jumping only performed by hatchlings (Figure 7).

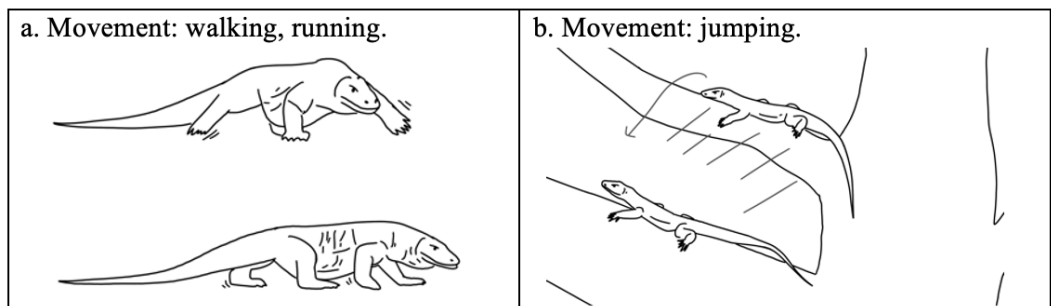


Figure 7. Illustration for movement behavior of Komodo dragons.

3.6.1. Walking/running

Komodo dragons walk and run with all four legs, the right front footsteps followed by the left hind foot stepping then vice versa, performed alternately.

3.6.2. Jumping

The movement of hatchlings of Komodo dragons from one place to another is by jumping on tree trunks, tree branches, and the ground.

3.7. Resting

Resting behavior is general behavior that is performed every day by all Komodo dragons. But perching activity is only performed by Komodo dragons who live on the tree, which means only hatchlings and juveniles can do that (Figure 8).

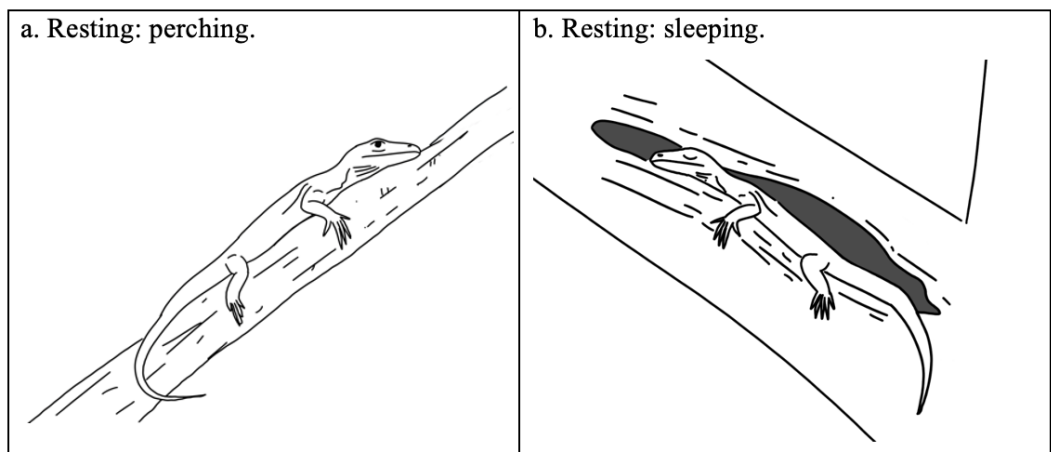


Figure 8. Illustration for resting behavior of Komodo dragons.

3.7.1. Perching

Conducted by a hatchling and juvenile Komodo dragon, usually by sitting quietly with its head and hands attached to a tree trunk or twig (about 8 meters above ground level), sometimes taking shelter or between leaves.

3.7.2. Sleeping

The Komodo dragon lays its head down, its legs stretched out, its eyes closed. Komodo dragons sleep in various places such as holes in the ground, tree holes, or under fallen trees. The hatchling and juvenile Komodo dragon went into the tree hole to rest.

3.8. Sexual

Sexual behavior only performed by adult Komodo dragons during the mating season (Figure 9).

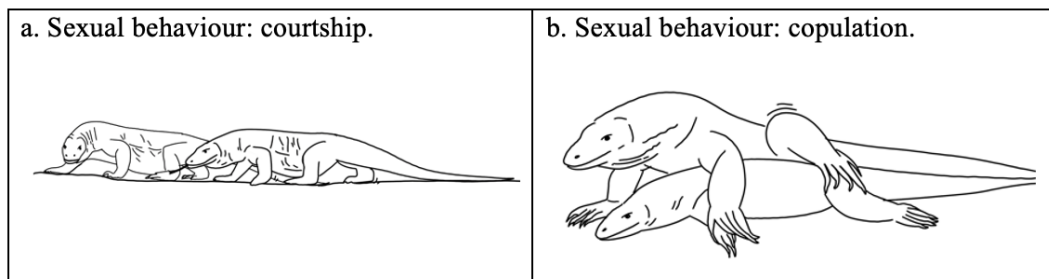


Figure 9. Illustration for sexual behavior of Komodo dragons.

3.8.1. Courtship

The male approaches the female, sticking out his tongue around the female's hind legs to the tail. The female accepting the male's approach will let the male climb onto her back.

