

King Commodos

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Abstract: The genus name "Varanus" was introduced in 1820 by German professor, Blasius Merrem. It is a latinization of the Arabic "waran," the Egyptian name for the Nile monitor. (Egyptians believed that these lizards served as "monitors," alerting people to the presence of crocodiles.). 70 species and subspecies of Varanus have been described but only 50 species are currently recognized. Size is the most variable anatomical characteristic in the family (length varies from 0.32m to 3.5m). All species are similar in appearance. The family Varanidae includes the largest living lizards. First mention of Komodo dragon in scientific literature: Peter Owens in 1912 mentions "Varanus species of an unusual size" from Komodo Island. Common Names •Komodo Dragon. (Komodo is the name of one of the islands on which they are found). "Ora" is a local name in the Mangarrai dialect. The Hindi name "biscobra" implies that it is twice as deadly as the cobra. The Malaysian name "buaja darat" means land crocodile. Members of the Varanidae family are commonly referred to "varanids," "monitors," or (in Australia) "goannas". Phylogeny, the oldest varanoid fossils (95 million years ago, Cretaceous) are related to the early mososaurs and snakes; lived in Europe and Asia. Genus Varanus first recognized in the fossil record from about 34 million years ago (Late Eocene) (Homes et al. 2010). Fossils found in Egypt; dispersals followed into Europe, Asia, Australia. A direct ancestor of the Komodo Dragon is the gigantic Pleistocene fossil Megalania prisca from Pleistocene deposits in eastern Australia.

Keywords: V. komodoensis

1. Introduction

Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Subclass: Diapsida (Crocodiles, tuataras, lizards, snakes)
Order: Squamata (lizards, snakes and amphisbaenians or "worm-lizards")
Suborder: Sauria (Lacertilia)
Infraorder: Autarchoglossa
Family: Varanidae
Genus: Varanus (50+ recognized species)
Species: V. komodoensis

2. Taxonomy

The genus name "Varanus" was introduced in 1820 by German professor, Blasius Merrem. It is a latinization of the Arabic "waran," the Egyptian name for the Nile monitor. (Egyptians believed that these lizards served as "monitors," alerting people to the presence of crocodiles.)

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- All species are similar in appearance
- The family Varanidae includes the largest living lizards
- First mention of Komodo dragon in scientific literature:
 - Peter Owens in 1912 mentions "Varanus species of an unusual size" from Komodo Island
- Common Names
 - Komodo Dragon (Komodo is the name of one of the islands on which they are found)
- "Ora" is a local name in the Mangarrai dialect.
- The Hindi name "biscobra" implies that it is twice as deadly as the cobra.
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- Members of the Varanidae family are commonly referred to "varanids," "monitors," or (in Australia) "goannas."
- Phylogeny •The oldest varanoid fossils (95 million years ago, Cretaceous) are related to the early mososaurs and snakes; lived in Europe and Asia
- Genus Varanus first recognized in the fossil record from about 34 million years ago (Late Eocene) (Homes et al. 2010)
- Fossils found in Egypt; dispersals followed into Europe, Asia, Australia
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3. Distribution & Habitat

(Auffenberg 1981) (CBSG 1995) (Fitch et al 2006)

- Varanid lizards occur throughout Africa, the Middle East, South-East Asia, Australia (Fitch et al 2006)

Komodo distribution:

Adapted from www.d-maps.com

- Komodo dragons restricted to the islands of Komodo, Flores, Rinca and Gilli Motang in the middle of the Lesser Sunda Islands, Republic of Indonesia. Less than 1000 sq km of is officially protected and designated Komodo National Park.
- Different methodologies have produced different population figures. Best current estimate from the IUCN/SSC/CBSG: 5000

In Komodo National Park:

- 1600 on Komodo
- 1100 on Rinca
- 70 on Gilli Montang

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Flores:

- 100 on W. Flores (Wae Waul Reserve)
- 2000 scattered in non-protected areas
- One of world's major volcanic areas. Slight tremors felt every few weeks; volcanic ash fall occurs periodically.
- Largest komodo habitat is on the island of Komodo where they occupy the entire island. On Flores they occupy 400 sq km and on Rinca 278 sq km
- Regions inhabited are arid and mountainous. Komodos are usually found in the rocky valleys between 500-700 m. They prefer the extensive flat savannas. The driest savanna is studded with lontar palms. Moist grasslands have tamarind and jujube trees. Adult Komodos frequently occupy the transition zone between tropical monsoon forest (tamarind and kapok trees, cycads and ferns) and the savanna.
- Found from sea level to 800 m.
- Average temperature 26.7 C at sea level (Range: 17C - 43C)

