Module #4 – Component #2

Class: Reptilia Order: Squamata (The scaly ones)

Objectives:
To gain a full understanding of the very diverse entities of the group called lizards.

Expected Outcomes:
1. To be able to group this Order taxonomically in the Animal Kingdom.
2. To be able to recognise all 230 South African species as belonging to the Order Squamata, based on external morphology.
3. To gain an insight into thermoregulation as it relates to reptiles in general and lizards in particular.
4. To categorise all South African species into their respective families.
5. To have a general understanding of the ecology of the group and their role in all ecosystems where they may be encountered.
"Reptiles and amphibians are sometimes thought of as primitive, dull and dimwitted. In fact, of course, they can be lethally fast, spectacularly beautiful, surprisingly affectionate and very sophisticated."

— David Attenborough
Sub-order: Lizards (Sauria)

Origin and Classification

The earliest fossil remains of lizards found so far date back to the Carboniferous period (286 - 360 million years ago), whilst the earliest fossils of worm lizards date to the Palaeocene at about 65 million years before the present.

For more insights into the fossil record, please refer to Module # 1, component #2 – Origin of Life, Evolution and Natural Selection. Lizards are classified in the following way as shown in this example of a Striped skink.

<table>
<thead>
<tr>
<th>Kingdom:</th>
<th>Animalia</th>
<th>(Animal Kingdom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum:</td>
<td>Chordata</td>
<td></td>
</tr>
<tr>
<td>Class:</td>
<td>Reptilia</td>
<td>(Reptiles)</td>
</tr>
<tr>
<td>Order:</td>
<td>Squamata</td>
<td>(Scaley ones)</td>
</tr>
<tr>
<td>Suborder:</td>
<td>Sauria</td>
<td>(Lizards)</td>
</tr>
<tr>
<td>Family:</td>
<td>Scincidae</td>
<td>(Skinks)</td>
</tr>
<tr>
<td>Subfamily:</td>
<td>Lygosomatiinae</td>
<td>(Advanced skinks)</td>
</tr>
<tr>
<td>Genus:</td>
<td>Mabuya</td>
<td>(Typical skinks)</td>
</tr>
<tr>
<td>Species:</td>
<td>striata</td>
<td>(Striped skink)</td>
</tr>
<tr>
<td>Subspecies:</td>
<td>striata</td>
<td>(Typical striped skink)</td>
</tr>
</tbody>
</table>

For more on how animals are classified, please refer to Module # 1, component #1 – Classification and Taxonomy.

Lizards are distinguished from other reptiles by the following combination of characteristics:

- The majority have limbs with **claws** at the ends of the digits. Many genera have developed highly specialised digits, depending on their chosen habitat.
- All but the geckos have **moveable eyelids**.
- Most have external ear openings.
- Their bodies and tails are **elongated**.
- The **right lung** in worm lizards is reduced or absent.
- The majority **can shed** their tails.
- Ventral **scales** are always in multiple rows.
- Lower **jaw bones** are **fused** at the anterior edge.
- The **tongue** is usually short, broad and non-retractile.

There are more than **3700 species** and subspecies of lizards world-wide, with approximately **230 species** and subspecies occurring in **Southern Africa**.
**External Anatomy**

The basic appearance of lizards is so familiar to most people that they do not require description. A few anatomical peculiarities are, however, listed here.

- Most lizard species **shed their tails** when **threatened** or **attacked**. This is known as **autotomy**. The tail can often be **regenerated** after this damage.

- Worm lizards are highly **adapted to burrowing**. Their skins are loosely joined to the body and they are thus able to thrust up and down in their skin to act as a "battering ram".

- **Chameleon species** have a **prehensile tail** (a tail with the ability to grip) which helps them hold onto vegetation whilst feeding.

- Lizards regularly **shed their skins**, since this does not grow along with the individual. Unlike snakes, however, the skin is usually **shed in pieces and is frequently eaten**.
**Colouration and Markings**

The colour and markings of most lizard species are designed to provide **maximum camouflage** within that species’ chosen habitat.

