

Hawaiian Reptiles and Amphibians

150



By Sean McKeown

HAWAIIAN REPTILES

AND

AMPHIBIANS

BY SEAN MCKEOWN

SUPERVISING HERPETOLOGIST – HONOLULU ZOO

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Back Cover: Green Iguana (*Iguana iguana*)

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Jackson's Chameleón
Chamaeleo jacksoni

male

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Bullfrog (*Rana catesbeiana*)

AN INTRODUCTION

The composition of Hawaii's herpetofauna (reptiles and amphibians) while interwoven with the location, topography, and flora of the Islands, is primarily a result of man's activity. Located near the middle of the Pacific Ocean, the Hawaiian Islands are isolated from the continents of North America and Asia by distances greater than 2,400 miles. The climate is mild. Temperatures average in the 70's and 80's with seasonal temperature fluctuations of less than 10 degrees. Topography ranges from beach to tropical valley to high mountain slope. Rainfall over adjacent areas often differs markedly.

The Hawaiian Islands are volcanic in origin and have never been connected to any major land mass. The archipelago, consisting of more than 20 islands, extends in a fairly linear chain across 1,600 miles (2,560 km) of the north Pacific: seven of these at the southeast end of the chain are inhabited. These include Hawaii (called "the Big Island" as it is almost twice the size of all the other islands combined), Maui, Oahu (on which Honolulu is located), Kauai, Molokai, Lanai and Niihau. The small islands and coral atolls in the northwest are locally known as the Leeward Islands and are designated as a wildlife sanctuary for many seabirds, Pacific Green Sea Turtles, Monk Seals, and other indigenous wildlife.



Pacific Green Sea Turtle

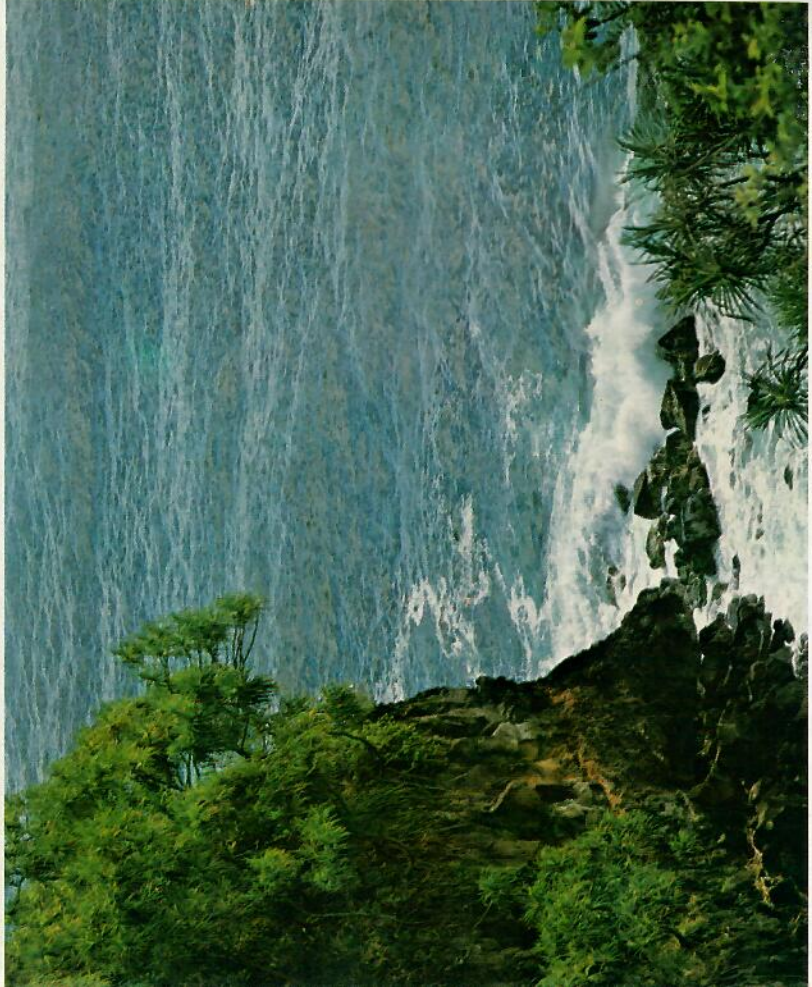
Chelonia mydas agassizii

There are 22 species of reptiles and amphibians which occur in Hawaii or its surrounding waters. Eighteen of these are either terrestrial or semi-aquatic, representing only a small sample of the variety found in most continental areas. Virtually all of these forms have become established in Hawaii recently through the agency of man. Only the marine reptiles — a sea snake and three species of marine turtles — may be considered indigenous to (naturally occurring in) Hawaii. All four are found over a wide area of the tropical Pacific.

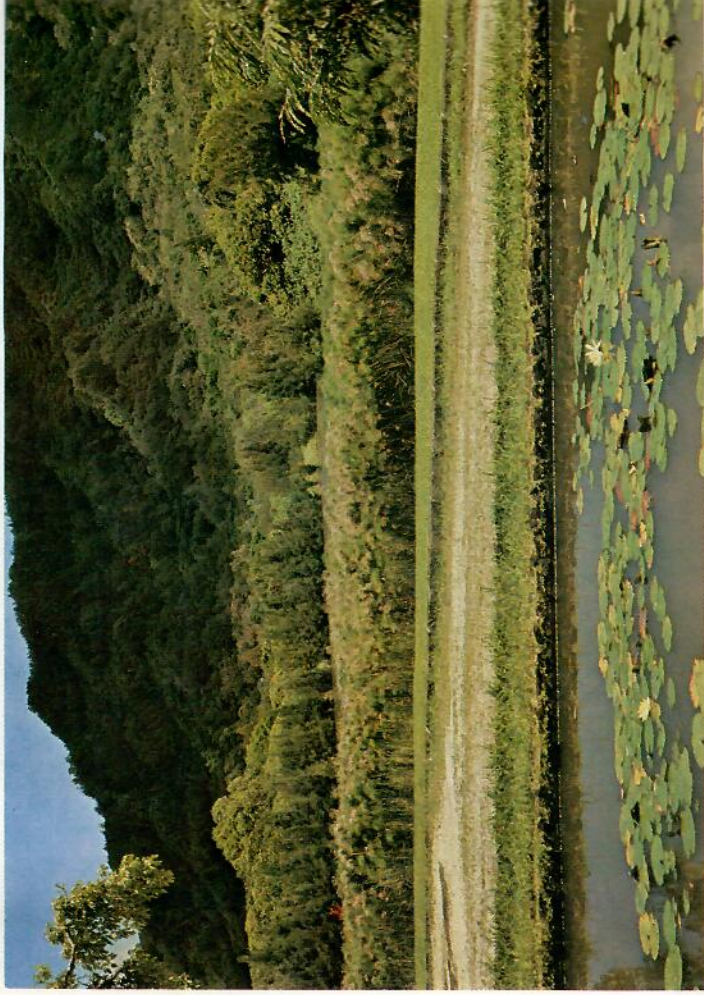
Amphibians as a group, because of their soft, moist skins, are not adapted to dispersal across saltwater and are rarely present on oceanic islands. Of the four species of frogs and toads, all may be categorized as purposely introduced. The Bullfrog was brought in from California for food in 1867 and 1879. Albert Koebele, a biologist employed by the Republic of Hawaii, introduced four species of frogs and toads from Japan as well as several species from California for insect control in 1896. One of the four introduced Japanese species is the Wrinkled Frog. Two of the others may have been the Asiatic Toad (*Bufo bufo*) recorded only from Kauai by Svihla in 1936 and the Black Spotted Frog (*Rana nigromaculata*) reported from Oahu by Tinker (1941). Neither are part of the current herpetofauna. Tinker (1941) also lists the Green Frog (*Rana*

5 *clamitans*) probably misidentified, and Bryan (1915) and Tinker (1941) mention a toad from Oahu, most likely the California Toad (*Bufo boreas halophilus*) which also is no longer present. In 1932, at the request of Hawaiian Sugar Cane Association, C. E. Pemberton introduced 148 adult Giant Neotropical Toads onto Oahu to feed on sugar cane beetles. He reported a mere two years later that their number had swelled to over 100,000. One other anuran purposely introduced was the Green and Black Poison-Arrow Frog, also in 1932. In that year David T. Fullway brought in 206 of these frogs from either Toboga or Tobogilla Islands in the Gulf of Panama and released them in upper Manoa Valley for mosquito control. These frogs have since spread to other moist valleys on both sides of the Koolau range.

Seven species of lizards, including four geckos, the Mourning Gecko, Stump-toed Gecko, Tree Gecko and Indo-Pacific Gecko as well as three skinks, the Moth Skink, Snake-eyed Skink, and Azure-tailed Skink were probably present in Hawaii before the arrival of Captain James Cook and the first Europeans. Because of the wide dispersal of all of these lizards on Pacific islands and because of their morphological uniformity throughout their range, it is believed that they were unintentionally transported to the Hawaiian Islands by the early Polynesians in their double-hulled voyaging canoes.



Tropical Beach — near Akaka Falls (Big Island)



Water Reserve — Nuuanu Reservoir (Oahu)

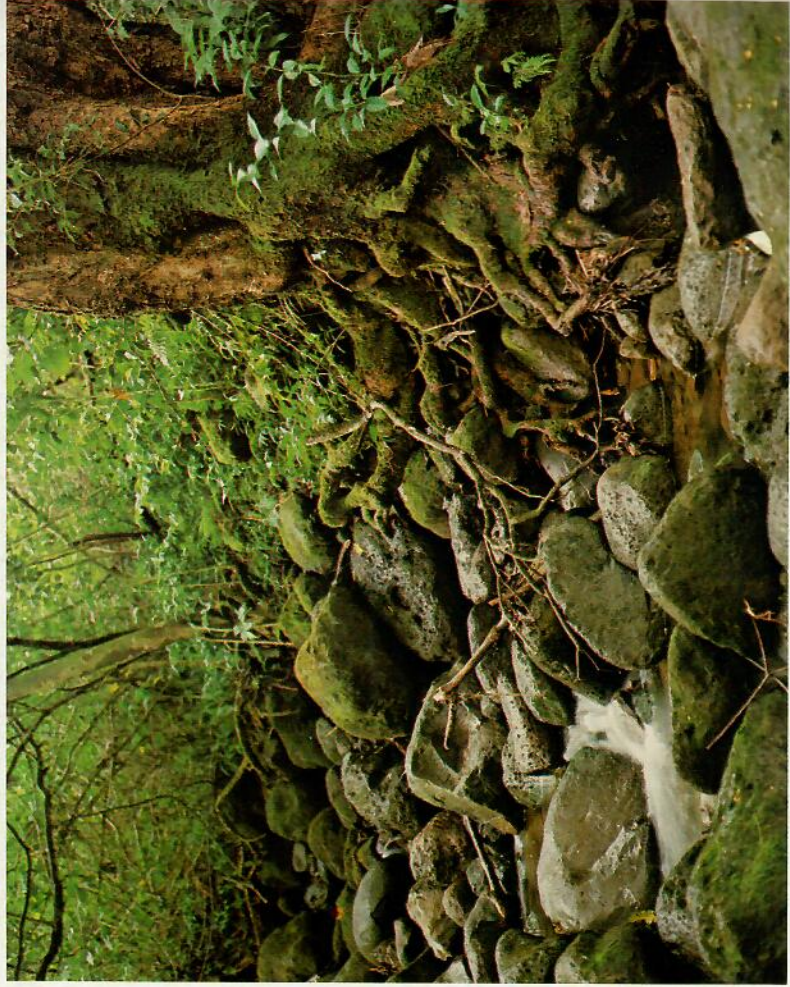
However, rafting on floating debris cannot be entirely ruled out. Both geckos and skinks are superior rafters and stowaways. Geckos can hide almost anywhere and their eggs have an unusually hard durable shell that can stand up to adverse conditions. Skinks, because of their streamlined shape and burrowing nature, have the ability to get under and inside wood and other material and in this way protect themselves from both detection and external hazards. The remaining gecko, the House Gecko, is believed to have entered Hawaii as a stowaway aboard equipment moved between Pacific Islands during or just following World War II. The presence of the single remaining skink, the Metallic Skink, is somewhat more enigmatic. First recorded in 1909, it is small, generalized and potentially a good stowaway, but is largely absent from Polynesia and is instead native to Australia, more than 3,000 miles away. Perhaps this lizard arrived aboard a shipping vessel bringing in wood or plant imports. While its origins and date of entry are in doubt, today it is the most common species of skink on all the major Hawaiian Islands.

There are three lizard species that remain to be discussed. Two are iguanids and one is an Old World chameleon. The first of these is the Green Anole Lizard. First observed by Paul Breese in the Kaimuki district of Honolulu in 1950, it has spread over much of Oahu and to several of the other islands. The Green Anole, locally called "chameleon," is often sold in pet shops in the islands, and no doubt many of these have been released on purpose or escaped. As the only diurnal, arboreal insect-eating lizard, it was a natural to catch on.

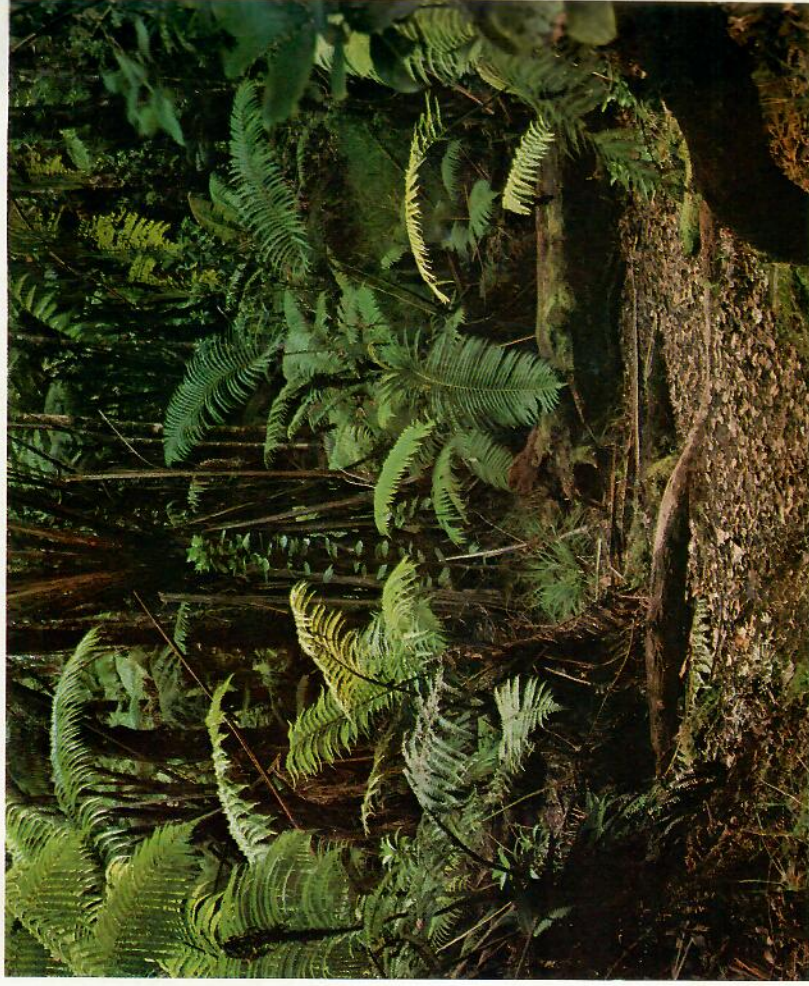
The second species of this family to become established is the Green Iguana, a native of Mexico and Central America. Wild specimens, probably escaped pets, were reported to the State Department of Agriculture beginning in the 1950's. Reproductive colonies exist in Nuuanu and Manoa Valleys as well as in several other locations on Oahu. This lizard has not as yet spread to neighboring islands.