3.8.2. Copulation

The male positions himself on the top of the female's back and with his hind legs will scratch the female's hind legs. The female lifts her tail and the male pushes his pelvis to insert the hemipenis into the female's cloaca.

3.9. Parental

This behavior is only performed by female adult Komodo dragons during the nesting season, they will be preparing the nest and after they lay their eggs, they protect it from other Komodo dragons and predators (Figure 10).

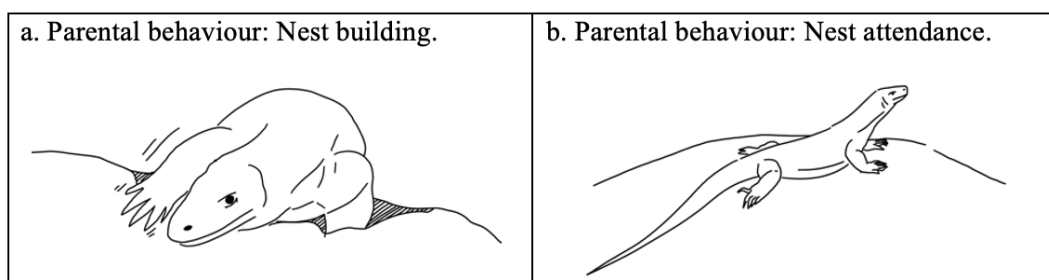


Figure 10. Illustration for parental behavior of Komodo dragons.

3.9.1. Nest building

Only females perform nesting behavior. A gravid female will inspect the available nest mount of Orange-footed Scrubfowl by poking into holes and sometimes entering the hole, occasionally digging with her forelegs. The female digs the nest by entering all her body into the nest and moving back and forth to remove sand.

3.9.2. Nest attendance

The nesting female will ward off other Komodo dragons (either female or male) that come either to fight over the nest or to prey on eggs. The nesting female will chase other approaching Komodo dragons, attacking them until they leave, similar to agonistic behavior.

4. Discussion

Adult Komodo dragons walk, run, and rest on the ground, while hatchling and juvenile Komodo dragons live in the trees to avoid predation by adults [14]. They live for 1-2 years in the trees [15] and prey on small animals in trees, such as geckos, lizards, bird eggs, and insects [16]. The juveniles that can start living primarily on the ground but still climb the trees will remain sleeping on the tree to avoid predation. This behavior is maintained until the juveniles can no longer rise due to increased body weight. Juvenile Komodo dragons move more and are more active than adult Komodo dragons. The level of alertness of juvenile dragons also tends to be higher. This is because they still must avoid attacks from adult dragons [16].

Komodo dragons are active during the day and spend much time sunbathing, sheltering, and occasionally looking for food. At night, they will sleep under buildings, in holes in the ground, under trees, or in hidden places. As a poikilothermic animal, sunbathing and shelter activities are the Komodo dragon's way of regulating body temperature [17]. Komodo dragons, like most reptiles, are ectotherms which means they need to bask every morning to increase their body temperature to their preferred temperature, around 34-35.6°C [18]. In all observed behavior, Komodo dragons exhibit tongue flicking, with the highest frequency occurring during agonistic behavior.

Komodo dragons are solitary animals, but they can work together in a place with a reasonably high resource potential, i.e., around active kitchens or in locations with carcasses. An active kitchen produces odors from processed food ingredients, and kitchen waste also invites other animals to gather around it. We observed Komodo dragons sharing their prey with other dragons, so they often gather in locations with dead or carrion animals. During this congregation, agonistic behavior between Komodo dragons was observed, usually to newcomers or smaller Komodo dragons.

Only adult Komodo dragons can perform mating activities. When the breeding season began in June-July [19], male Komodo dragons could walk further than usual to find females and fight among male dragons over females. The succeeding male will mate with the female and perform copulation. Female Komodo dragons nested within their resident valley and did not migrate elsewhere to oviposit. They prepare their nests in July and lay their eggs in the nest around August [11,19]. During the nesting season, female Komodo dragon will be active around the nest: preparing a nest, laying eggs, and guarding the nest (Figure 10). The nesting period usually ends in November, when the female Komodo dragon will leave the nest [19]. Parental care behavior is only carried out by Komodo dragons during the nesting period, as hatchling Komodo dragons will survive on their own. They will climb nearby trees to avoid predators, including another more enormous Komodo dragon [16]. This is typical behavior of most reptiles, for example, in the Anguillidae family, which only performs parental care on their eggs [20].

5. Conclusion

There are 23 behaviors grouped into 9 categories based on their function. Among them are maintenance, ingestion/egestion, investigative, self-defense, agonistic, movement, rest, sexual, and parental behavior. This ethogram consists of behaviors of adult males, adult females, and juvenile Komodo dragons.

Author Contributions

AMF: Writing - Original Draft Preparation, Writing - Review & Editing, Visualization, Investigation; **MDK:** Conceptualization, Writing - Review & Editing, Supervision; **YAM:** Writing

- Review & Editing, Supervision; **MGGN**: Investigation; **FES**: Investigation; **RAS**: Investigation; **AA**: Writing - Review & Editing, Supervision, Funding Acquisition

Conflicts of interest

There are no conflicts to declare

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