The chameleons, however, can adapt their body colouration to match that of their surroundings. These colours are normally in shades of green, brown and yellows. Special colour patterns are displayed in courtship or threat scenarios. Its colour may also change in response to temperature and other environmental changes. The change in colour is controlled partly or entirely by the sympathetic nervous system. The initial impetus for a colour change will be in response to something the animal has seen.

Unlike other reptiles, male lizards frequently show a change of colouration during the breeding season. These vivid colours are used as territorial displays. Therefore, this ability to change colour is not only limited to the Family that contains the chameleons.

![Image: Luke Kemp](image-url)
Lizards are very variable in size, ranging from the gigantic Komodo Dragon which reaches a length of 3m (± 10 ft.), down to the very small dwarf geckos which only attain a length of 7 cm (± 2.5 in.).
The Origin of Modern Reptiles

The Origin of Modern Reptiles is a controversial and much debated topic. There are several competing theories that are each supported by some physical evidence, none conclusively or definitively enough to satisfy everyone.

The two main schools of thought are that Modern Reptiles evolved from Dinosaurs or that they didn’t.

To determine which scenario is more likely, palaeontologists look to the features of modern reptiles, specifically lizards and compare them to the fossil characteristics of dinosaurs.

The ways in which these groups differ is as follows:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Dinosaurs</th>
<th>Modern Reptiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Massive in many species</td>
<td>Mostly small</td>
</tr>
<tr>
<td>Endothermy</td>
<td>Possibly endothermic</td>
<td>Ecotothermic</td>
</tr>
<tr>
<td>Heart chambers</td>
<td>4 (found in one specimen)</td>
<td>Always 3</td>
</tr>
<tr>
<td>Lung Structure</td>
<td>Bird like</td>
<td>Reptile like</td>
</tr>
<tr>
<td>Bipedalism</td>
<td>Many examples</td>
<td>Almost absent</td>
</tr>
<tr>
<td>Hip structure</td>
<td>Bird like</td>
<td>Reptile like</td>
</tr>
<tr>
<td>Coloutration</td>
<td>Assumed very variable</td>
<td>Not very variable</td>
</tr>
</tbody>
</table>

Since many of the characteristics of dinosaurs are “possibilities” and not standard though out the group, it’s difficult to draw concrete conclusions.
Senses

Lizards generally have a well-developed sense of smell. The monitor lizards use their tongues for scenting in exactly the same way as the snakes. Scent particles are transferred to the Organ of Jacobson (situated on the roof of the mouth) by the tips of the tongue. Sensory epithelial cells then interpret the message.

Most lizards have very acute eyesight which they use to detect predators and prey. Since the males of many species show bright breeding colours, it has been assumed that some lizards can see colours in some ranges of the spectrum.

The external ear opening of lizards is adapted to allow them to hear quite well. Chameleons have poor hearing because they do not have a well-developed middle ear. Hearing is used mostly to detect the approach of predators.

Young Water Monitor - Varanus niloticus
Feeding Habits

Lizards have stout, **conical peg-like teeth** that enable them to **crush their prey** before swallowing it. Their jaws are well developed and are often powered by very **strong muscles**, another adaptation enabling them to crush the **exoskeleton** of their chosen insect prey. Only the **monitor lizards** show any ability to **swallow extremely large prey**.

**All lizard species in Southern Africa are carnivorous** and prey on a wide variety of **insects, scorpions, spiders, amphibians, mammals, birds, fish, bird’s eggs** and other **lizards**. Their digestive juices are very strong but are incapable of digesting keratin, the substance comprising the exoskeleton of insects.

Most lizards simply **rush up** to their prey, **seize it** and **crush** the entire body in a rapid chewing motion up and down the body. The prey is swallowed thereafter. After feeding, lizards often **rub their mouths on the ground** to wipe off any body fluids and dirt that may have accumulated there.