Another iguanid, the Texas Horned Lizard (*Phrynosoma cornutum*) was reported by Hunsaker and Breese (1967) to be a permanent resident of Oahu during the late 1960's, a time when it was available in several of the local pet shops. While this species may have survived in the wild for one or two generations, it eventually died out. Its demise could have been predicted considering the low humidity levels of desert areas this lizard normally inhabits compared with the high humidity level throughout Oahu.

Perhaps the most unique reptile to become established in the Hawaiian Islands is the remarkable Jackson's Chameleon. This is a true Old World chameleon from East Africa with turreted eyes, a retractable pistol-like tongue, and, of course, the ability to vary its color. This lizard was imported by a pet shop owner on Windward Oahu and a number were released by him in the early 1970's in Kaneohe and Kailua to which they readily adapted and began reproducing.



Stream Valley — Manoa Stream (Oahu)



Fern Forest — Volcanoes National Park (Big Island)

The only land snake to be found in the wild in Hawaii is the tiny secretive Hawaiian Blind Snake. This reptile, an expert stowaway, is believed to have been introduced unintentionally from the Philippines amidst soil surrounding a large shipment of plants used in landscaping the campus of Kamehameha Schools in Honolulu in 1929. It is now present on much of Oahu and has spread to the other main islands.

The single established freshwater turtle, the Chinese Softshell Turtle is reported by Brock (1947) to have been imported from the Orient alive, as an item of food prior to World War II and raised locally in fishponds. The wild populations on both Oahu and Kauai are descendants of both purposely released, and escaped individuals.

In summary, of the 22 species of reptiles and amphibians of the Hawaiian Islands, only three marine turtles and one sea snake are indigenous. Seven of the skinks and geckos probably arrived with the Polynesians. The single land snake, one skink and one gecko may be considered recent accidental importations, while the only fresh water turtle, three remaining lizards and all four frogs and toads can be classed as purposely introduced foreign species.

AMPHIBIANS

Class Amphibia

INTRODUCTION

Amphibians are an ancient class. Fossil skeletons have been dated from the Devonian period, 280 million years ago. The word "amphibian" is derived from the Greek *amphi* meaning both or double and *bios*, meaning life. The term implies an animal that leads a double life, or put another way, one that lives on both land and in water. There are approximately 2,500 living species of the class Amphibia. They are divided among three orders: the frogs and toads (order Anura), with over 2,000 species; the salamanders (order Caudata) containing approximately 300 species; and the caecilians (order Gymnophiona) with about 160 species.

RELATION TO OTHER VERTEBRATES

Amphibians are ectothermic ("cold-blooded") vertebrates that stand intermediate on the evolutionary scale between the aquatic fish and the semi-aquatic and terrestrial reptiles. They have soft, moist bare or warty skin liberally supplied with mucous glands. Most amphibians are poorly adapted to living exclusively on land and must never venture too far from water or cool, damp places because their skin is in constant danger of drying out. Normal moisture loss is replaced through skin absorption.

LIFE HISTORY

The amphibian life cycle begins with the fertilized egg. Fertilization is usually external. The egg develops into a larval form which breathes through the use of gills and lives out its life in water. The larva undergoes a metamorphosis that prepares it for a second life on land. The cycle is completed when the adult again returns to the water to breed. There are, however, exceptions to the characteristic life cycle — a few frogs and toads and some salamanders bypass the aquatic stage altogether and emerge as fully formed, miniature adults.

Of the three orders of amphibians, only the frogs and toads (anurans) occur in Hawaii.

FROGS AND TOADS

Order Anura

Frogs and toads are easily recognizable to most people. Typically they have short, fat bodies, slim waists, and no tail. All have four legs, generally with four toes on each of the front feet and five each on the hind feet. The rear legs are usually well developed for hopping or jumping with webbing between the toes.

The majority of anurans are highly vocal. Usually only the males sing. During periods of courtship and mating, the calls draw both sexes together in an aquatic environment for egg laying and amplexus. During amplexus, sometimes referred to as the "love hug," the male embraces the female from behind. As the jelly-like, shell-less eggs are laid, the male discharges sperm so that the eggs are actually fertilized in the water outside of the female's body. The number of eggs laid may range from a few to several thousand. Courtship and mating behavior vary from species to species.

All four species occurring in Hawaii develop into larval forms commonly known as tadpoles, or polliwogs. Tadpoles breathe through gills, have mouth parts adapted for scraping and may be either herbivorous or omnivorous. Through a gradual metamorphosis in which the gills and tail are reabsorbed and the limbs are grown, tadpoles transform into miniature adults which grow to breeding size over a period ranging from a few months to two years. Adult frogs and toads breathe air through lungs in addition to skin respiration. They feed on insects and other small animals.

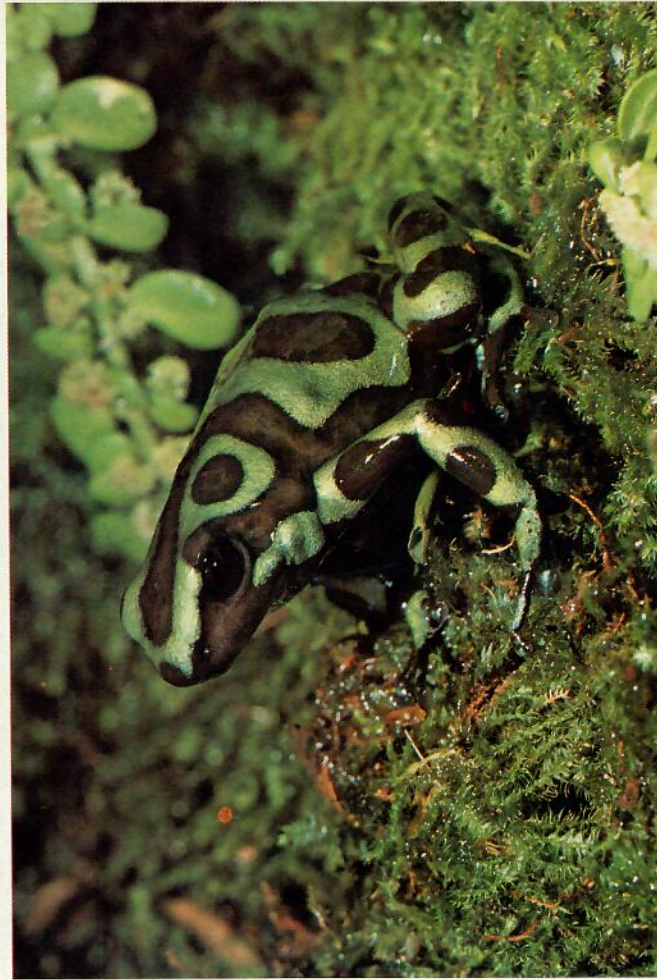
One of the most commonly asked questions is: "What is the difference between a frog and a toad?" The names "frog" and "toad" originated in England where there are only two native families of tailless amphibians. The problem is, on a worldwide basis, these two terms do not accurately describe the majority of the world's anurans which are classified into 14 additional families: some frog-like, some toad-like, and many with characteristics all their own. For these reasons, the vernacular name "frog" may be used for all members of the order while the term "toad" is generally applied to the relatively dry, warty-skinned members of the family Bufonidae.

POISON-ARROW FROGS

Family Dendrobatidae

Poison-Arrow Frogs are tiny brightly colored frogs from the tropical forests of Central and South America. The name "Poison-Arrow Frog" is applied to members of this family because the local Indians use the highly toxic, roasted skin secretions to poison the tips of their darts and arrows to bring down small game. However, these frogs are *not* dangerous to touch as long as the skin secretions are not swallowed, or allowed to enter the eyes, mouth, or open wounds. As an added precaution, one should wash one's hands after handling these amphibians.

GREEN and BLACK POISON-ARROW FROG



Dendrobates auratus

Family Dendrobatidae

The Green and Black Poison-Arrow Frog was introduced into Hawaii in 1932 from Panama to assist in mosquito control in the upper Manoa Valley on Oahu. This vividly marked green and black spotted frog, the size of a 25¢ piece, is the Island's most striking amphibian. The brilliant colors are known as "flash characteristics" and serve as a warning to potential predators that this frog is poisonous, if eaten. The skin toxins, however, are not dangerous to man unless swallowed or rubbed into the eyes. Poison-Arrow Frogs are diurnal. They move with a jerky gait and hop low to the ground. They are most active during and just after rainstorms, and on cloudy days. During the cooler, wetter months of the year (November-April), this amphibian ventures forth in search of mosquitos and other insects and may be found out in the open. However, during late spring, summer and fall, most of these frogs spend their time in moist places such as under debris, logs, stones, tangled root systems or under elevated valley homes. They almost never enter streams but



occasionally frequent standing water in such places as depressions in lava rocks, or rain-water filled debris.

The Green and Black Poison-Arrow Frog has a very unusual reproductive cycle. No amplexus occurs. Instead the female deposits her eggs in a moist place on land where they are fertilized and tended by the male. About two weeks later when they hatch, the male transports the emerging tadpoles to nearby standing water by allowing them to swim onto his back. Later, he may "tadpole-carry" both small and large tadpoles on his back between available water sources. The tadpoles themselves are omnivorous and grow to about $7/8$ of an inch (2.2 cm) before metamorphosis.

Identification: Midnight black or deep chocolate brown with large green or greenish-yellow spots and bars which cover the entire body. Total snout-vent length is less than $1\frac{1}{2}$ inch (3.8 cm). These frogs seldom vocalize.

Distribution: The Green and Black Poison-Arrow Frog is found in well-forested moist valleys on both Leeward and Windward Oahu. It is native to Central America.



Green and Black Poison-Arrow Frog tadpole



"Tadpole Carrying"

TRUE FROGS

Family Ranidae

True Frogs are represented worldwide by over 400 species. Many live in or around rivers, lakes, and streams. Typically they are long-legged, narrow waisted, and smooth-skinned. Most have heavy webbing between their rear toes and are prodigious leapers when escaping from danger.

BULLFROG



Rana catesbeiana

Family Ranidae

The Bullfrog ("Poloka lana") so named for its loud bellowing voice, is the largest frog native to the United States. It is highly aquatic and may be found adjacent to or in larger streams, rivers, ponds, marshes, and reservoirs. It feeds on almost anything that moves and is small enough to be swallowed including a wide variety of insects, snails, slugs, and even mice.

This frog is thought to have been the first amphibian to become successfully established in Hawaii. It was purposely introduced in 1867 and again in 1879 from California as an additional food source. Frog-legs were available in local market places as early as 1900.

The Bullfrog is an excellent swimmer and jumper. A large individual is capable of jumping six feet or more on a single leap. This amphibian is frequently encountered along the water's edge and, if disturbed, makes a squawking noise, followed by a loud splash.

Bullfrogs are active at night. Males stake out territories in the water and bellow to attract the females. After amplexus takes place, the female lays round egg masses up to a foot across among plants on the water's surface. The tadpoles grow to be 3 to 4 inches (7.6 cm–10.2 cm) in length. But because of our tropical climate, they transform into frogs in less than six months instead of the usual two years. These frogs were more common in Hawaii fifty years ago before taro patches and marshes were drained to make way for urbanization.



Bullfrog tadpole



Bullfrog color variant

Identification: Bullfrogs are 4 to 7 inches (10.2 cm–17.4 cm) long. They have smooth skin and are mottled brown with a green snout. The underside is whitish with dark spotting. The eardrum (tympanum) of the male is larger in size than the frog's eye. In females and juveniles, the eardrum approximates the size of the eye. The bullfrog may be distinguished from the Giant Neotropical Toad by the *absence* of both warts and enlarged paratoid glands.

Distribution: Occurs on all the main Hawaiian Islands. It is native to North America and has been transported by man throughout the world.

WRINKLED FROG



Rana rugosa

Family Ranidae

The Wrinkled Frog was introduced into Hawaii from Japan in 1896 for insect control. It has since become established in most mountain streams which offer both abundant shade and year-round clear, cool running water. It likes to bask on rocks protruding out of the stream or along the stream bank. It inhabits some streams with the Bullfrog, the latter living in the broad deeper sections, while the Wrinkled Frog is found in shallow pools. These species are rarely encountered together as the Bullfrog is an aggressive feeder and will consume almost anything smaller than itself including Wrinkled Frogs.

A good leaper, if alarmed, the Wrinkled Frog will dive into the water, frog-kick to the bottom and hide in the leaf litter for five or ten minutes before resurfacing at a different spot.

About the size of a silver dollar and uniform charcoal or brownish-gray in color, the frog derives its common name from narrow ridges along the dorsal surface which gives its skin a "wrinkled" appearance.

metamorphosing Wrinkled Frog



The female lays her eggs in a jelly-like mass in slow moving water amidst protruding sticks and vegetation. The greenish-grey tadpoles grow to about 1½ inches (3.8 cm) before transforming into tiny adults.

Identification: Has a snout-vent length of 1¼ to 1¾ inches (3.2 cm–4.4 cm). It is uniformly grey and *not* mottled brown with a green head like the Bullfrog. Lacks circular bumps (warts) and enlarged parotoid glands like the Giant Neotropical Toad.

Distribution: Native to Japan, the Wrinkled Frog is now found on all the main Hawaiian Islands.



Wrinkled Frog tadpole

TRUE TOADS

Family Bufonidae

True Toads are fat-bodied, warty amphibians with rough, relatively dry skin. They rely on camouflage and toxic skin-secretions to protect themselves from predators. Most are nocturnal and as adults are more terrestrial than aquatic. They do not cause warts. All may be safely handled as long as the skin secretions are not swallowed or brought into contact with the eyes.

GIANT NEOTROPICAL TOAD



Bufo marinus

Family Bufonidae

The Giant Neotropical Toad ("Poloka") referred to locally as "Bufo toad" or "Bufo" was introduced into Hawaii from Puerto Rico in 1932 to control sugar cane beetles and other injurious insects. Although primarily active at night, it is probably the most familiar amphibian to Hawaiian residents because it thrives in well-watered yards and gardens and is common on all the main Islands.

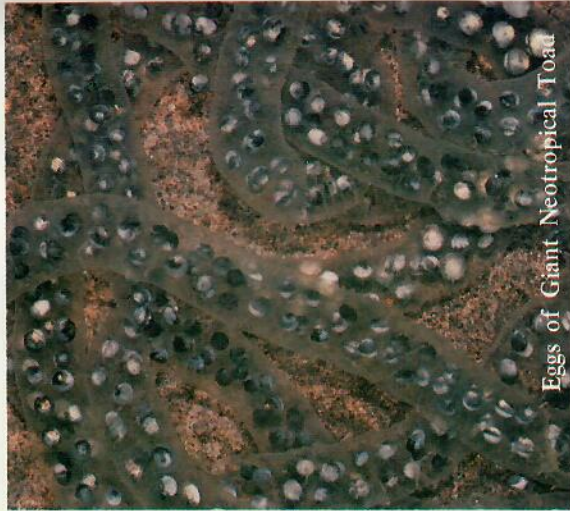
This toad is compact and heavy-bodied, with relatively short legs, rough bumpy skin, and large parotoid glands behind its eyes. Unlike the smooth-skinned Bullfrog, it is not dependent on water except to breed, and can range over wide areas effectively feeding on large quantities of cockroaches, beetles, grubs, crickets, grasshoppers, other insects, spiders and centipedes.

This amphibian breeds in fish ponds, irrigation ditches, temporary pools and reser-



Giant Neotropical Toad *Bufo marinus*

voirs. After sundown, the males enter the water and begin their repetitive trilling call to attract females. During amplexus, the male grasps the female around her chest from behind. Fertilization of the eggs is external. She releases thousands of eggs attached to one another in a string-like manner into the water. After a few days the eggs hatch into tiny dark-colored tadpoles. The tadpoles are herbivorous, feeding on algae and other microscopic plant life. In about a month they are $\frac{3}{4}$ of an inch (2.2cm) long and are ready to undergo metamorphosis. During this process, they grow arms and legs, their mouth changes from a scraping to biting form, their gills develop into air-breathing lungs, and their tail is reabsorbed. Soon large numbers of tiny toadlets emerge onto the land. Only a few will survive to adulthood and return to the water to mate.



