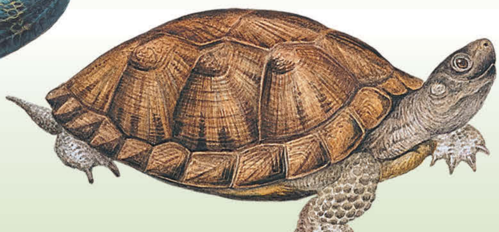
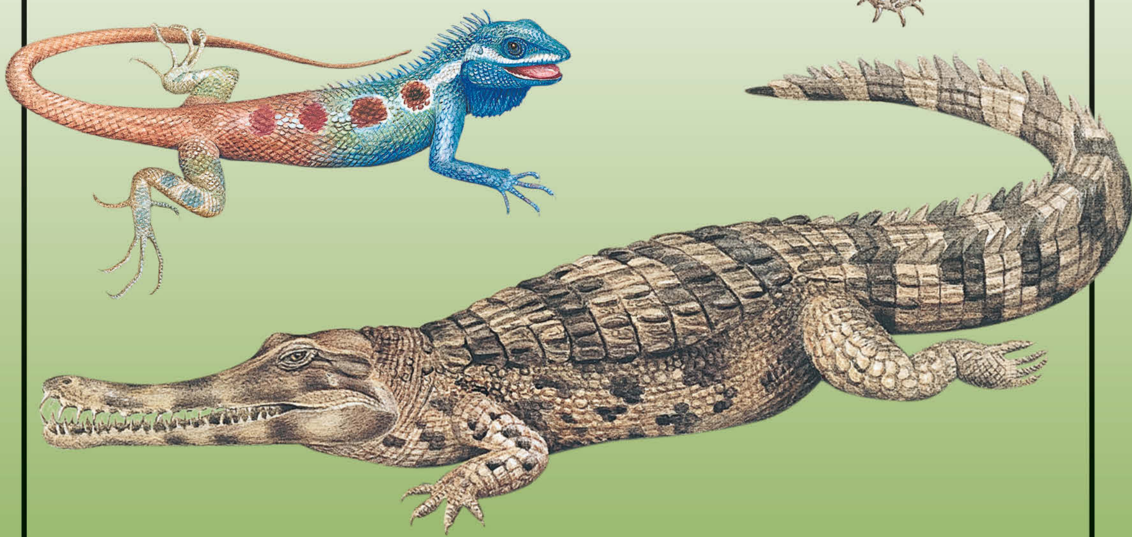



A FIELD GUIDE TO THE

REPTILES OF SOUTH-EAST ASIA

INDRANEIL DAS



MYANMAR, THAILAND, LAOS, CAMBODIA, VIETNAM, PENINSULAR MALAYSIA, SINGAPORE, SUMATRA, BORNEO, JAVA, BALI

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Illustrated by Robin Budden, Sandra Doyle, Rachel Ivanyi, Szabolcs Kokay,
Jonathan Latimer, Denys Ovenden, Lyn Wells

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Abbreviations and Conventions

ASEAN Association of South East Asian Nations
asl above sea level
ca circa
IUCN International Union for Conservation of Nature and Natural Resources
nr near
SCL straight carapace length (of turtles)
SVL snout-vent length (of most lizards)
TL total length (of snakes and anguid lizards)

This book provides a convenient means for both non-specialists and professional herpetologists working in the field to identify all valid species of reptile currently known in South-East Asia. In this work, South-East Asia refers to all political entities on the Asian mainland east of India and south of China, and bordered by the Sahul Plate to the south (see page 13 for further details).

Given the intense sampling now taking place in many countries in the region, and from habitats that were until recently inaccessible, new species discoveries, as well as rediscoveries of species hitherto known only from textual descriptions, are now routine. New methods for differentiating cryptic species, especially molecular techniques, have also added significantly to the arsenal for species prospectors. A work of this nature is thus likely to become rapidly outdated, and one hopes it can be revised at periodic intervals, incorporating all new information that becomes available.

Not all species covered here can be reliably recognized in the field: for a number of groups, particularly within the squamates (lizards and snakes), reliable identification can be carried out only after careful scale counts, in addition to examination of dentitional and hemipeneal structures, which is challenging to all except those with access to a microscope or at least a good hand lens.

DEFINING REPTILES

Unlike mammals and birds, which are natural units (or share a common ancestry), reptiles are not easy to define. Contemporary classifications based on both bones and molecular data show that modern birds are 'nested' well inside the group. Exclusion of these feathered cousins therefore renders 'reptiles' incomplete. Reptiles belong to a natural group called 'amniotes', which is characterized by the production of water-tight eggs that are relatively better buffered from the external environment than the eggs of other vertebrates, such as fish and frogs. Amniotes comprise most of the land vertebrates, including mammals, birds, turtles, the tuatara, lizards, snakes and crocodiles. Within this group, with a membership of 20,000 species, are the classes Synapsida, which includes mammals, and Sauropsida, which embraces all other groups (including reptiles and birds). In the latter group, the turtles have been argued to be either the sister group to the clade Sauria, or a sister group to the superorder Lepidosauria. Recent molecular evidence also shows a close relationship between birds and crocodilians. Adding extinct amniotes contributes further complexity to these relationships.

'Reptiles' as defined in this work follows Gauthier et al. (1988) in including 'the most recent common ancestor of extant turtles and saurians, and all of its descendants plus, following conventional usage in the herpetological literature, crocodilians'.