**Chameleons** show the remarkable ability to shoot their **tongues** out to capture prey. This is achieved by a special arrangement of bones and muscles on the floor of the mouth. Contrary to popular belief, **chameleons do not roll up their tongues**.

Reproduction

Male lizards have paired copulatory organs known as hemipenes. These lie on either side of the tail just behind the cloaca and are retracted into the body when not in use. Before copulation, the hemipenes are projected forwards and are turned inside out by a muscle attached to the end of each organ. Copulation takes place with only one of the pair of hemipenes actually penetrating the cloaca of the female.

Most species of lizards are oviparous, and lay eggs that are quite like those of snakes in that they are covered in a parchment-like material. The eggs are laid and left to incubate under natural conditions.

Other species, however, retain the eggs within the body cavity until incubation is complete and thereafter give birth to live young. This is known as ovo-viviparous.

Some gecko species have communal egg-laying sites and congregate there to mate and lay eggs.
**Defence**

Lizards are not usually able to defend themselves successfully from predators since they are so small. Most species therefore rely on **agility** and **speed** to escape predation.

If this is not successful, many species can **shed their tail**, which once free of the body begins to wriggle around. This movement is aimed at **attracting the attention of the predator** and thereby allowing the lizard to escape. Should a lizard be grasped by the tail by a predator, the same system of **autotomy** is implemented.

Other species of lizards have developed warning signs to scare would-be predators.

- **Chameleons** hiss, gape their mouths and inflate their bodies to make them look large and dangerous. They also **change their colour** to black to appear more intimidating.

- Some species of **worm lizards** wave their tail around in the air if cornered by a predator to attract attention to it rather than to their more vulnerable head.

- The **monitor lizards** will hiss and lash out with their tails at predators. Should they be attacked, they often **bite** and **scratch viciously**, as well as **emptying their bowel** content over the attacker. If this does not deter the predator, they sometimes **play dead** in the hope that the attacker will lose interest in them.
Thermoregulation and Hibernation

Lizards are **ectothermic**. This means that their body temperature is **determined by external conditions**. Temperature regulation is therefore carried out by the lizard positioning itself to take advantage of direct, convected or conducted heat. This allows it to adopt its ideal operating temperature. If the temperature gets too high, then the animal will remove itself from all heat sources until the correct temperature is again reached.

Most species of lizards (and indeed reptiles in general) prefer conditions ranging from about 25 - 30 °C (± 77 – 86 °F). At temperatures below 21°C (± 70 °F) lizards become **inactive**.

During the cold winter season, most lizards **hibernate**, surviving on large **reserves of fat** that have been built up during the summer. Hibernation is characterised by a **reduction in the speed of all body functions**. In the warmer areas of the country, some species do not hibernate, but are simply inactive on the very coldest or overcast days.

**The Endangered Pondo or Transkei Dwarf Chameleon - *Bradypodion caffer***
Venomous Lizards

Of the 3,700 or so species world-wide, there used to be only two species that were classified as venomous, both found in the Americas. These are the Gila Monster and the Mexican Beaded Lizard.

An important Update

The Komodo Dragon, found on the island of Komodo east of Java, was initially believed to be venomous but later this assumption was overturned and the “venom effect” was then attributed to its vile saliva which teemed with over 80 species of bacteria, a product of carrion rotting between its teeth.

Those bitten by a Komodo Dragon experience effects that ranged from shock, massive bleeding & neurotoxicity within the first few hours and then death, curiously no known Bacteria work in this manner.

Enter Bryan Fry Ph.D. (Dept. of Biochemistry University of Melbourne, Australia) whose research has found that the Komodo Dragon has the same venom glands that are found in snakes.

Using magnetic resonance imaging to scan the head of a Komodo Dragon researchers noticed that it has large bulges along the of lower jaws on either side of its head. This revealed an arrangement of venom glands like those found in snakes.

The lizard’s sharp, serrated teeth open wounds into which the venom flows from the gland that runs along the jawline. The venom acts as an anticoagulant, increasing the blood flow and reducing blood pressure, sending the victim into shock. The victim’s blood cannot clot and it bleeds to death.