Eggs of Giant Neotropical Toad

Identification: Females grow to 6 or 7 inches (15.2 cm–17.7 cm) in snout-vent length, while males reach only two-thirds that size. Both sexes are brown, tan, or greyish in color. Huge paratoid glands and numerous oval warts readily distinguish these toads from bullfrogs and wrinkled frogs.

Distribution: Although native to Mexico, Central, and South America, the Giant Neotropical Toad has been widely transported by man throughout the tropics where sugar cane is grown. It occurs on all the main Hawaiian Islands.



Giant Neotropical Toad tadpole

Special Note: Giant Neotropical Toads are perfectly safe to handle. However they should never be eaten as the paratoid glands and certain other modified warty glands on the backs of these toads secrete a milky white fluid that is highly toxic if ingested, rubbed into the eyes, or brought into contact with mucous membranes.

REPTILES

Class Reptilia

INTRODUCTION

Reptiles evolved from the amphibians. For over 150 million years, from the late Paleozoic through the entire Mesozoic Era, they were the dominant animal group on the earth.

Today there are only about 6,000 species of living reptiles representing four orders. These are the alligators and crocodiles (order Crocodylia) with about 25 species, the turtles (order Chelonia) with approximately 250 species, the lizards and ringed lizards (amphisbaenians) and snakes (order Squamata) with over 5,700 species, and the single surviving member of the order Rhynchocephalia, the Tuatara of New Zealand. Only turtles, lizards and snakes are present in Hawaii.

RELATION TO OTHER VERTEBRATES

Reptiles are vertebrates (backboned animals) that, like the amphibians, are ectothermic, that is they derive their heat from the external environment and control their body temperature by moving between shade and sun as necessary. Reptiles have dry skin, are clad in scales or scutes, and their toes, if present, typically bear claws. These animals were the first group of vertebrates to successfully colonize the great land masses.

LIFE HISTORY

Perhaps the most significant reptilian advance was the development of a "land egg" differing from those of the fish and amphibians by having a hard shell and extra embryonic membranes, the amnion, chorion, allantois, and yolk sac. This major evolutionary adaptation freed the reptiles from the necessity of laying their eggs in water or other moist places as well as the need of a larval stage. Not all reptiles lay eggs, however. Some lizards and snakes are ovoviviparous; that is the female retains the eggs in her body where they hatch, and the young are born alive. In a few species, a primitive placenta actually develops.

Other major reptilian adaptations to a dry environment include skin that is protected by scales in order to cut down on water loss, and well-developed lungs which eliminate the need for respiration through the skin. Equally important is a reproductive advance passed on to the birds and mammals — internal fertilization.

LIZARDS

Order Squamata

Suborder Lacertilia

Lizards are the most successful and adaptable of all living reptiles. Over 3,000 species exist. They not only inhabit every continent except Antarctica, but many oceanic islands as well. There are lizards that live in trees, on the ground, that burrow, that are aquatic, and even one species, the Galapagos Islands Marine Iguana, that has invaded the sea. Lizards, while especially numerous in tropical rainforests and scorching deserts, are also plentiful in many temperate regions, and are even found within the Arctic Circle.

While lizards may vary in size from tiny $2\frac{1}{2}$ inch (6.4 cm) geckos to the $9\frac{1}{2}$ foot (2.9 m) Komodo Dragon, the vast majority of these reptiles are between 5 inches (12.7 cm) and $2\frac{1}{2}$ feet (.76 m) in total length.

Lizards are dry-skinned, scale-covered reptiles that have well-developed eyes with eyelids, external ear openings, four legs, and a long, easily broken tail. While most lizards fit this description, a number do not.

Like snakes, lizards have paired copulatory organs, the hemipenes. Some species are sexually dimorphic. Males may be larger or more brilliantly colored than females.

More than three-fourths of all lizards are insectivorous and play a key role in keeping insect populations in check.

Four families of lizards are represented in Hawaii: the iguanids (two species), the chameleons (one species) the geckos (five species), and the skinks (four species). All but four of the geckos and three of the skinks have entered Hawaii during the past 125 years.

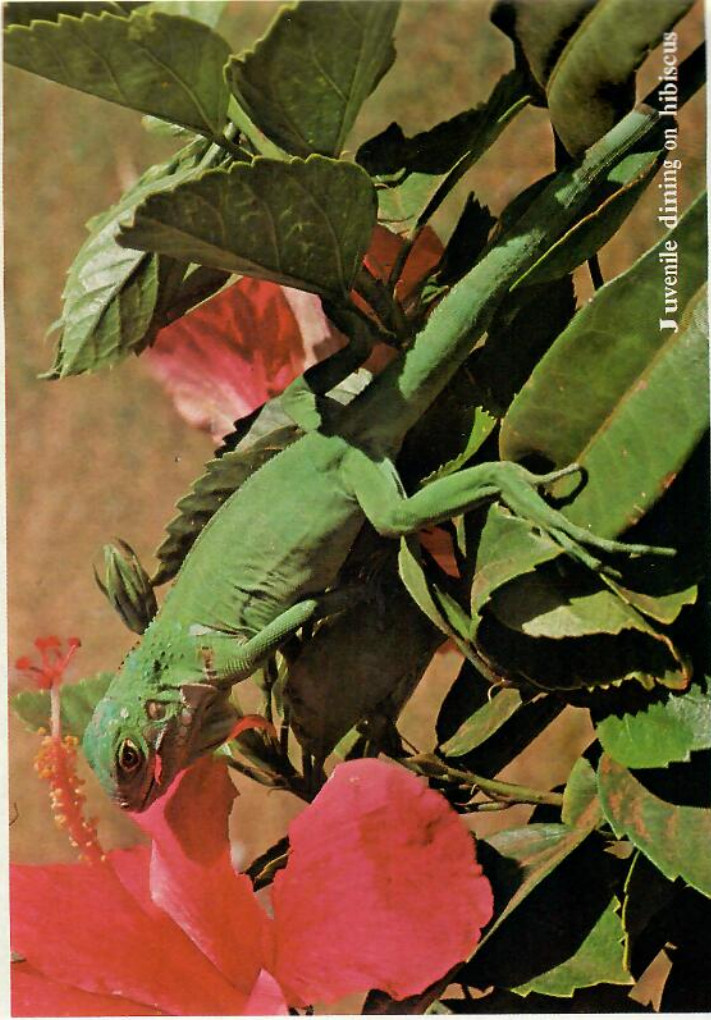
IGUANID LIZARDS

Family Iguanidae

There are slightly more than 700 species of iguanid lizards. Most are found in temperate, tropical, and subtropical regions of North, Central, and South America, although one endemic species lives on the western Pacific islands of Fiji and Tonga and seven others on the Island of Madagascar off East Africa.

They range in size from slightly over 3 inches (7.5 cm) to almost 6 feet (2 m). All have the same pleurodont dentition in which the teeth of the lower jaw are attached on the inner surface instead of along the jaw margin. Most are either terrestrial or arboreal and have well-developed limbs, round pupils, movable eyelids, and relatively long tails. Two species have been successfully introduced into the Hawaiian Islands.

GREEN IGUANA



Iguana iguana

Juvenile dining on hibiscus

Family Iguanidae

The Green Iguana is a 3 to $5\frac{1}{2}$ foot (.9 m – 1.68 m) lizard, two-thirds of which is a long slender tail. Despite its size and initially awesome appearance, it is gentle-dispositioned and poses no danger to people or pets. This lizard is primarily a vegetarian



CLOSE-UP OF HEAD

against its sides and using its tail as a paddle, swim underwater to the protective cover of shoreline vegetation.

Males display to other males and to females in order to show dominance, and to confirm territory during courtship. Head bobbing plays the principal role. A male will distend its dewlap (throat fan) and repeatedly nod its head up and down. Less dominant males will usually seek unoccupied areas nearby and only rarely will a fight ensue.

Identification: The large size of this lizard immediately distinguishes it from other island species. Young individuals are bright green while adults frequently have some brown banding and old males are often a rust-brown color. There is a single row of impressive spines that extends along the crest of the back. A large circular shield known as the subtympenic plate is present under the ear. The dewlap is well developed. This species used to be one of Hollywood's favorites for depicting prehistoric dinosaurs.

Distribution: First recorded in the wild in the 1950's, this lizard is found in Mānoa and Nuuanu Valleys, and Aina Haina on Oahu, although its distribution is spotty. It is indigenous to Mexico, Central and South America. In Latin America, its eggs and flesh are regularly eaten and it is sometimes called "gallina de palo" (chicken of the tree).

and feeds on brightly colored flowers, tender shoots, leaves and fruits, although young individuals may also eat insects. It lives in forested areas and in stream valleys.

The Green Iguana is fast, a good climber, and very difficult to catch. Its principal defense is camouflage, followed by a speedy retreat to the nearest tree. It is sometimes encountered basking on a tree limb near water and is a good swimmer. If afforded the opportunity, it will dive into the water, and with its legs



GREEN ANOLE LIZARD



Anolis carolinensis porcatius

Family Iguanidae

The slender 6 to 8 inch (15–20 cm) Green Anole Lizard initially became established in the Kaimuki district on the island of Oahu in about 1950 through the release of pet store imports. Sometimes called the “American Chameleon,” it is in fact an iguanid (Family Iguanidae) and is not related to the Old World chameleons. It does, however, possess the ability to vary its color between green, brown, tan, and grey. These variations are the result of rearrangement of pigment cells in the skin, and in response to such stimuli as degree of activity, particular emotional state, temperature and humidity.

This lizard has elongated toepads with many transverse ridges on the undersurface that aid in climbing trees, bushes, and other rough horizontal or vertical surfaces. It has a long slender tail which will break off if the lizard is seized by that appendage.

The Green Anole Lizard becomes active as soon as it is warmed by the sun's rays. Any morning dew or raindrops are lapped off surrounding foliage. This lizard moves at a slow pace along the top of a fence or tree limb in search of insects and spiders to feed on. It has a strong sense of territoriality and, should another male enter its area, the defending male extends his pink dewlap (throat fan) and bobs up and down as if doing a

series of pushups. The intruding male will either respond in kind or turn and leave. If he stays, both continue to threaten until a fight ensues. The loser, with little more than a deflated ego and a few bite marks, moves rapidly away. An intruding female, in contrast, will either be ignored or courted. During courtship the male bites the female's neck, wraps his tail around hers, and extends and inserts his hemipenis into her cloacal opening. Several weeks later she will deposit four to ten eggs under a layer of loose moist soil in a protected spot.

In Hawaii the Green Anole Lizard has filled an empty niche; that of a mobile, diurnal insect eater. It coexists with man and is commonly found in backyards and gardens.

Identification: Small size and bright pink dewlap readily distinguish it from the Green Iguana, the only lizard with which it might be confused.

Distribution: This reptile is common in residential neighborhoods throughout Oahu, and at some localities on Maui and the Big Island (Hawaii). As it is popular with local people, it is likely that it will soon spread to the other main islands as well. This lizard is a native of Cuba. A closely related subspecies lives in the Southeast United States.





Green Anole Lizard
Anolis carolinensis porcatius

CHAMELEONS

Family Chamaeleonidae

Chameleons, family Chamaeleonidae, are particularly fascinating because of three adaptations: their ability to change colors, hues, and patterns quickly; the fact that their eyes, set in turrets, move independently of each other; and their remarkable tongue, which can be shot out of the mouth with considerable speed to capture prey at a distance greater than the total length of the body of the lizard. There are about 80 species of chameleons worldwide, the great majority of which live either in Africa or on Madagascar. Several others are found in Spain, Sri Lanka (Ceylon) and India. The word "chameleon" has become synonymous with color change.

JACKSON'S CHAMELEON



male

Chamaeleo jacksoni

Family Chamaeleonidae

The 6–10 inch (15.2 cm – 25.4 cm) long Jackson's Chameleon, a native of East Africa, entered Hawaii via the pet shop trade in the early 1970's.

This lizard is highly specialized for living in bushes and trees. It has opposable toes on all four feet for sure footing, even on slender branches. The prehensile tail, which is normally coiled, can be used as a fifth grasping appendage when the lizard is stalking a prospective meal. It can flatten its body from side to side for wind resistance and concealment. In addition, the independently swiveling eyes set on turrets provide both independent and binocular vision. Often this reptile will sway from side to side while pursuing an insect in order to view it from several angles and gauge the distance between itself and its intended prey.



female

Chameleons are the "sharpshooters" of the lizard world. The thick hollow tongue, enlarged and sticky at the tip, may be shot out a full body's length by muscle contraction at an insect and through the use of a second set of muscles, be withdrawn almost instantaneously. When the tongue is not in use, it is coiled in the floor of the mouth. Its movement or motion by an insect which initially attracts the lizard's attention. This reptile feeds on a variety of climbing and flying invertebrates including grasshoppers, crickets, cockroaches, flies, butterflies, moths, spiders, slugs, and snails.

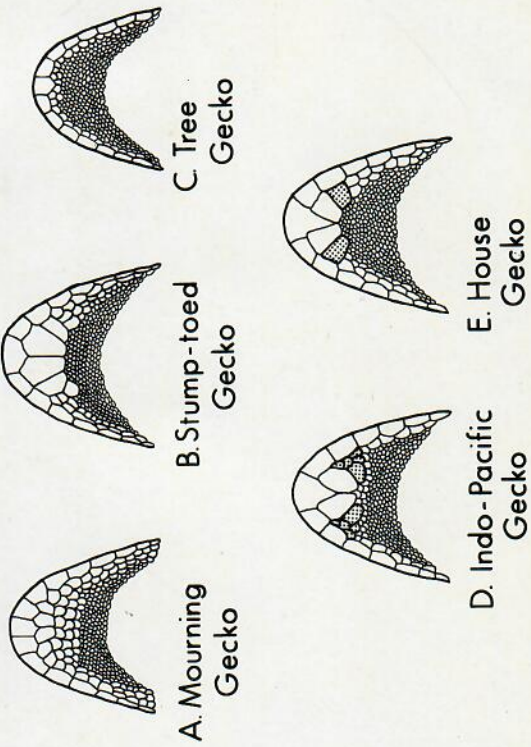
Chameleons are renowned for their ability to change color, from brown to shades of green, yellow, grey, charcoal, and black in solid hues or variously blotched, spotted, or striped. The spectacular color changes are not in response to the coloration of surrounding vegetation as is commonly believed, but rather occur because of changes in emotional state, degree of activity, intensity of light, or the temperature. These changes serve both to camouflage the chameleon and to visually cue other chameleons as to its mood. The species is sexually dimorphic. The adult male has three horn-like projections at the front of the head: one over each eye and a third at the tip of the snout; while the female has none. The horns are used in ritualistic sparring with other males to establish dominance during courtship and in settling territorial disputes. The ovoviparous female may give birth to as many as forty young which are miniature replicas of the mother (Young males develop their horns as they mature).

Identification: The Jackson's Chameleon is so sufficiently distinctive that no additional description is necessary.

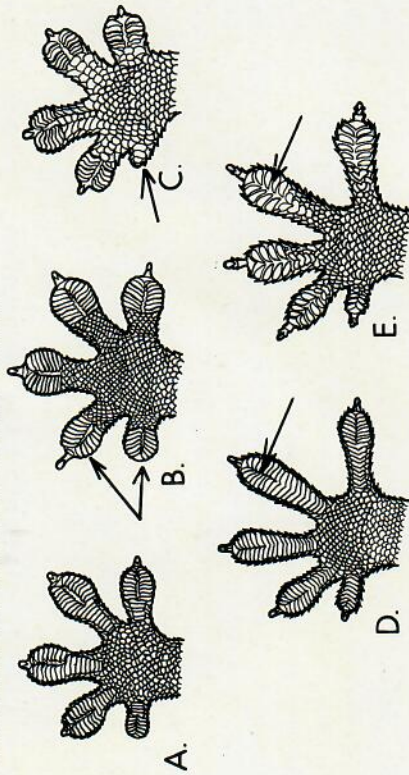
Distribution: Wild reproducing colonies have existed in Kaneohe and Kailua on the moist Windward side of Oahu since 1972, although this lizard does not have widespread distribution. It is native to East Africa.