4. Physical Characteristics

(Auffenberg, 1981) (Ciofi 2004) (De Lisle, 1996) (King & Green, 1993) (Fry et al. 2006) (Fry et al. 2009)

- Largest living lizard. (Males: 3 m, 90 kg; Females 2 m, 70 kg)
- Average field weight: about 47 kg. (Heaviest 54 kg)
- Average field length: Up to 260 cm
- Head raised to full extent is approximately 40 cm above the ground. When lowered the animal is less than 20 cm high (Long neck can stretch to give the dragon a better view of its surroundings in tall grass.
- Toes have sharp, recurved claws.
- Teeth are specialized for a carnivorous diet. They are serrated, compressed laterally, and curved posteriorly with a sharp tip and broad base, (Curved teeth are better than straight teeth for catching and holding prey). Although many varanids have one or two replacement teeth at each position, the komodo has four or five. Longest teeth are approximately 2 cm.
- Venom toxins are now known to be present in toxin-secreting glands of monitor lizards (Fry et al. 2006; Fry et al. 2009)
- Biologists hypothesize that venom systems evolved early in the evolution of both snakes and lizards
- Nine toxin types are shared between lizards and snakes
- In one monitor lizard, the Lace Monitor (*Varanus varius*), its toxin effects blood pressure and clotting ability of its prey
- Short intestine is typical of carnivores (Diets high in proteins and lipids don't require a great deal of digestive processing)
- Juvenile Komodos are slender and agile. Adults are massive with flatter bodies and proportionately shorter tails

- Skin is like "chain-mail" with numerous osteoderms. Shedding occurs in patches and lasts about 6 months each year (In the Komodo this begins in September)
- Tongue is long and narrow with a deep fork at its tip. It does not move freely in the mouth, but retracts into a sheath. It is partially supported by a complex structure of bone and cartilage called the hyoid apparatus. Varanids are unique in using their tongues only as a sensory organ for locating prey and as a socialization tool. Other lizards use the tongue to manipulate food.
- Males are bulkier and larger than females.
- Coloration
 - Most adults are uniformly gray or clay-colored. Until the age of four they have much brighter, speckled skin. (Komodos of Flores retain brighter coloration)
- There is little sexual dimorphism. The flanks of adult females have more red than males. Yellowish-green nose spots are more common in males
- The light yellow tongue is species specific. (*V. salvator* has a blue tongue, *V. dumerili* and *V. grayi* have pink tongues)
- Olfaction
 - Sense of smell extremely important in food detection. Komodos can detect the scent of carrion from as far as 11 km. (Decomposition releases volatile oils - wind and size of prey are important factors)
- Each external nostril leads to a multi-chambered nasal capsule. (One of the chambers functions to excrete excess sodium.) A pair of Jacobson's organs opens into the roof of the mouth. Scent particles are collected by the forked tongue and delivered to these sense organs which stimulate the brain to react.
- Vision
 - Eyes are placed laterally and covered by two unequal lids.
- Upper lid has little mobility.
- Lower lid contains a cartilaginous plate which slides over surface of the eye
- Hearing
 - The ear is important for maintaining balance as well as sound reception.
- Behavior seems to be more scent than sound oriented
- Respiration
 - Varanid lungs are larger than most reptiles.
- Take in relatively larger amounts of oxygen and their physiology produces a more efficient system of air circulation.
- Breathing rate is regular and low but varanids can voluntarily hold their breath for long periods.
- Circulation
 - Varanids have more complex heart structure and blood chemistry than other lizards.
- This allows them to achieve intense activity without becoming exhausted.
- Water/Salt Balance
 - Water makes up 70% of a lizard's body weight. (10% more than humans).
- Varanid skin is covered with scales and contains no sweat glands.