The venom makes the animals formidable killers even though their bite is much weaker than that of a crocodile. “The teeth and the venom work in perfect harmony,” said Fry, the head of the international team whose research on the lizard’s killing powers is published in the US journal Proceedings of the National Academy of Sciences.

The venom is as potent as those found in the word's most venomous snake, Western Australia's inland Taipan.

Snakes typically have a single venom duct that leads to their fangs. But Komodos have multiple ducts located between their teeth.

However, this means Komodo dragons don't deliver their venom as efficiently as snakes, rather than injecting venom directly via a forceful bite, the dragons use a specialized bite-and-pull motion to ooze the toxin into wounds during a sustained, frenzied attack.
Lizard Families in Southern Africa

Southern African lizards and worm lizards are divided into the following families:

**Tropical Worm Lizards - (Amphisbaenidae)**

Small, highly specialised burrowing reptiles capable of burrowing in extremely hard ground. All are limb-less. All lack external ear openings, and have rearward facing nostrils to prevent ingress of dirt during burrowing. Scales are arranged in annuli (rings) giving them an earthworm-like appearance. Most species prey on termites and other soft-bodied invertebrates.

12 species are found in Southern Africa.

© Valter Jacinto
Chameleons - (Chamaeleonidae)

All have protruding, independently moveable eyes. They all have laterally compressed bodies. The scales are small and granular and do not overlap. The digits of the feet are opposable and able to exert a strong grip for climbing. The tail is prehensile and not sheddable. The tongue is telescopic and can be protruded for a distance greater than the body length. Most species are arboreal. All display the ability to change colour according to the surroundings.

There are 16 species known in Southern Africa.
Agamas - (Agamidae)

These are stout, triangular - headed lizards with small granular body scales. Tails are short and thin and not sheddable. Pupils are round, and eyelids are moveable. Some species show the third eye or Pineal eye. All are active, diurnal species. Most feed on ants and termites. Males develop distinct breeding colouration, and are quite territorial.

Nine species are found in the region.

Male Southern Rock Agama - Agama atra – Luke Kemp
**Geckos - (Gekkonidae)**

All have fixed eyelids and clean their eyes with their tongues. All species are vocal - the only reptiles in which this ability is well developed. Toes are highly adapted and may be *webbed, sticky* or *fringed* depending on the substrate on which the species is found. All are oviparous. All have tails that can be shed. The majority are nocturnal.

**64 species** are found in Southern Africa.

![Image of a gecko]

**Whalberg's velvet gecko - Homopholis whalbergii** – Luke Kemp
**Monitors** - (Varanidae)

This family contains the **largest lizards in the world**. All have muscular bodies and tails and their limbs are strong and armed with well-developed claws. **Tails cannot be shed** or regenerated if damaged. Tongues are forked and retractable. Many species are **semi-aquatic**. All are oviparous and lay their eggs in termite mounds.

**Two species** are found in Southern Africa.

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**Water Monitor**
Skinks - (Scincidae)

Scales are smooth and overlapping and often appear iridescent. Most species are terrestrial or fossorial. Many have reduced limbs for burrowing. All species can shed their tails.

59 species are found in the region.

Striped skink - *Trachylepis striata* – Luke Kemp
Plated Lizards and Girdled Lizards - (Cordylidae)

Body scales are usually overlapping, rectangular plates which may or may not be heavily keeled and armoured. Eyes and ears are well developed. The body is normally dorso-ventrally depressed with a lateral fold in the skin.

52 species are known in Southern Africa.

Van Dam’s Girdled Lizard - *Smaug vandami* 
(Above Image: Warren R Schmidt)
Old World Lizards - (Lacertidae)

All have slender bodies, elongated tails and well developed limbs with claws. Tails may be shed and regenerated. Most are active and **diurnal**, some are known to be **fossorial**. All species are oviparous.

**30 species** are known in the region.

*Lacerta agilis argus* female