GECKO IDENTIFICATION KEY

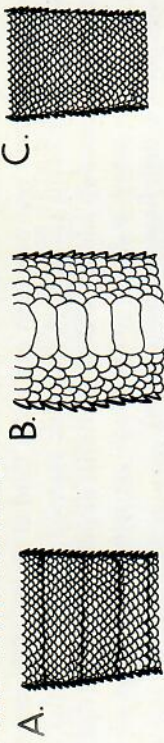
CHIN SHIELDS:



TOE LAMELLAE (RIGHT FOREFOOT):



VENTRAL TAIL SCALES:



DORSAL TAIL SCALES:



GECKOS

Family Gekkonidae

Geckos are a large family of opportunistic lizards well represented in warmer areas of the world. They are unique among lizards in their ability to vocalize, making chirping noises as part of their social interaction. The five species in the Islands all have specialized toe pads, elliptical pupils and are arboreal and primarily nocturnal. All are beneficial to man, consuming large quantities of cockroaches, termites, mosquitos, ants, moths, and other noxious insects.

MOURNING GECKO



Lepidodactylus lugubris

Family Gekkonidae

The Mourning Gecko may have arrived as a stowaway aboard the early Polynesian voyaging canoes. It, like other Hawaiian geckos, has enlarged toe pads. The undersurface of each digit contains microscopic hook-like bristles which fit into irregularities in almost any surface. This enables these lizards to move freely on vertical planes such as tree trunks, walls, ceilings, and even glass.



The Mourning Gecko usually stays hidden under bark or rocks during the day although it sometimes ventures short distances from its hiding place to lick nectar off ripe mangos and papayas that have fallen to the ground. This lizard is gregarious and several individuals may often be found in close proximity. At night this gecko becomes active and can be observed in and around houses and other buildings near lighted areas to which many small insects, its principal food, are attracted. This species is equally at home in residential neighborhoods or in uninhabited areas.

Like other Hawaiian geckos, it has a well-developed voice, and it makes a loud single syllable chirping noise which is repeated five to ten times in quick succession and sounds something like "chik, chik, chik, chik, chik, chik, chik, chik . . ."

The Mourning Gecko is often cream colored, but it can change shades of color between white, brown, and grey and thus camouflages well against most backgrounds.

This species is parthenogenic which means that each and every lizard is a female and each female produces fertile eggs without copulating with a male. Each of these unisexual adults lays two wet eggs which quickly dry and permanently adhere to their immediate surroundings. Usually the eggs are laid under loose bark. Several individual females may lay their eggs in the same spot so that a number may be present, all in different stages of development.

Identification: The skin is smooth and satiny. There are large paired dark spots and bars extending the length of the dorsal surface. The tail is without tubercles, and if regenerated, may be quite bulbous. This is the second smallest Hawaiian gecko and grows to a total length of only $2\frac{1}{2}$ - $3\frac{3}{4}$ inches (6.4 cm - 9.5 cm).

Distribution: After the House Gecko, this is the most common gecko on each of the main Islands. It is also found on many islands throughout the Pacific and occurs as far south as Australia.



utilizing camouflage

STUMP-TOED GECKO



Gehyra mutilata (= *Peropus multilatus*)

Family Gekkonidae

The stout-bodied Stump-toed Gecko has an uncanny ability to vary its body color to blend in with almost any brown, grey, or white background. If foraging for insects near a light on the side of a building at night, it is whitish, almost transparent. When on trees, it is usually a deep chocolate brown.

This lizard has one very alarming escape mechanism. If seized tightly, it will twist in a person's hand so as to slough off large pieces of its skin, exposing bare, pink flesh. It is hard to say how well this trick works on a mynah bird or mongoose, but for *Homo sapiens*, it is very effective.

The Stump-toed Gecko lives equally well in uninhabited areas or in close association with man, and although it may occasionally be found foraging for food around lighted areas at night like the House Gecko and Mourning Gecko, it is more often encountered around warehouses, in lumber piles, or amidst debris. In uninhabited areas look for it under rocks and palm fronds, inside rock piles and on the roots, trunk and under the bark

of banyan, monkeypod, and other large shade trees. This species is inactive during the day and ventures forth at night. It is strongly territorial. Males and females intertwine their bodies during mating. The male inserts one of his hemipenes into the vent (cloaca) of the female. The round white eggs are laid in a sheltered place and take less than two months to hatch.

Identification: This lizard, about 3¼ to 4½ inches (8.3 cm – 11.5 cm) long, has broad toe pads and a thick ventrally flattened tail which is often constricted at the base. Its heavy build and wide median row of ventral tail scales distinguish it from the Tree Gecko, the only other Hawaiian gecko with such wide toe pads (see gecko identification key).

Distribution: Present on all the main Hawaiian Islands as well as other areas of Polynesia and Micronesia.



utilizing camouflage

TREE GECKO



Hemiphyllodactylus typus typus

Family Gekkonidae

Tree Geckos are different from the other four Hawaiian geckos in two respects. They do not live in association with man on houses or buildings, and they are not generally gregarious. Instead they live in forested areas and stream valleys and may be found singly under tree bark, in rock piles, or occasionally in debris. They are the least common gecko on the Islands and it is likely that their numbers will continue to dwindle in the face of continuing urbanization and habitat modification.

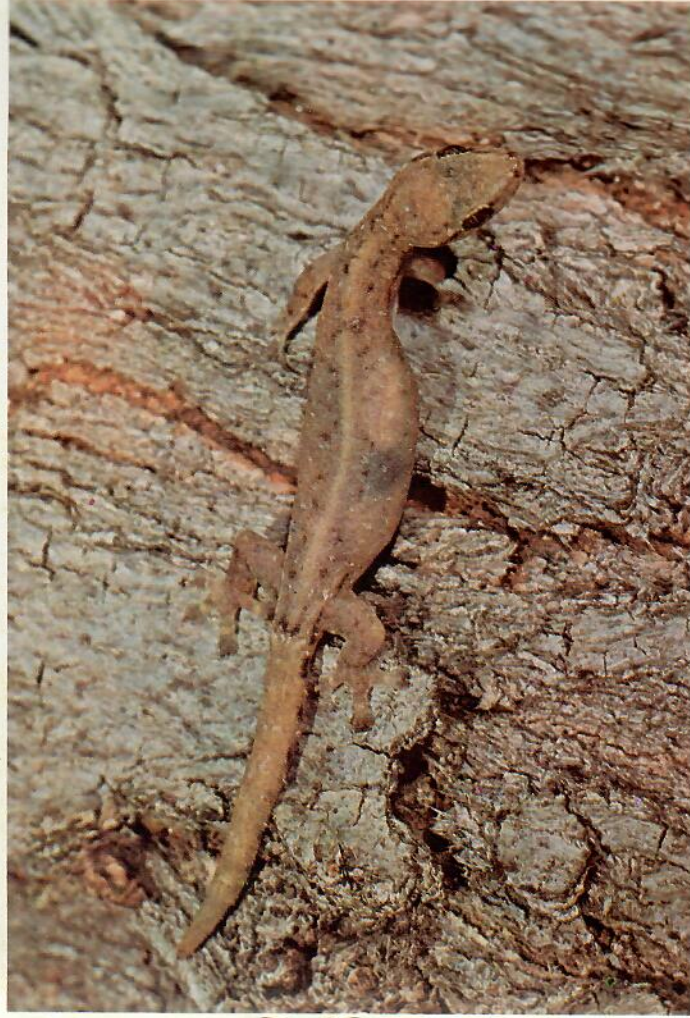
These lizards feed at night on small insects, especially cockroaches. Like other Hawaiian geckos, they have vertical "cat-like" pupils for better night-time vision and their lidless eyes are protected by a fused transparent membrane which resembles a permanent "contact lens." The long tongue is used to lick dust, rain drops, or other particles off the eye surface. Members of this species are not as vocal as other Hawaiian geckos.

The female normally produces two eggs which are pliable when laid, but quickly harden and adhere to any surface. They take one to two months to hatch.

Tree Geckos are the smallest species of Hawaiian gecko averaging only 2¼ to 3½ inches (5.8 cm – 8.9 cm) in total length. The head, body, and tail are very slender. The tail, usually bright orange ventrally, lacks tubercles, and is rarely longer than the combined length of the head and the body. When this lizard is in light color phase, its skin is almost transparent. It may change to shades of light or dark brown, and even charcoal.

Identification: Two thin dark stripes, one on each side of the head, extend through the eye to the shoulder. Two prominent irregular dark spots edged in white, are situated at the base of the tail. No paired dark spots or bars are present on the body as on the Mourning Gecko and the chin shields bordering the mental plate are not enlarged like on the Stump-toed Geckos. The toe pads are broad (see gecko identification key).

Distribution: In addition to inhabiting all the main Hawaiian Islands, this lizard is widely distributed on other tropical islands of the western Pacific.



TREE GECKO



Hemiphyllodactylus typus

Family Gekkonidae

Tree Geckos are different from the other four Hawaiian geckos in two respects. They do not live in association with man on houses or buildings, and they are not generally gregarious. Instead they live in forested areas and stream valleys and may be found singly under tree bark, in rock piles, or occasionally in debris. They are the least common gecko on the Islands and it is likely that their numbers will continue to dwindle in the face of continuing urbanization and habitat modification.

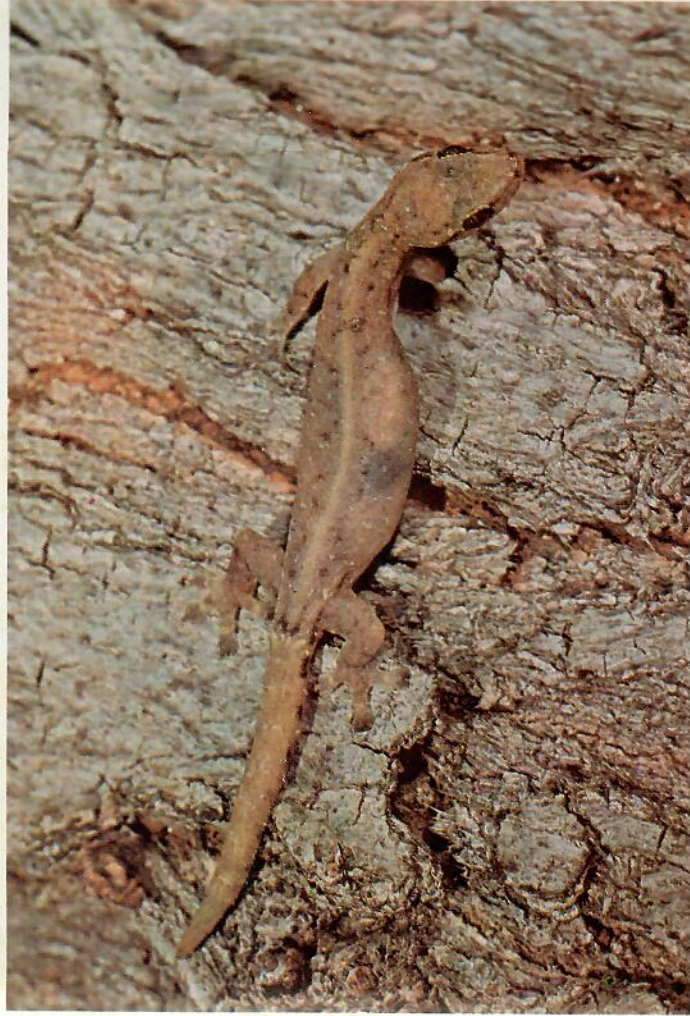
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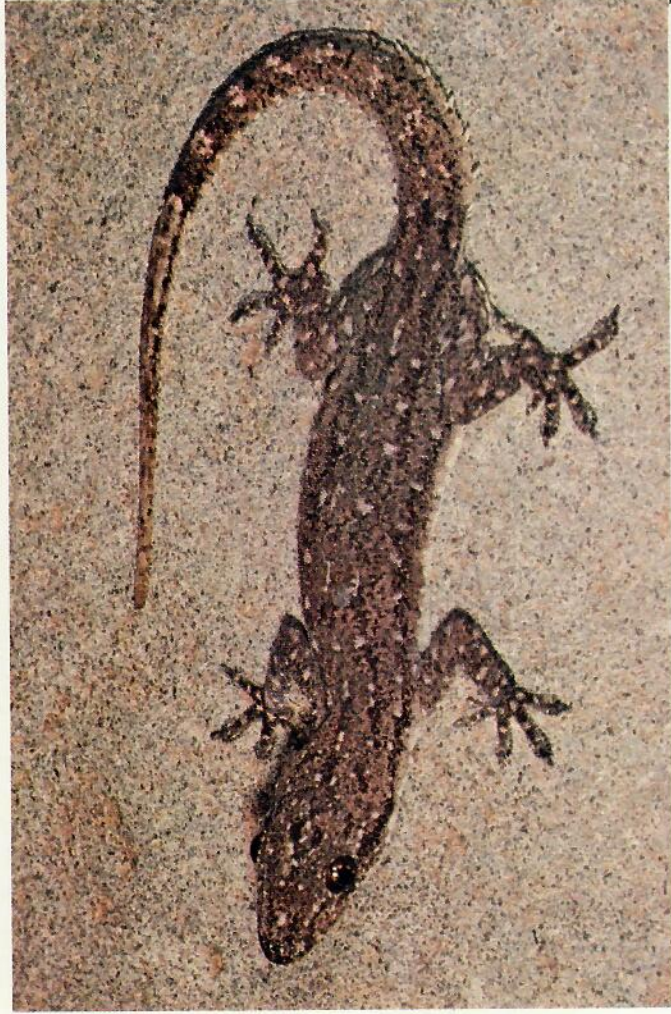
Tree Geckos are the smallest species of Hawaiian gecko averaging only $2\frac{1}{4}$ to $3\frac{1}{2}$ inches (5.8 cm - 8.9 cm) in total length. The head, body, and tail are very slender. The tail, usually bright orange ventrally, lacks tubercles, and is rarely longer than the combined length of the head and the body. When this lizard is in light color phase, its skin is almost transparent. It may change to shades of light or dark brown, and even charcoal.

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Distribution: In addition to inhabiting all the main Hawaiian Islands, this lizard is widely distributed on other tropical islands of the western Pacific.



INDO-PACIFIC GECKO



Hemidactylus garnoti

The Indo-Pacific Gecko, sometimes called the Fox Gecko because of its long narrow "fox-like" snout, is a member of a tropicopolitan genus renowned for its ability to live in association with man. Like Hawaii's other four geckos, it is tremendously beneficial because of the large quantity of noxious insects and other small invertebrates it eats including cockroaches, ants, termites, flies, mosquitos, beetles, moths, caterpillars, silverfish, and spiders. In turn it is preyed upon by Mynah Birds, Hawaiian Short-eared Owls, Barn Owls, Hawaiian Hawks, mice, rats, Mongooses and Giant Cane Spiders.