- Excess sodium is removed by a special salt-secreting glands in the nasal capsules (many lizards have them)

5. Behavior & Ecology

(Auffenberg, 1978, 1981)(Bennett, 1998) (Burden, 1927)
(Lange, 1989) (Lutz & Lutz, 1991)

Activity Cycle

Daily Pattern

Ridding body of excess heat impacts behavior patterns

- Primarily diurnal. (Range is from 4:30-23:30). Usual waking time is between 6:00 and 6:30 AM.
- Two activity peaks: 9:30 and 15:30
- Travel about 2 km/day (Adults may travel as much as 10 km/day).
- Adults spend an average of 26 days searching for prey. 10-20 minutes eating. (A 50 kg female was observed to swallow a 31 kg boar in 17 minutes). 3-6 days is spent in digestive pause.
- Activity levels are lowest in early part of dry season. At the end of the season and throughout the rainy season activity increases (probably related to weaker prey)
- Basking = 72% of morning activity. 33% of afternoon activity
- Shade-seeking = 22% of morning activity; 58% of afternoon activity
- Largest Komodos spend all waking hours on the ground. Younger animals readily climb into trees to feed, rest, or escape predation
- Sleep about 12 hours every day. Shelters are burrows, natural cavities and overhanging vegetation
- Range (Auffenberg, 1981)
 - Factors influencing range: topography, prey density, social status, size and sex
- Range consists of a foraging area and a scavenging area
 - Foraging area has a core area related to shelter/burrows and thermoregulatory/basking sites
- 50% of activity occurs in core area
- Foraging area is 5-28 times larger than core area. For hatchlings this area may be a clump of trees; for an adult the average area is 4.2 sq km ◦ Scavenging area is determined by the location of dead animals and can be extremely large (young oras do not scavenge)

Locomotion

Quadrupedal, plantigrade

- Body, head, and tail are undulated gently from side to side in walking rhythm. Normal speed 4.8 km/hr (3 mi/hr)
- When running body and tail are held fairly rigid. Tail is off the ground. Hind feet move in wide lateral arc. 14-18.5 km/hr over short distance (8.7-11 mi/hr)
- Swimming:
- Most monitors are good swimmers. Diving and swimming under water is effective escape behavior.

- Longest known swim: between the islands of Komodo and Nusa Mbarapu, a distance of at least 450 m. (a bit over 1/4 mile)
- Tree climbing:
 - At young ages dragons are fairly good but cautious climbers.
- They lose their skill as they get older and heavier.
- Only very young lizards jump from branch to branch.
- Digging
 - Common activity. Komodos regularly excavate burrows, dig out megapode eggs, search for rodents, lizards and snakes.
- Digging is done with the front feet. One leg digs repeatedly for several strokes, then the other. Hind legs are not used to throw out dirt. Lizard backs up slowly, throwing the dirt with fore limbs.
- Rubbing
 - Smaller Komodos rub their bodies on the ground near or in carrion. Most rub themselves in hair or intestinal contents.
- Rubbing behavior not practiced by adults.
- Thermoregulation
 - All varanids are ectotherms. (Heat their bodies by basking and absorbing energy from the sun or warm surfaces. Cool themselves by seeking shade, or burrowing
- "Gular fluttering" or "hyoid panting" is used only in cases of extreme overheating. (Mouth is held open and gular region of throat is inflated with air. Air is expelled in fluttering fashion).
- Dig dens to protect themselves from the heat of the sun. They may also occupy thickets or burrows at night to regulate their temperature
- Optimal body temperatures do not differ significantly from most other reptiles but deep body temperatures tend to remain more uniform than any other reptile.
- Body temperatures of individuals drop to as low as 20 degrees Centigrade at night and can reach above 40 degrees Centigrade during the day.
- Drinking is similar to snakes: immerse snout to the eyes, suck up water then raise head and allow water to run down throat. Most manage without free water from April through December.
- Communication
- General
 - Komodo dragons are solitary animals, meeting only to reproduce.
- Territorial Behavior
 - Foraging and scavenging areas are very large and not easily defensible so territoriality is minimal if it exists at all.
- Dominance hierarchies are based on sex and size. This determines position at feeding sites.
- Displays / Visual signals:
 - No sexual displays but an aggregation of Komodos may be essential to successful breeding. Aggregations are also believed to be important in establishing and reinforcing hierarchies
- Threat display includes loud hissing. Tail lashing and/or quivering, gaping mouth, gular inflation, arched back
- Appeasement: licking, ritual walking. Mouth closed (no hissing) Subdominant individual usually flees.