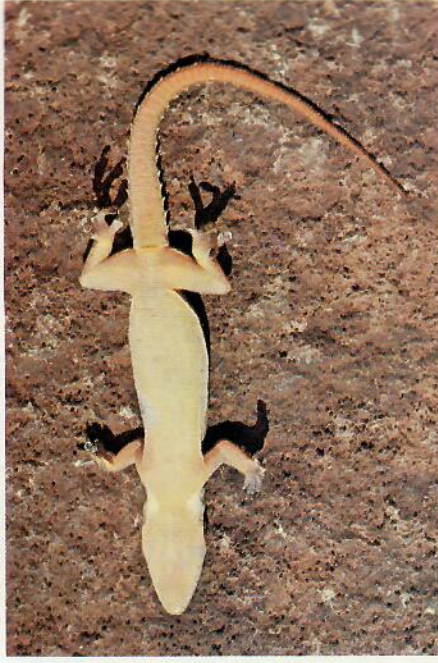
Indo-Pacific Geckos are most active at night, although they may bask and look for food during the day while remaining near a favorite hiding place. These geckos may be encountered most frequently under rocks at the base of trees.

Although found in all Hawaiian life zones from dry coastal areas to moist inland forested regions, this lizard has all but disappeared from urban areas where 30 years ago it was very common. This is probably due to its inability to compete successfully with the more aggressive House Gecko, a post-World War II immigrant.

The Indo-Pacific Gecko is parthenogenetic (unisexual). The gravid parent lays two brittle-shelled eggs in a protected spot. These hatch in one to two months. Hatchlings need only two to three months to reach sexual maturity. Adults attain a length of 3¾ to 5½ inches (9.9 cm - 14 cm). This lizard has the ability to change body patterns and hues between white, tan, and grey and blends well with its immediate surroundings.

Family Gekkonidae

Ventral View



Identification: Unlike the House Gecko, the outer pair of postmental chin shields are separated from the infralabials by one or more smaller scales. There is a *single* row of enlarged spine-like scales along the lateral edge of the tail. (These are absent on replacement tails.) The tail itself is *ventrally flattened* and generally salmon pink colored underneath (see gecko identification key).

Distribution: Occurs in localized areas on all the main Hawaiian Islands. It also inhabits many other islands of the western Pacific.



HOUSE GECKO

*Hemidactylus frenatus*

Family Gekkonidae

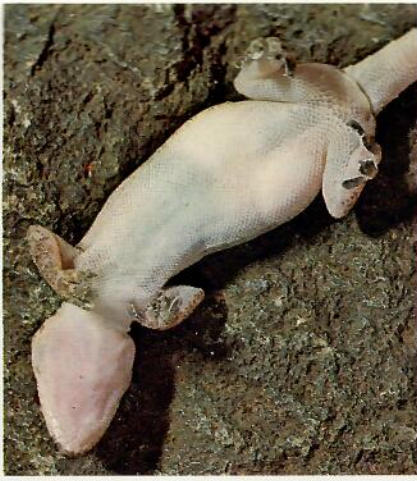
The House Gecko, a relatively recent immigrant, is thought to have arrived in Hawaii as a stowaway amidst the large amount of equipment and materials moved between western Pacific islands during or directly after World War II.

It is now the most common gecko in urban areas, having displaced the Indo-Pacific Gecko, and it has successfully moved into uninhabited areas as well.

House Geckos thrive around man and the structures he builds. They are typically found in such places as near light fixtures at night, on the sides of buildings, in houses, on walls and ceilings, in cupboards, between wood slats, and behind refrigerators, and other appliances. They also frequent other man-made structures including storm drains, and stone walls.

This reptile has the ability to change colors and shades between grey, off-white, and white. This lizard is generally darker during the day while resting in a secluded place, and paler at night if near a light, so that it blends in with its surroundings. Strongly territorial, its call is a series of quickly repeated chirps. Often it makes a squeaking noise when captured. This species and the Indo-Pacific Gecko are frequently parasitized by tiny red mites that attach themselves between scales on the tail and the digits of the feet.

A male may be distinguished from a female by its well-developed pre-anal and

Ventral
View

femoral pores. The female lays two round white eggs in crevices, usually on wood. This gecko, Hawaii's largest, grows to between 4 to 5½ inches (10.2 cm – 14 cm) in length.

Identification: There are rows of enlarged spiny scales that encircle the tail. The outer pair of postmental chin shields border the infralabials (see gecko identification key).

Distribution: Present on all the main Hawaiian Islands and is also widely distributed in other subtropical and tropical areas of the world.





House Gecko
Hemidactylus frenatus

SKINKS

Family Scincidae

There are over 600 species of skinks worldwide. They are cosmopolitan in distribution and are especially numerous in the tropics. Most are small lizards under nine inches (22.8 cm) in length with conical heads, smooth shiny skin, short legs, and long, easily broken tails. Some are expert stowaways and have the ability to "raft" to islands and successfully colonize once they arrive. They are well represented on Pacific islands where one species grows to two feet (60 cm) and several live in trees. However, the four species occurring in Hawaii are more typical of the family as a whole. They are small diurnal insect-eating lizards that live their lives around, on, or under leaf litter, rocks, logs, and debris.

METALLIC SKINK



Leiolopisma (= *Lygosoma*) *metallicum*

Family Scincidae

The Metallic Skink is a slim-bodied lizard covered with smooth shiny scales. It shares with Hawaii's other skinks a number of adaptive modifications associated with living on and under the ground. All have wedge-shaped heads to facilitate burrowing. The external opening of the ear and the nostrils are reduced in size to keep out dirt. The flat glossy scales offer little surface resistance. Also the body tapers gradually into the tail which itself is quite thick and assists in propulsion and movement.

This lizard is active during the day. It feeds on cockroaches, beetles, grasshoppers, moths, other insects and spiders which it crushes with its jaws and teeth and then swallows.

The Metallic Skink is not especially afraid of man and is common in backyards, gardens, parks and vacant lots. It is also plentiful in undisturbed habitats particularly in wooded areas and stream valleys in leaf litter and around debris. Although this is the most common species of skink in the Hawaiian Islands, it was only first recorded here in 1909. About the same time two other lizards, the Moth Skink and Azure-tailed Skink are documented as having become increasingly rare. Did the Metallic Skink come onto the scene and simply out compete these lizards? Additional scientific research is needed to answer this question.

The female lays one to seven eggs in a sheltered place.

Identification: This lizard has a metallic sheen to its skin and its coloration may vary slightly. The head is rust brown while the dorsal surface of the body and first third of the tail are brown or grey-brown, often with tiny dark flecking. The remaining two-thirds of the tail is uniform grey sometimes with a reddish tinge at the tip. Striping on the sides of the body is present, but variable. The wide uniform dark brown lateral stripe may be bordered top and bottom by a thin white stripe no more than one or two scales wide. The entire ventral surface is off-white or light grey. It averages between 3 - 4½ inches (7.6 cm - 11.5 cm) in total length.

Distribution: In addition to all the main Hawaiian Islands, this reptile is found in eastern Australia.

Special Note: James K. Baker, a research biologist with the Hawaii Field Research Center, Hawaii Volcanoes National Park on the Island of Hawaii in conjunction with Allen Greer and Harold G. Cogger of the Australian Museum in Sydney, are in the process of reclassifying this lizard, probably as a subspecies of *Lampropholis delicata*.



Metallic Skink
Liotropisma metallicum

SLAKE-EYED SKINK



Cryptoblepharus (= *Alblepharus*) *boutoni poecilopleurus*

Family Scincidae

The Snake-eyed Skink is the only Hawaiian skink without movable eyelids. The eyelids are fused together, but are completely transparent so that the lizard actually sees through the lids of its closed eyes.

Whereas the three other Hawaiian skinks live on the ground or under logs or debris, the Snake-eyed Skink prefers rock walls overlooking, or adjacent to the beach. It spends a lot of time sunning on rocks and if approached, disappears into the nearest crevice. It has relatively long legs and is quick and mobile. Because of its agility, it appears to have little difficulty in avoiding hungry rock crabs. An aggressive feeder, this lizard will sometimes climb down onto the sand between the rocks and the ocean to feed on beach flies. It also eats cockroaches, beetles, sand fleas, butterflies, moths, caterpillars, spiders and other small arthropods.

Skinks are usually gregarious, and this species is no exception. It would be unusual to see just *one* Snake-eyed Skink.

This lizard was more common at the beginning of this century. It is likely that development of beach front property has contributed to its decline.

A female Snake-eyed Skink will lay her eggs, generally two of them, in a protected spot. Sometimes more than one female will lay her eggs in the same location. The eggs take four to seven weeks to hatch. Newly hatched juveniles are less than 2 inches (5 cm) long.

Identification: This lizard has immovable eyelids which cause its eyes to appear unusually large and circular, and which immediately distinguishes it from any other Hawaiian skink. The dorsal color is variable, but is usually mottled brown or grey. Two thin metallic-gold colored dorsolateral stripes are usually present on the head and body but they do not extend past the rear legs. The sides are black or grey with extensive white flecking. The entire ventral surface is pale yellow. This skink averages 3½ – 5 inches (8.9 cm – 1.7 cm) in length.

Distribution: The Snake-eyed Skink is largely confined to rocky shoreline areas and has spotty distribution on all the main Hawaiian Islands. It also inhabits many other islands of the western Pacific.



MOTH SKINK



Lipinia (= *Lygosoma*) *noctua noctua*

Family Scincidae

The attractively marked Moth Skink is the only member of the skink family found in Hawaii that does not lay eggs. Instead, the female gives birth to one to four fully developed young from eggs retained in the body.

This lizard, like Hawaii's other skinks, utilizes tail loss as an escape device. If a would-be predator grabs it by the tail, that part will almost invariably snap off at one of several "breakage points." The violently writhing tail diverts the attention of an attacking mongoose or mynah bird, which allows the lizard to slip out of sight under a nearby rock or log. The skink will completely regrow a new tail in about two months, but the regenerated caudal appendage will be shorter and less colorful than the original.

Individuals will sometimes have toes missing and this has to do with another escape mechanism. If a predator grabs a Moth Skink by a finger or limb, this lizard will rapidly twist over and over in an attempt to free itself even if it means losing that digit.

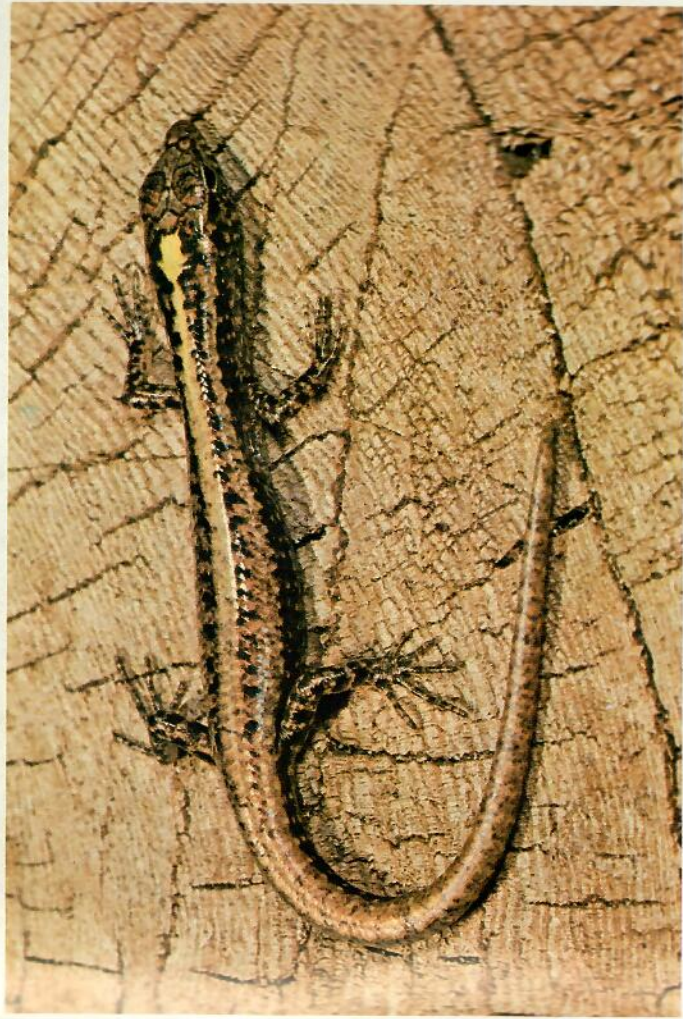
It has been reported in the literature that the Moth Skink climbs a great deal and is active at night. In fact, neither is true. This reptile is found in association with leaf litter

both in backyards and around the root system of large trees. At night it seeks shelter under surface objects or loose top soil.

At the turn of this century the Moth Skink was documented as being relatively common throughout the Hawaiian Islands. Today, however, it is definitely known to occur on only two islands, and there only in isolated pockets. Competition with the Metallic Skink, habitat destruction, and the introduction of the mongoose have all been suggested as reasons for its decline.

Identification: A prominent yellow spot is always present at the back of the head. This spot continues posteriorly as a pale middorsal stripe that fades out before reaching the tail. The dorsal color is variable, but usually light brown while the sides are generally darker. The tail is a light tan color above and off-white or grey below. This skink grows to a total length of only about 3 to 4¼ inches (7.6 cm – 10.8 cm).

Distribution: May be found in Kaimuki, Makiki, Punahou, Laie, and other scattered locations on Oahu and in isolated pockets on the Big Island (Hawaii). It is well represented in other parts of Oceania.



juvenile

AZURE-TAILED SKINK

*Emota cyanura* complex — Fiji

Family Scincidae

The Azure-tailed Skink is a slender, active diurnal lizard. The scales on its body and tail are small, rounded, shiny, and uniform in size while those on its head are enlarged. It has movable eyelids and as an added feature the lower lid contains a transparent “window” through which the lizard can see, even when its lids are closed.

The longitudinal striping and different shades of color on the body and tail serve to break up the body outline and to camouflage the lizard to match its surroundings.

Skinks lack the ability to quickly change colors like many geckos and some iguanids. A feature they do, however, share with these lizards is “tail loss.” An Azure-tailed Skink’s brightly colored tail serves to draw the attention of any would-be predator. Once severed, the tail wriggles and twitches leaving the attacking animal with nothing more than a regrowable appendage while the lizard itself disappears into nearby leaf litter.

Identification: Typically this lizard has three prominent white stripes, one mid-dorsal

and two dorsolateral, which extend from the front tip of the nose almost to the tail. The head is dark brown and the body lighter brown. The tail is a beautiful azure blue. However, the only specimens examined by the author from Hawaii were melanistic and lacked both the blue tail and the striping. Adults average 3–5 inches (7.6 cm — 12.7 cm) in total length.

Distribution: The Azure-tailed Skink is recognized as a first class stowaway and it is found on many islands throughout the Pacific Ocean, yet it has almost totally disappeared from Hawaii. In recent years, very few Azure-tailed Skinks have been collected, and only on the Island of Kauai. Whether it is simply unable to live in areas modified by man, whether it cannot successfully compete with the ubiquitous Metallic Skink, or whether it suffers from predation by the mongoose, or any combination of these variables, is presently unknown. This lizard’s status in the Hawaiian Islands is uncertain and additional research is needed.

SNAKES

Order Squamata

Suborder Serpentes

Snakes, although uniform in general body shape, are versatile in their modes of life. There are over 2,700 species. Most are nonvenomous and beneficial to man. They inhabit every continent except Antarctica, but they do not "raft" well and are thus absent from many islands, even relatively large ones such as Ireland, Greenland, and New Zealand. Snakes may burrow, live on the ground, or in trees and bushes. Some live in and around streams and lakes. Members of one family are entirely marine. Many of the desert forms are nocturnal.

While snakes vary in size from 5 inch (12.7 cm) blind snakes to 30 foot (9.14 m) reticulated pythons and anacondas, most have a total length of between 2 and 6 feet (.6 m and 1.8 m) depending upon the species.

Snakes are dry-skinned, scale-covered reptiles, similar to the lizards but lacking eyelids, external ear openings, and functional limbs. All snakes are carnivorous. The quadrate bone at the back of the head and elastic muscles in the front of the lower jaw allow for maximum jaw flexibility enabling these reptiles to swallow prey considerably greater in diameter than themselves. Most feed on rodents although some consume other mammals, birds (their eggs), reptiles, amphibians, fish, insects and other invertebrates. Snakes swallow their food whole, without mastication. All soft parts as well as bones are completely digested. Because of the quantity of food consumed, snakes do not have to feed as frequently as most lizards, and much less frequently than mammals.

Snakes are sensitive to surface vibrations and recent studies have shown they can hear. However, a snake's most useful sense is that of "taste-smell." When a snake flicks out its long two-pronged tongue, it picks up chemical particles from the air. When the tongue is retracted, its tips brush against the Jacobson's organ along the roof of the mouth where the particles are instantly analyzed. "Taste-smell" plays a key role in the recognition of prey, enemies, or potential mates.

Probably because of their unique elongate shape, snakes have always fascinated man. Generally people are conditioned to react to snakes. Those persons who have had a chance as youngsters to observe and handle snakes, respond positively. Those persons who have not shared these opportunities generally exhibit repulsion or fear.

BLIND SNAKES

Family Typhlopidae

Blind Snakes are tiny wormlike burrowing snakes with cylindrical bodies and vestigial eyes. They feed on small insects and other invertebrates. Members of the family are widely distributed in tropical and subtropical areas of the world.

HAWAIIAN BLIND SNAKE



Typhlops braminus (= *Typhlops braminus*)

Family Typhlopidae

This reptile, the only species of land snake occurring wild in the Hawaiian Islands, was initially observed in 1930 on the grounds of the Kamehameha Schools in Honolulu. Individuals are thought to have come as stowaways in soil around the base of potted palm trees imported from the Philippines and planted at the school the previous year. The Hawaiian Blind Snake is completely harmless as are the great majority of snakes through-

out the world. It is beneficial to man because it eats large quantities of termites, other small soft-bodied insects and insect larvae.

This small secretive snake, almost worm-like in appearance, is well adapted to a burrowing life. It has vestigial eyes which appear as two tiny dark spots beneath the head scales, a countersunk lower jaw that resists dirt, and a short blunt tail for probing that aids locomotion. The dark underground environment in which it lives places a premium on the senses of taste, smell, and touch rather than on sight. The number of teeth are reduced. It has only a single enlarged tooth on either side of the lower jaw.

This snake must live in loose moist soil because the small uniform scales covering its body are prone to drying out and prolonged desiccation can cause death. It frequents shaded gardens and moist valleys and may be found under potted plants, plastic liners, large stones, logs and debris. This species is parthenogenic (unisexual). The single female parent deposits two to eight elongated eggs in moist soil.

Identification: Almost always under eight inches (20 cm) long and very thin, it is dark brown or black above and lighter ventrally. However, about two or three days before shedding, the outer layer of skin loosens, and this causes the snake to turn light blue. It remains this color until it sheds off the old skin.

Distribution: Found on all major islands of Hawaii, and on other islands of Oceania, it is native to the Philippines, and Southeast Asia.



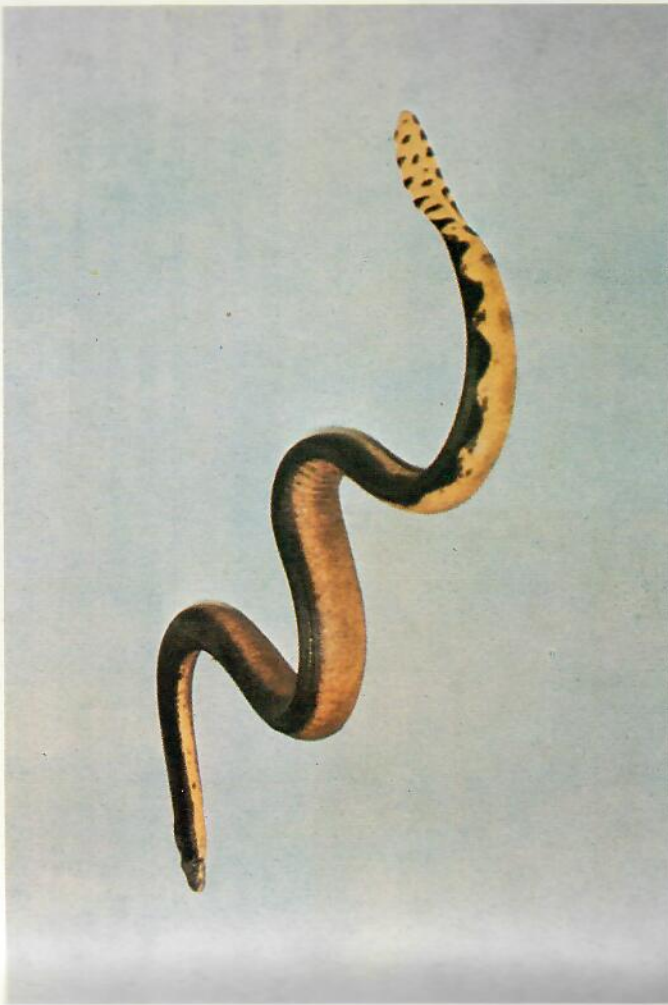
CLOSE-UP OF HEAD

SEA SNAKES

Family Hydrophidae

Sea Snakes are distant relatives of the cobras that have adapted to life in the warm portions of the world's oceans. They typically have a laterally compressed body and a flat oar-like tail and feed on a variety of fishes including eels. All are venomous, but are not generally aggressive towards humans. Most stay close to land, along coasts, and only one, the Yellow-bellied Sea Snake, is truly pelagic.

YELLOW-BELLIED SEA SNAKE



Pelamis platurus

Family Hydrophidae
VENOMOUS

This marine snake is an infrequent visitor to the waters around the Hawaiian Islands and is the only member of the sea snake family to stray into our area. This reptile lives its entire life in the ocean and can stay submerged underwater for up to two hours before resurfacing for air. Its aquatic locomotor specialization is developed to such a degree that it has difficulty returning to the water, should it become stranded on the beach by the tide.

The Yellow-bellied Sea Snake is venomous but not aggressive towards man, and no bites have been recorded here. However, the neurotoxic qualities of the venom, not unlike those produced by members of the cobra family, are highly toxic to humans and

capable of causing severe muscle, kidney, and nerve damage, even death. The venom is injected through permanently erect fangs inside the front of the upper jaw which are connected by venom ducts to poison glands located at the rear of the head.

The Yellow-bellied Sea Snake feeds entirely on fishes which it catches with a sideways strike of the head. The prey is quickly paralyzed from the effects of the venom, after which it is swallowed.

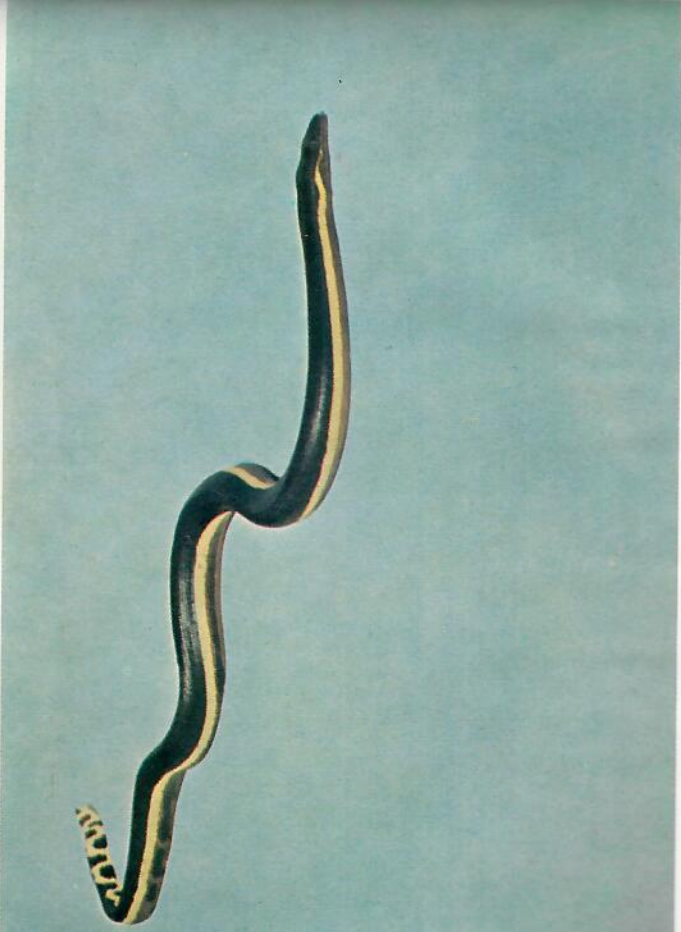
Like other snakes, it sheds its skin several (generally 2-6) times a year. Any barnacles or other invertebrates that have attached themselves are shed off with the old skin.

During courtship and mating, males and females intertwine their bodies as they glide through the water. They are livebearing and the young are born in the open sea.

Identification: Among the different types of snakes, only sea snakes have valvular nostrils, a laterally flattened, ventrally keeled body, and a paddle-shaped tail. Our species has a purplish-black dorsal surface while being yellow ventrally. The tail is black and yellow spotted or barred. This reptile grows to between 24-34 inches (61 to 86 cm).

Distribution: This species of sea snake lives in tropical waters of the Pacific Ocean from Central America to Australia, and the Indian Ocean.

Special Note: Eels, which of course are fish, breathe through gills and do *not* have scaly skin.



TURTLES

Order Chelonia

Turtles look much like their ancestors did over 200 million years ago. The most characteristic feature of any turtle is its shell. The lower portion of the shell (plastron) is joined on each side by a bridge to the upper portion of the shell (carapace). In most species the bony shell is covered with horn-like plates. However, in a few like the soft-shelled turtles and Leatherback Sea Turtle, the shell is covered by layers of flexible skin. Openings at the front and rear allow for the extension of the head, four limbs, and tail.

Turtles breathe through lungs although some aquatic species can absorb additional oxygen from the water through the walls of the cloaca and pharynx.

Turtles lack teeth but their jaws have sharp ridges to cut and tear food. Some are vegetarians while others are omnivorous, or carnivorous. Chelonians are amorous creatures. Many species engage in elaborate courtship behavior preceding mating. The male has a single penis which is housed inside of the tail when not in use. The male mounts the female from the rear. Fertilization is internal. A female is able to store viable sperm for a period of two to five years. Eggs are laid on land, typically in a hole dug by the female with her rear feet in moist earth or sand. A female may lay several times a year and the number of eggs deposited varies with the individual species. Incubation may take 1½ - 8 months.

Turtle longevity is sometimes exaggerated, but it is still true that they are long-lived. Under ideal conditions some species have a life expectancy of 50 to 80 years, and several individual turtles have been documented as living in captivity for over a century.

The terms "turtle" and "tortoise" may be used differently in several of the English-speaking countries. In the United States, the vernacular name "turtle" refers to all chelonians, while "tortoise" is synonymous with land turtle and should only be applied to members of family Testudinidae which typically have elephant-like feet and domed shells.

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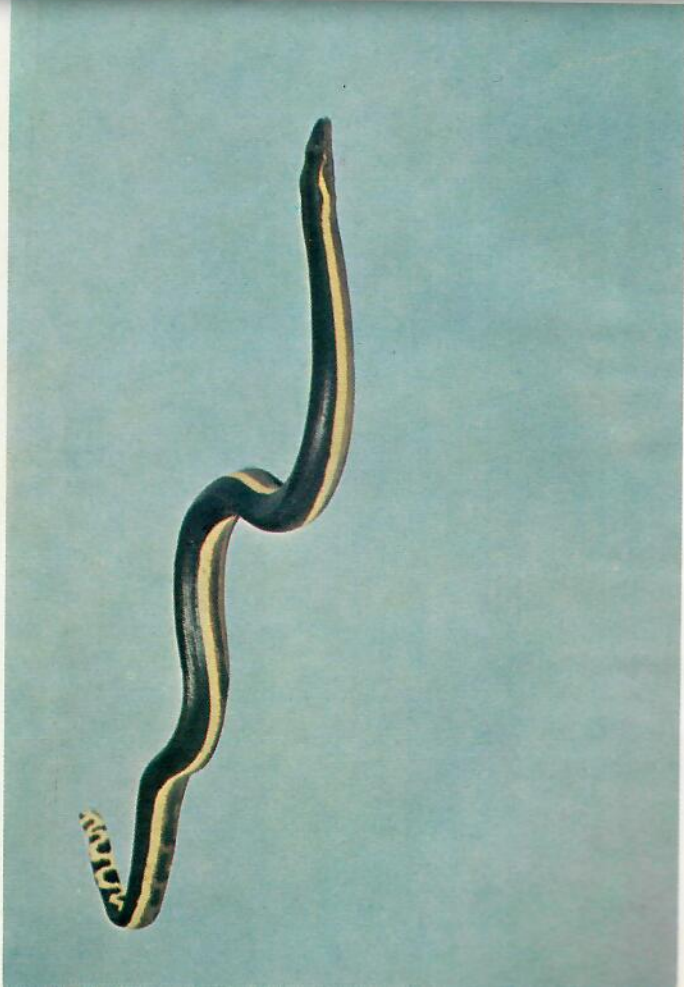
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SOFTSHELL TURTLES

Family Trionychidae

Softshell Turtles are leathery-skinned freshwater chelonians whose rounded, flattened shells lack horny scutes. They have been described by one expert as "animated pancakes." Members of the family have long, retractile necks, and paddlelike limbs, each with three claws. They are quite shy of man, and are quick, agile swimmers.

CHINESE SOFTSHELL TURTLE



Trionyx sinensis sinensis

Family Trionychidae

The Chinese Softshell Turtle has keen senses of sight and hearing. It is adapted to an aquatic life, swims well, and can hold its breath underwater for over an hour. It is established in some of the streams, canals, and drainage ditches on the islands of Kauai and Oahu. This turtle used to be imported from the Orient alive, as an item of food prior to World War II and was sometimes propagated locally in fish ponds. Few people are aware of the presence of this reptile because it is almost entirely aquatic and rarely comes out of the water to bask. The typical specimen donated to the Honolulu Zoo was initially mistaken for "a rock on the bottom of the stream that moved when I stepped on it."

Chinese Softshell Turtles are primarily carnivorous, feeding on fish, crawfish, and mollusks. Females grow to a length of about 16 inches (41 cm), while males are generally smaller but have considerably longer tails, with the vent opening closer to the tail tip. Adults seem to be territorial and are aggressive towards others of the species.

Mating occurs in the water. Eggs are deposited in moist soil above the water line. The female digs a hole with her hind feet about four inches across and four to five inches deep, deposits some or all of her eggs and then fills in the hole. Clutch size varies from 3-28. The round white eggs average about 7/8 inch (2.2 cm) in diameter and are about half the size of a ping-pong ball. The eggs have an incubation period of 48-68 days. A female may lay between one and four clutches a year. The young are about an inch (2.54 cm) long upon hatching and closely resemble the adults except for the presence of tiny dorsal tubercles that disappear with age. Sexual maturity is reached the fifth or sixth year. This turtle is not aggressive. However, if captured and handled carelessly, it is capable of giving a painful bite.

Identification: Chinese Softshell Turtles because of their leathery, pliable shells can be readily distinguished from other freshwater turtles which may occasionally turn up in ponds and reservoirs. (The most commonly released pet turtle in Hawaii is the Red-eared Pond Slider, *Chrysemys* (= *Pseudemys*) *scripta elegans*. However, this species has not as yet established widespread wild breeding populations.)

Distribution: Native to China, Formosa, Southeast Asia, and Japan, the Chinese Softshell Turtle is now found on the islands of Kauai and Oahu.