- Strongly scented fecal pellets are deposited on trails and are investigated by other animals with their tongues
- Flight/escape includes lunging and biting, scratching, and defecation Regurgitation may occur in younger animals.
- Fighting between males often results in severe lacerations and even death.
- Vocalizations
 - Hissing is one of few sounds made.
- It is usually associated with defensive behavior and is used during feeding, during attacks and frequently by females during mating.
- Olfactory signals
 - As with all snakes and lizards, many of their responses are completely dependent on chemical cues.
- Scent plays an important role in territorial marking while hunting
- Ethogram (=behavior inventory): See Auffenberg (1981: 124-127), The Komodo Monitor
- Interspecies Interaction (Auffenberg, 1981) •In addition to Komodo dragons, at least 190 species of terrestrial animals co-habit the Indonesian islands
- Feral dogs, man and medium Komodos compete for the same major resources (deer & boar)
- Varanus salvator coexists on only one island and avoid contact with the larger Komodo
- Smaller animals: Snakes, lizards, and rats utilize Komodo burrows for shelter.

6. Diet & Feeding

- Auffenberg, 1980, 1981) (Burden, 1927) (Fry et al. 2006)
- Opportunistic carnivores. Feed on a wide variety of prey
- Hatchlings feed exclusively on insects (beetles and grasshoppers)
- Small komodos tend to be arboreal and feed on smaller lizards, insects birds and their eggs.
- Medium Komodos feed largely on rodents (rats, shrews) birds (megapodes and various small species) geckos, skinks and small snakes.
- Large Komodos feed on carrion or hunt animals along game trails: wild boar, sunda deer, water buffalo, large snakes, occasionally smaller Komodos.
- About 16 scavenging dragons occupy a sq km
- Large Komodos kill about one large prey ungulate (deer or boar) per month. This is supplemented with small prey (birds, rats)
- Most lizards have broad flat tongues that are used primarily for food handling but varanids have snake-like tongues which lack tastebuds and can be retracted into a sheath. As the lizard searches for food or explores, the tongue is moved up and down through an arc sampling about 7 sq cm of air. Odor molecules are then carried back to the vomeronasal organs
- Jaws close rapidly (enabling capture of fast-moving prey.) Prey is held (sometimes thrashed) until all movement ceases. Small prey is swallowed whole, usually head first. Large prey is sliced in pieces and devoured.

- Tongue is partially attached to a skeletal structure called the hyoid apparatus. All snakes and lizards have such a structure which helps in swallowing large food items.
- Swallowing is accomplished by pushing prey down the throat while the flexible jaws move forward to engulf it. Large prey is torn apart. The hyoid apparatus moves it back to the esophagus. Neck muscles bend from side to side to move food through the esophagus.
- Ingestion rate may be as much as 2.5 kg/min - higher than any other predator except large snakes.
- After a heavy feeding, Komodos drink from water holes produced by wild boar
- High digestive efficiency (70-90%) Time is dependent upon temperature (about 26 hours at normal body temperature) Cool nights can delay to almost 5 days. Stress can slow or even stop digestion (defecation of partially digested prey may occur)
- Similar to owls, all varanids regurgitate gastric pellets of undigestible material.
- Fecal pellets may include hair, feathers, partly digested bones, hooves, teeth, and claws and are excreted covered with a semisolid, white uric acid paste.
- Researchers identified venom in the saliva of monitor lizards, and venom-producing glands (Fry et al. 2006; Fry et al. 2009)
 - The idea that bacteria-laden saliva contributes to their success in killing their prey (Auffenberg, 1981) is discounted
 - A comparatively high venom yield and large gland size argue convincingly for venom being vital to monitors' predation

7. Reproduction & Development

(Auffenberg, 1981)(IUCN/SSC CBSG, 1994)(Judd & Bacon, 1977)

Courtship •Sexual maturity for both males and females occurs between 5 and 7 years (Data from captive population indicates first reproduction for females occurs 7-10 years)