Marchling

HEAD SHIELDS OF SEA TURTLES KEY

MARINE TURTLES

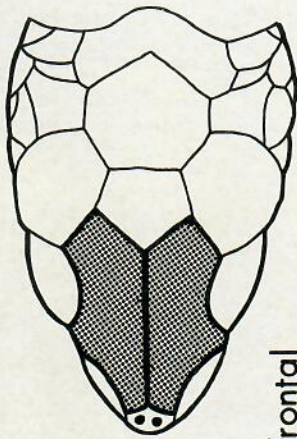
There are three species of marine turtles which may be found in the seas around Hawaii. All are air breathing reptiles with long paddle-shaped limbs referred to as flippers and are especially adapted to life in the ocean. All migrate great distances across the open seas and all must return to land to lay their eggs. Not much is known about the lives of juvenile sea turtles; however, it is believed that adults return to lay their leathery-shelled eggs on the same beaches on which they were born. In past centuries sea turtles were much more common in and around most of the Pacific islands and were an important food source to the Polynesians. However, due to the tremendous exploitation by man during the nineteenth and twentieth centuries for meat, soup, leather, and shell artifacts, the world's sea turtle populations have declined dramatically, and several species are in danger of extinction in many parts of their former range.

All sea turtles belong either to the Family Cheloniidae or Dermochelidae.

SEA TURTLES Family Cheloniidae

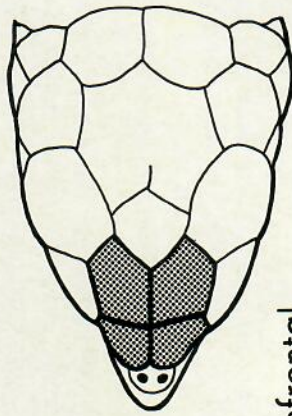
Sea Turtles of this family are large marine turtles with paddle-shaped limbs and hard, plate-covered, heart or shield-shaped shells. They rarely venture onto land. Two species are found in our area, the Pacific Green Sea Turtle (*Chelonia mydas agassizi*) and the Pacific Hawksbill Sea Turtle (*Eretmochelys imbricata bissa*).

GREEN SEA TURTLE



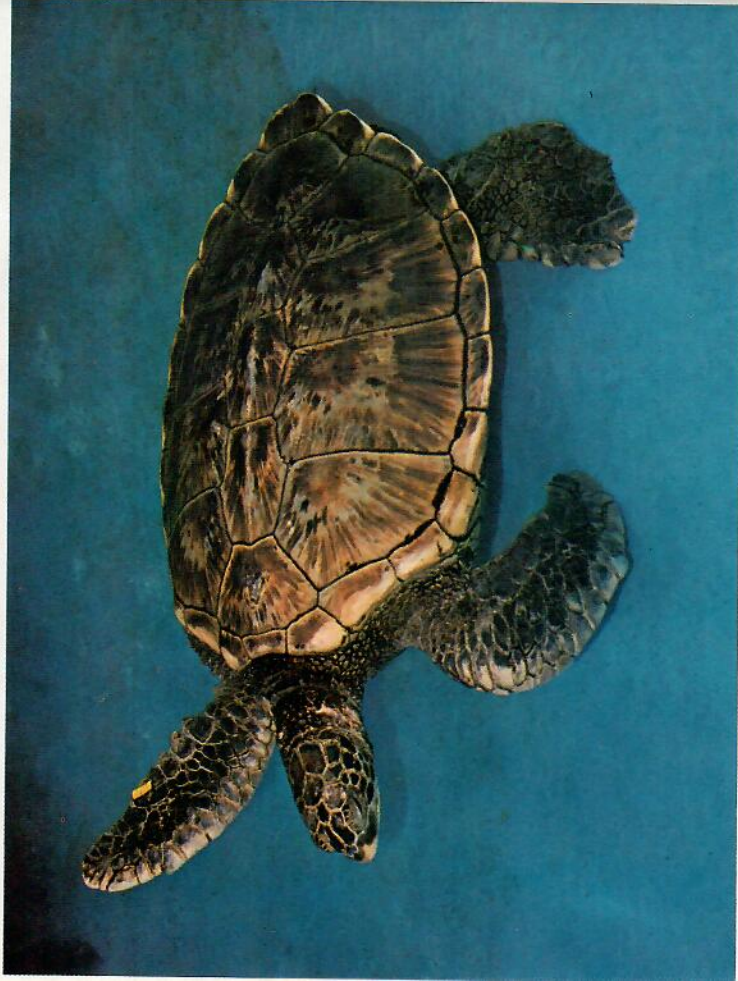
1 Pair of Prefrontal Shields

HAWKSBILL TURTLE



2 Pairs of Prefrontal Shields

PACIFIC GREEN SEA TURTLE



Chelonia mydas agassizi

Family Cheloniidae

The Pacific Green Sea Turtle ("Honu") is the most prevalent marine turtle in the seas around Hawaii. This shy, gentle, 150–400 pound (67.5 Kg – 180 Kg) air-breathing reptile is primarily herbivorous, grazing in shallow waters on marine vegetation. Its carapace may be dark olive, dark brown, or even blackish. The plastron is coral white or yellow. The word "green" in its name refers not to the color of the skin or shell, but rather to the greenish color of the fat inside its body. Turtle soup is derived from the cartilage or "calipee." It is the vegetarian diet that gives its flesh an excellent flavor. Man is the turtles' deadliest enemy. Over-exploitation of both eggs and adult animals within the past 150 years has resulted in serious population declines locally and around the world.

Between May and August, adult Green Sea Turtles from Hawaiian waters migrate primarily to French Frigate Shoals although a small number travel to other parts of the Leeward Islands that extend for 1,200 miles northwest of Kauai. These tiny, isolated, volcanic islands, reefs, and shoals, first set aside as a wildlife sanctuary in 1909, are today known as the Hawaiian Islands National Wildlife Refuge. There, adults mate in the water. The males may be identified by their longer, thicker tails. Females crawl ashore at night several times during each breeding season and dig out a nest in the sand with their hind flippers well above the high tide mark. The female lays anywhere from 100–200 eggs,

after which she carefully fills in the hole, and returns to the sea. The eggs incubate for 50–60 days and all the hatchlings emerge within a short time of one another. The baby Green Sea Turtles, each about 2 inches (5.1 cm), race for the ocean immediately after emerging from the nest. At French Frigate Shoals, unlike some nesting beaches in other parts of the world, seabirds generally do not eat the young, but they are easy pickings for crabs and reef fish. Few will survive the rigors of the next 5 to 13 years to return to the same beach as nesting adults.

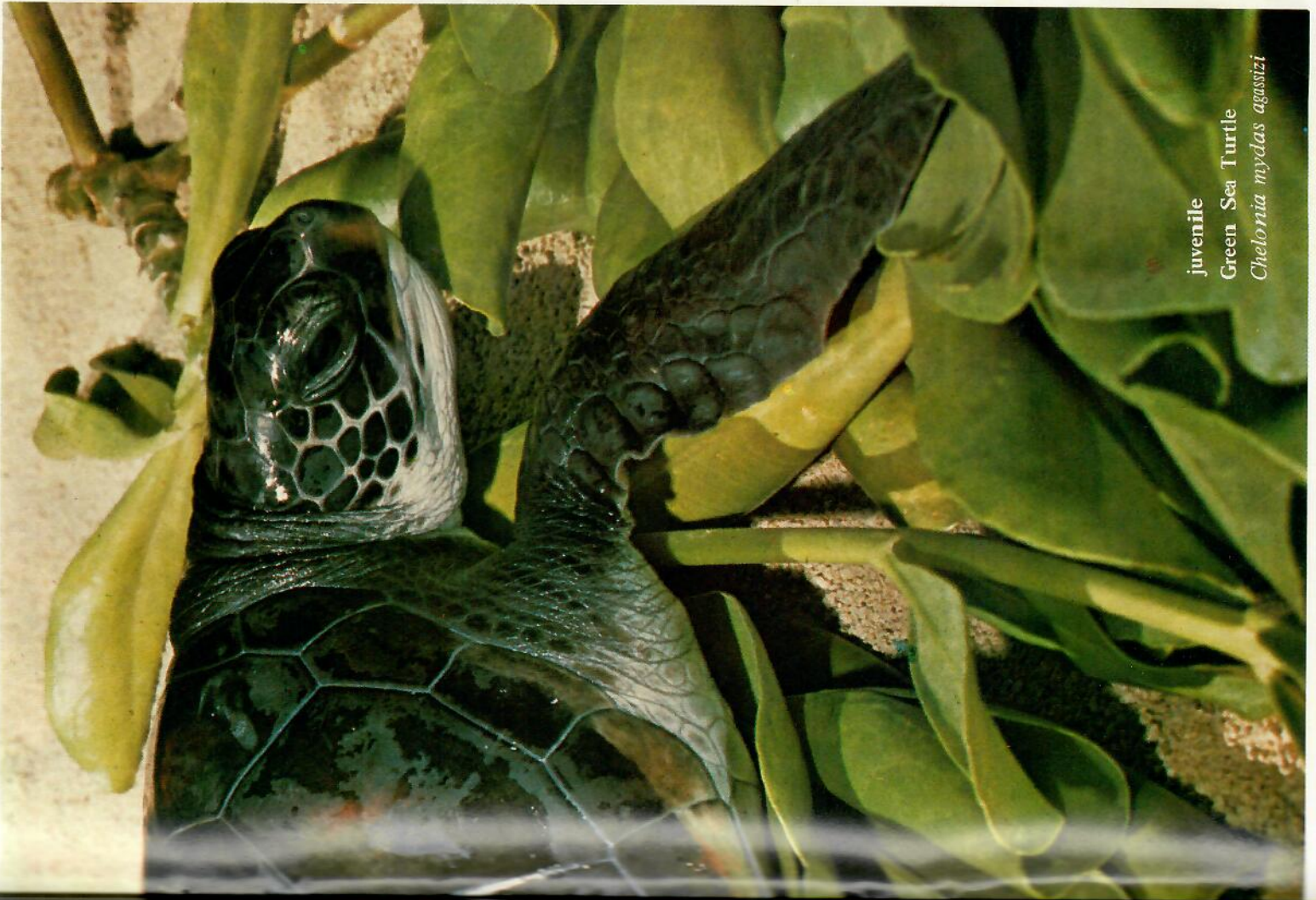
Identification: Adults from Hawaiian waters have an average shell length of 32–42 inches (81–107 cm). Unlike the Hawksbill Sea Turtle, the large scutes of the carapace do *not* overlap and there is only a *single* pair of prefrontal scales on the head between the eyes. (See Head Shields of Sea Turtles Key).

Distribution: This turtle is found in tropical and subtropical waters of the Pacific and Indian Oceans. In Hawaii, adults of both sexes commonly come ashore to bask on the uninhabited Leeward Islands.

Special note: Effective September 6, 1978 the Pacific Green Sea Turtle has been reclassified as threatened by the United States Department of the Interior and it may not be taken in Hawaiian waters for any purpose. *(Institutions or individuals seeking scientific or research capture permits must apply directly to, and receive the written approval of, the U.S. Department of the Interior and the Department of Commerce.)



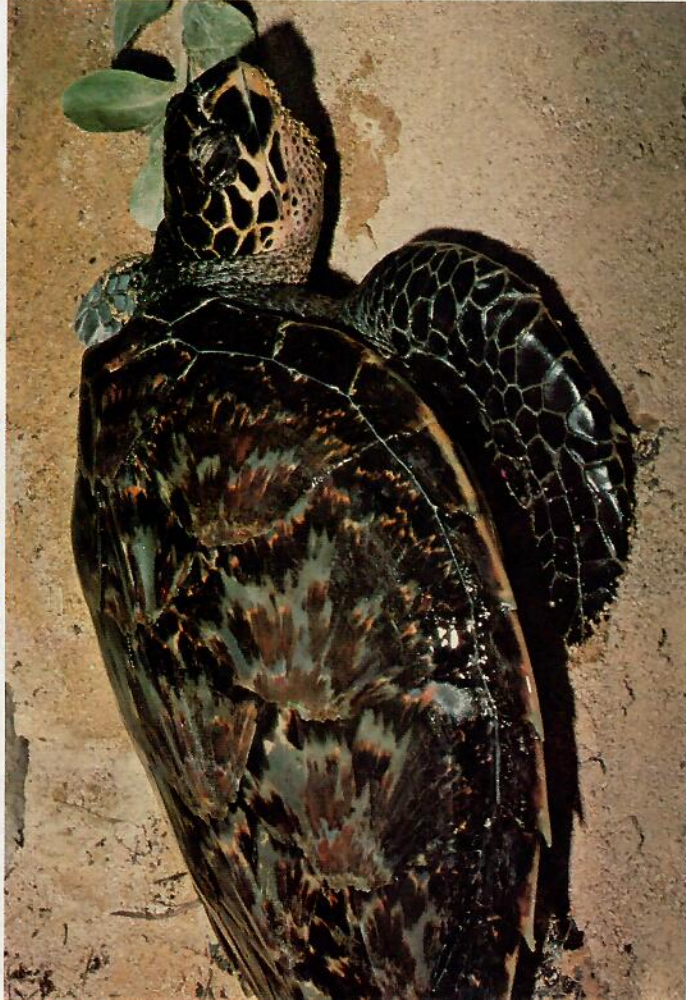
laying eggs at French Frigate Shoals



juvenile
Green Sea Turtle
Chelonia mydas agassizi



PACIFIC HAWKSBILL SEA TURTLE



Eretmochelys imbricata bissa

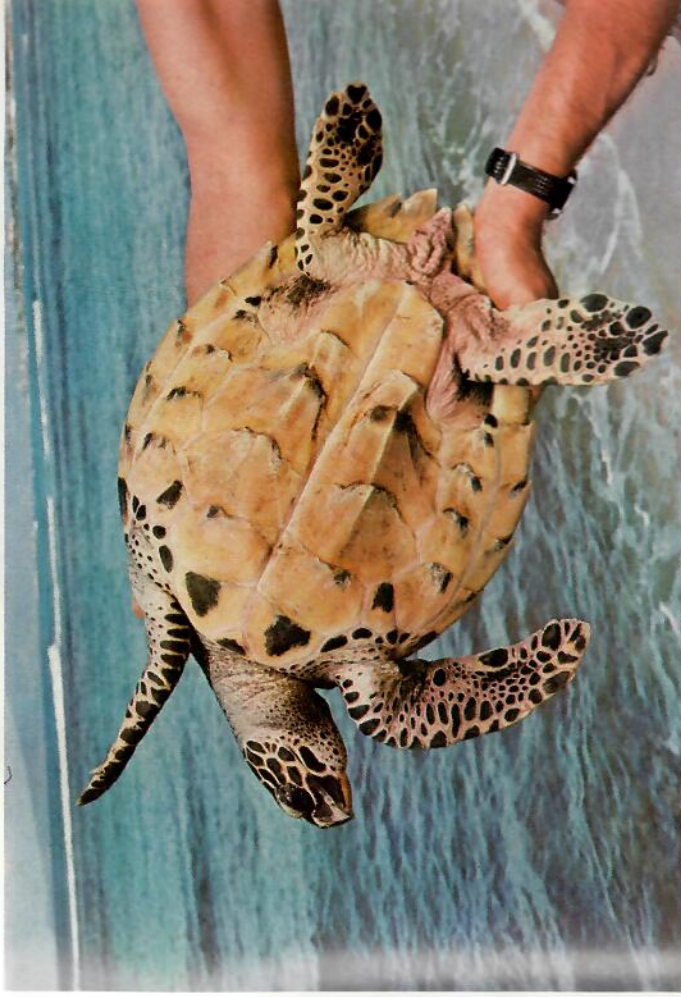
Family Cheloniidae

The Pacific Hawksbill Sea Turtle ("Ea") is the second most prevalent marine turtle in Hawaiian waters although it is no longer common. Only four nestings have been reported in the area during the past decade, three of these on the Big Island (Hawaii) and one on Molokai.

It is small as sea turtles go, with an average shell length of 32 inches (81.2 cm) and an average weight of 75 to 150 pounds (34 kg to 67.5 kg). The shell is shield-shaped, generally mottled brown above and yellow below. Commercial "tortoise-shell" or "carey" from the shell scutes of this turtle used to be extracted for combs, brushes, buttons, and similar items before the development of plastics. Exploitation outside the United States is widespread even today.