- Adult sex ratio: Auffenberg's 1981 study reports 3 males to 1 female. Lilley reports 3.4 males to 1 female in his 1994 CAMP report.
- Courtship and mating in Zoos and the field have been observed from Jan 19-October 1. Successful coition from June 28 to October.
- Territories are not established. Courtship and mating takes place in small aggregations of Komodos near carrion (other lizards usually mate alone).
- Monitors (like fishes and some birds) have a very brief courtship. Mating occurs quickly. Attacks of males upon females are common at the time of, and immediately after, coitus. Most female acts are agonistic (use teeth and tails) during early phases of courtship. Males must be able to completely restrain females in order to remain uninjured.
- Visual display is not significant. Other cues: rubbing chin on top of body and neck of female. Hard scratches to back. Tongue-licks to area around hind legs, shoulders, neck and head

- Mounting occurs several times in each courtship sequence
- Nesting
 - Nest is an excavation in soil or in nests of megapods (mound-builder birds)
- 1-30 eggs laid in a clutch (average is 18) Females may lay one or more eggs several times during several, successive days. Most females lay only one clutch per year. (July to early September)
- Eggs of all varanids have a soft, leathery shell.
- Incubation:
 - 2.5 - 8 months (probably dependent on temperature and soil moisture)
 - 220 days when in captivity
- Young appear in April or May and may remain together in small groups for several months. Hatchlings weigh about 80 grams and average length 49 cm
- Development
 - Young are arboreal during their first year
- Adults largely terrestrial and rarely climb. May construct burrows along vertical banks of stream beds or under boulders and fallen trees. May also spend the night sleeping in high grass or dense brush.
- Female breeding ability thought to decline around age of 20 and cease around 30 yrs
- Longevity: About 25 years in captivity. (Frankfurt Zoo & Berlin Aquarium) Auffenberg estimates a lifespan of 50 years in wild.

8. Managed Care

(Hudson, et al 1994) (Lange, 1989)

- ISIS captive population
- In 1934 the first Komodo Dragon was placed on exhibit at the Smithsonian's National Zoological Park.
- SD Zoo received first dragons in 1968, two females and a male (no offspring)
- Few successful breedings worldwide: 3 Indonesian Zoos (Ragunan, Surabaya and Gembira Loka), plus the National Zoological Park, Miami Metrozoo, Honolulu Zoo and the Cincinnati Zoo.

9. Population and Conservation Status

(CBSG, 1995) (Hudson, et al, 1994)

- IUCN status: Vulnerable (A taxon is vulnerable when not Critically Endangered or Endangered but facing a high rate of extinction in the medium-term future)
- CITES appendix I: Komodo dragon is threatened with extinction and affected by international trade.
- Protected under Indonesian law (1931,1990) and 1991 Ministerial Decree
- Different methodologies have produced different population figures. Best current estimate from the IUCN/SSC/CBSG: 5000

In Komodo National Park:

1600 on Komodo
1100 on Rinca

70 on Gilli Montang

Flores:

100 on W. Flores (Wae Waul Reserve)
2000 scattered in non-protected areas

Conservation Efforts

Komodo National Park established in 1980: First management unit - 1984.

173,300 hectares on 3 major islands - Komodo, Rinca and Gilli Motang

- Funded from central government office in Jakarta
- Management team is called "Perlindungan Hutan Dan Pelestarian Alam" or PHPA and is based at Labuan Bajo on the west coast of Flores. Staff of 90 (54 rangers)
- Park Administration has initiated a conservation awareness program for young people in the region - some training of tour guides - participation in annual census.
- Future plans: Extend KNP boundaries to two further islands; restrict population growth of island villages (two on Rinca and one on Komodo)

Threats to Survival •Main threat is human interference - habitat destruction due to logging, increased population

- Wild dogs
- Forest fires started by poachers to drive prey
- Dynamite and cyanide poisoning used to collect fish for food has disturbed population
- Poaching of deer on Padar led to Komodo's disappearance from this island
- Because the wild population is geographically restricted it is sensitive to fluctuations in environmental conditions, disease epidemics, genetic drift, and inbreeding
- Small closed populations are predicted to have low levels of genetic variability and increased disease susceptibility.
- Deposition of volcanic ash can destroy vegetation and alter habitat.
- Flores populations have declined markedly in the past few years because of logging concessions
- No Komodos observed on Padar since 1970