This turtle feeds on crabs, fish, sea urchins, shellfish, and seaweed. It will also eat jellyfish, and like other marine turtles when it does so, it closes its eyes to protect them from the stinging tentacles. The narrow, hawk-like beak from which this species derives its common name, is well adapted to probing into holes in the coral reef in search of food.

Adult turtles migrate to, and mate in, the ocean off the nesting beach. Each gravid female comes ashore at night, digs a deep hole in the sand above the high water mark with her rear flippers, and lays 125 to 175 perfectly round white eggs. She covers the hole and laboriously makes her way back to the relative safety of the water. The eggs usually hatch in 52 to 74 (average 59) days.



Subadult

Ventral View

Identification: The Hawksbill differs from the Green Sea Turtle in having two pairs of prefrontal scales on its head instead of just one pair. (See Head Shields of Sea Turtles Key.) Also, the edges of its carapace are serrated and the laminae overlap except in very old specimens.

Distribution: Although found in tropical oceans worldwide, it is becoming increasingly rare.

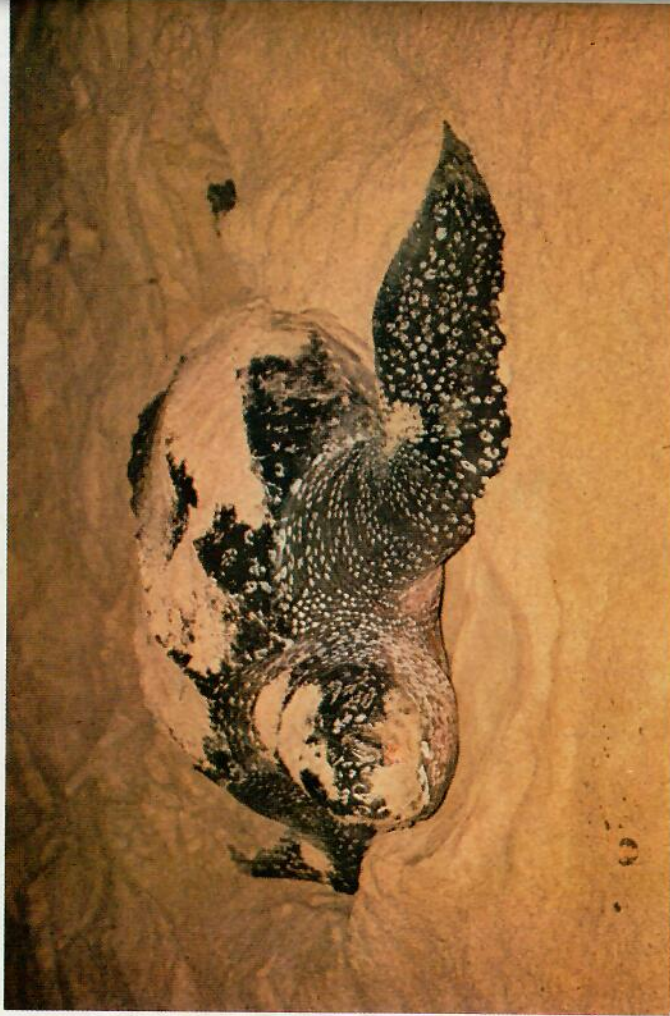
Special Note: This species is listed as endangered by the United States Department of the Interior and it may not be taken in Hawaiian waters for any purpose.* (*Institutions or individuals seeking scientific or research capture permits must apply directly to, and receive the approval of, the U.S. Department of the Interior and the Department of Commerce.)

LEATHERBACK SEA TURTLES

Family Dermochelidae

Leatherback Sea Turtles are represented by a single living species. This reptile is easily distinguished from other marine turtles in that it lacks a hard, bony scute-covered shell and is, instead, covered with layers of smooth black skin.

PACIFIC LEATHERBACK SEA TURTLE

*Dermochelys coriacea schlegelii*

Family Dermochelidae

The Pacific Leatherback Sea Turtle is the largest of all living turtles frequently weighing between 700–1,400 pounds (315 Kg – 630 Kg), record 1,500 ± pounds (680+ Kg) and obtaining a length of 5 to 8 feet (1.5 m – 2.4 m), record 9 ± feet (2.7 m). It is the only marine turtle that does not have a “typical” hard turtle shell. Instead it has a covering of smooth leathery skin set over a layer of small irregular bones. There are seven pronounced longitudinal ridges on the dorsal surface and five more on its underside. It has massive flippers.

This reptile is the fastest and most powerful of any of the sea turtles and it may be encountered in the open ocean a considerable distance from land. Although rare, there is hope for its survival in that only its eggs are generally exploited by man. Its meat is oily and poor tasting and its body has little economic value.

This huge marine reptile is known to nest on beaches in Malaya, South Africa, and Mexico. A female will lay 90–130 eggs in a hole she has dug above the high water mark on a sandy beach. The eggs are unusual because they are reported to be white with green speckling instead of solid white like most turtle eggs. Hatchlings are a mere 2¼ inches (5.8 cm) long and have an outer layer of scales that are shed within the first month of life. Very little is known about the habits of partially grown adults. Both young and adults feed on jellyfish. Squid, octopi, sea urchins, crustaceans, and floating seaweed are also sometimes eaten.

Identification: This turtle has a leathery shell. It is the only sea turtle that *lacks claws* at the end of its flippers. Adults are black with light colored spots on the head, back, and limbs. Hatchlings are slate grey or black with white or yellow spotting.



Distribution: This subspecies is wide ranging in tropical and temperate waters of the Pacific and Indian Oceans. It is only an occasional visitor in Hawaiian waters.

Special Note: The Pacific Leatherback Sea Turtle is listed as endangered by the United States Department of the Interior and it may not be taken in the Hawaiian waters for any purpose.* (*Institutions or individuals seeking scientific or research capture permits must apply directly to, and receive the approval of, the U.S. Department of the Interior and the Department of Commerce.)



Juvenile

GLOSSARY

- Aestivation.** A prolonged inactivity during the hottest periods of the year.
- Amplexus.** The sexual embrace of a female amphibian (frog or salamander) by a male amphibian.
- Anurans.** From the Greek "tailless" and referring to all frogs and toads, which comprise the order Anura.
- Carapace.** The upper shell of a turtle.
- Chelonian.** A turtle; any member of the order Chelonia.
- Cloaca.** The common chamber in reptiles and amphibians into which the digestive, urinary, and reproductive canals discharge their contents, and which opens to the exterior through the anus.
- Crepuscular.** Active at twilight periods (dusk or dawn).
- Diurnal.** Active during the daytime.
- Dorsal.** Of or pertaining to the upper surface of the body.
- Dorsolateral.** Of or pertaining to the upper sides of the body.
- Ectothermic.** Regulating the body temperature by means of outside sources of heat (= cold-blooded).
- Endemic.** Confined to a certain area, region, group of islands or continent and found nowhere else.
- Endothermic.** Regulating the body temperature by means of an internal regulating mechanism so as to produce a more-or-less constant body temperature (= warm-blooded).
- Femoral pores.** Small openings, containing a waxlike material, on the underside of the thighs in some species of lizard.
- Fossorial.** Adapted for and leading primarily a burrowing existence.
- Gestation.** The period of development or carrying of embryos by the female of a species.
- Granules.** Tiny flat scales.
- Gravid.** A female bearing eggs or young, ordinarily in the oviducts (= pregnant).
- Gular fold.** Fold of skin across the rear of the throat, well developed in certain lizards.
- Hemipenis (pl. hemipenes).** The paired copulatory organs (double penis), found in lizards and snakes and when not in use sheathed in the lateral portions of the ventral area of the tail. (Turtles have a single penis.)
- Herpetology.** The study of reptiles and amphibians.
- Herptile.** Any individual reptile or amphibian.
- Indigenous.** Occurring or living naturally in a particular region or place, but not restricted in distribution to that area.
- Jacobson's organ.** One of the primary sensory organs in snakes and lizards located in the roof of the mouth and used to perceive odors and chemical substances.

Labial. Of or pertaining to the upper or lower lip.

Lamina (pl. laminae). A horny plate overlying the bony layer of the shell of many turtles.

Larva (pl. larvae). The immature individual between egg and adult stages which differs in appearance from its parents and which typically must pass through metamorphosis before assuming the adult characteristics.

Lateral. Of or pertaining to the side.

Melanistic. Having an abundance of black pigment, resulting in an all-black or unusually dark animal; the opposite of albinism.

Metamorphosis. A marked change from larval to adult form or structure, and usually also in habits and food, as when a tadpole changes into a frog.

Middorsal. Of or pertaining to the center of the upper surface of the body.

Midventral. Of or pertaining to the center of the undersurface of the body or abdomen.

Neotenic. Retaining the larval form and appearance throughout life but capable of reproduction.

Nocturnal. Active primarily at night.

Nuptial pad. Rough, dark pigmented skin on the fingers of male amphibians which develop during the breeding period and aid the male in holding the female during amplexus.

Oviparous. Reproducing by means of eggs that hatch outside the body of the female.

Ovoviviparous. Reproducing by means of eggs that have a shell, but which hatch inside the female before or just before laying so as to produce living young.

Paratoid. One of a pair of large external wartlike glands located on each side of the back of the head in toads and particularly well developed in toads of the genus *Bufo*.

Parthenogenesis. Reproduction by means of the development of an unfertilized egg. Involves the development of eggs from virgin females without fertilization by spermatozoa (= unisexual).

Pectoral. Of or pertaining to the chest.

Pelagic. Of, or living in the open sea.

Pharynx. The portion of the alimentary canal between the cavity of the mouth and the esophagus.

Plastron. The lower shell of a turtle.

Pleurodont. Having the teeth located on the inner edge of the jaw, as in iguanid lizards.

Postanal scale. A scale located on the ventral surface posterior to the anus. Typically in male iguanid lizards, two or more of these scales are enlarged.

Prenatal scale. A scale located on the ventral surface anterior to the anus. Typically in geckos and certain other lizards these scales may have enlarged pores that secrete a waxlike substance.

Predation. Obtaining food through consumption of prey animals which may be either vertebrates or invertebrates.

Prehensile. Adapted for grasping or seizing, especially by wrapping around, as the tail of certain lizards and snakes.

Scale. Any enlarged scale of a reptile which may also be referred to as a "plate" or "shield."

Sexual dimorphism. A difference between males and females of the same species in color, form, or structure.

Shell length. The direct or straightline length of a turtle's carapace, measured along the midline from front to rear.

Shield. A plate. In reference to turtles, any of the "plates" or "scutes" of horn that cover the shell in most species.

Snout-vent length. The direct or straightline length of a reptile, amphibian or other animal as measured from the anterior tip of the snout to the posterior tip of the vent.

Species. A species is a group of animals that naturally interbreed to produce fertile offspring. The fundamental unit of classification.

Subspecies. When a population of animals is distributed over a geographic area with diverse environmental conditions, the members of the species in one section of the range may differ slightly in form or color from those in another section. Each subdivision is known as a race or subspecies.

Sympatric. A term applied to two or more populations of animals that occupy the same or overlapping geographical areas.

Tadpole. The aquatic larva of a frog or toad which through the process of metamorphosis develops into an adult.

Total length. The greatest straightline length of a reptile, amphibian or other animal as measured from the anterior tip of the snout to the posterior tip of the tail.

Tympanum. The eardrum. In many frogs and toads it is well developed and is larger in males than in females.

Vent. The ventral opening of the cloaca which serves as the terminus of both waste discharge and the reproductive canal; in snakes and lizards the vent is considered the division between the body and the tail.

Ventral. Of, or pertaining to the undersurface of the body.

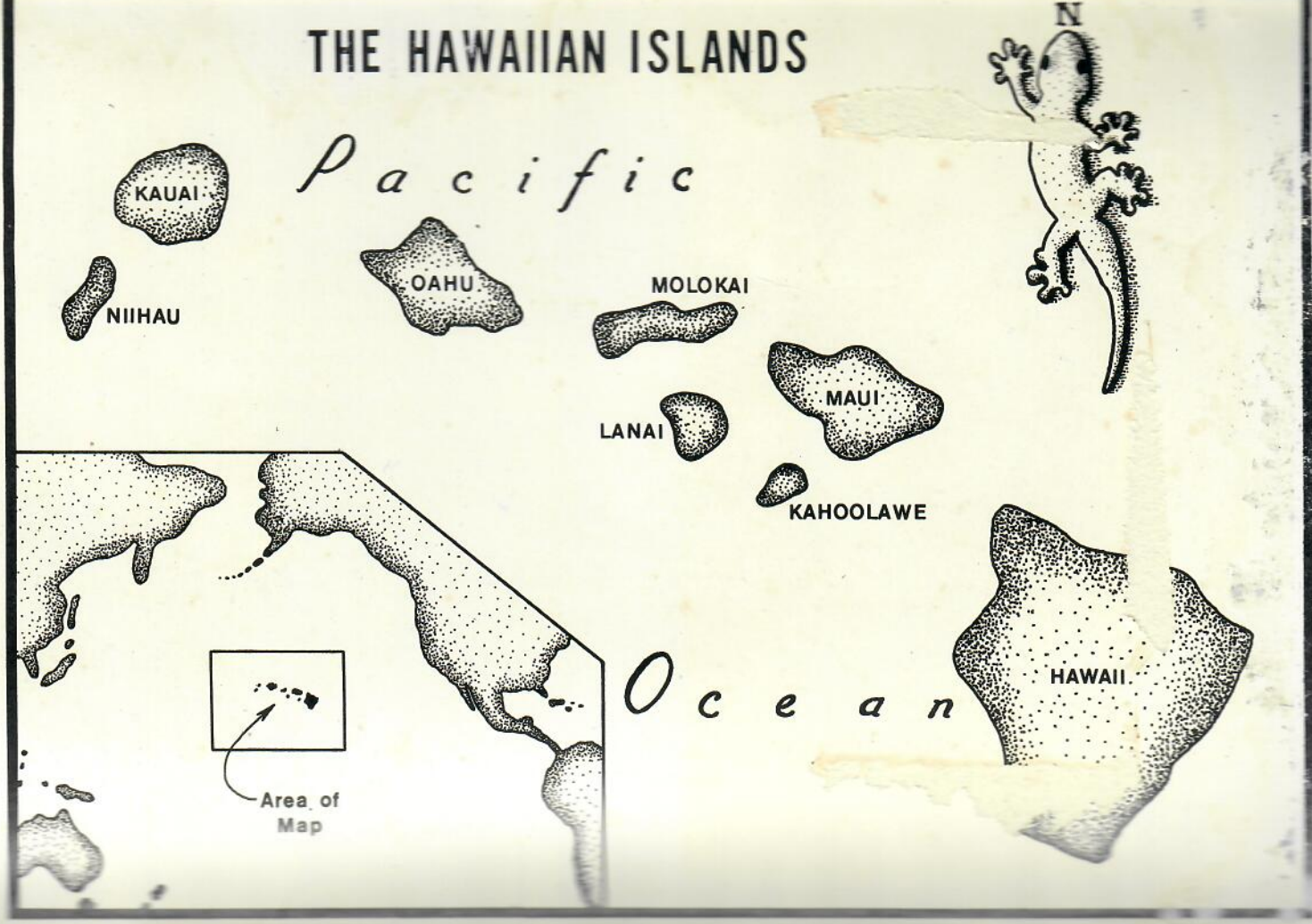
Vertical pupil. A vertically elliptical pupil of the eye that is especially useful to animals active at night. All Hawaiian geckos have vertical pupils.

Vocal sac. An inflatable pouch on the throat of frogs and toads that swells with air and serves as a resonating chamber when these anurans call (croak) and collapses at the end of the call.

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THE HAWAIIAN ISLANDS



Dedicated to Jinny—and—the Keikis of Hawaii

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Green Anole Lizard

Anolis carolinensis porcatu



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and
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