MORPHOLOGICAL SPECIALIZATIONS

While the monophyly (descent from a common ancestor) of the group, as traditionally defined, is itself in question, the use of the word 'reptiles' in this work refers to crocodiles, turtles, snakes and lizards, which do share a number of morphological features. These include: a. a tabular (bone on the posterolateral corner of the skull table) that is small when present; b. a suborbital foramen (hole under the eyeball); c. a supraoccipital anterior crista (prominent ridge above the orbit) and d. a narrow supraoccipital plate (median bone at the back of the skull, which borders the foramen magnum).

CROCODILES

Crocodiles (order Crocodylia) and their relatives today comprise just three living families with about two-dozen species, although a rich assemblage existed in former times. They are some of the largest of living reptiles. They have an enlarged head with powerful jaws equipped with numerous conical and pointed teeth; a broad and posteriorly flattened skull; external ear openings; shortened forelimbs and a long to extremely long elongated snout. A 'third eyelid', the nictitating membrane, covers the eyes while they are underwater. Other external characteristics shared by crocodiles and their close kin, alligators, include rather tough scaled skin, webbed feet and a laterally compressed, muscular tail bearing distinct ridges, the last two features being associated with a life in water and swimming.

Internal characteristics shared by the group include a skull with temporal fenestrae (bilaterally symmetrical holes in the temporal bones); well-developed neural spines (spinous processes of the vertebral column); a well-developed secondary palate and a four-chambered heart.

TURTLES AND TORTOISES

The order Chelonii (Chelonia or Testudines of some authors) includes turtles, tortoises and terrapins, which are arguably the most easily recognizable group within the reptiles. They are characterized by external features such as a lack of teeth (in all living species), and most famously by a shell located above (the carapace) and underneath (the plastron) the body. The carapace and plastron are associated with protection of the head, limbs, tail and internal organs, and derive from the fusion of the vertebral column with the ribs, sternum, and pectoral and pelvic girdles. Significantly, the girdles are located inside the ribs. A majority of turtles have added another element to this nearly impregnable fortress – a layer of keratinized scutes or scales, further reinforcing the shell.

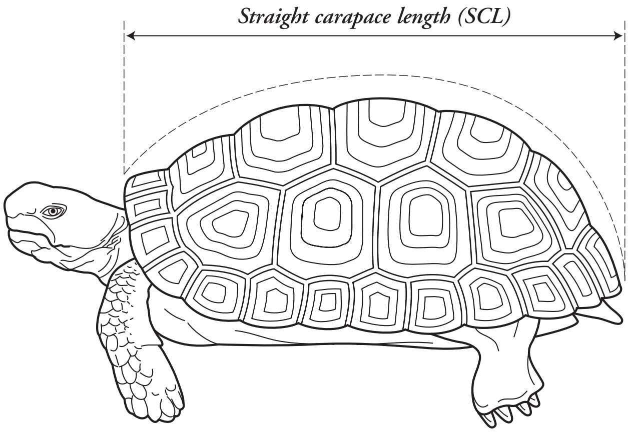
Only a few families of living turtles have done away with scutes altogether, and have a bony shell enveloped by leathery skin. Shell scutes of juvenile Leatherback Turtles (*Dermochelys coriacea*) are lost

IDENTIFICATION OF REPTILES

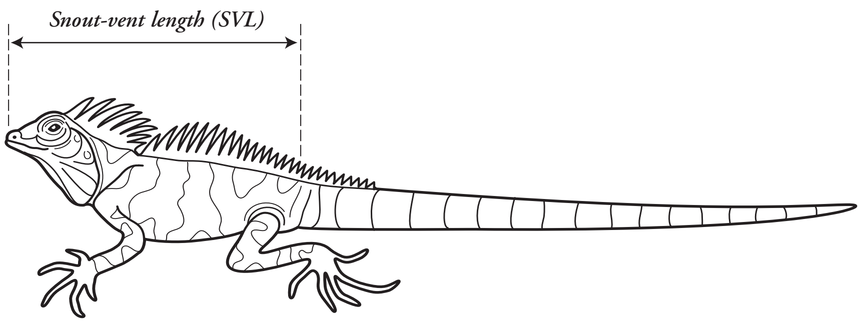
In many South-East Asian reptiles, body size, shape, form, colour and patterning are diagnostic. In lizards and snakes, scale patterns and counts on the head and body are often key to identification.

MEASUREMENTS OF SIZE

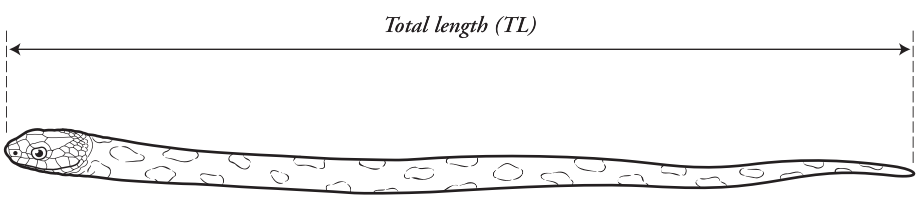
Turtles, Terrapins and Tortoises
There are several ways of assessing the size of turtles, terrapins and tortoises. The size of the species in this book is reported as the measurement along the midline of the straight length of the carapace (SCL).



Lizards
For all lizards apart from glass snakes, size is determined by measuring the body length from snout to vent (SVL), rather than the total length. Many lizards may lose and regenerate their tail, so knowledge of their total length is of little advantage for identification purposes.



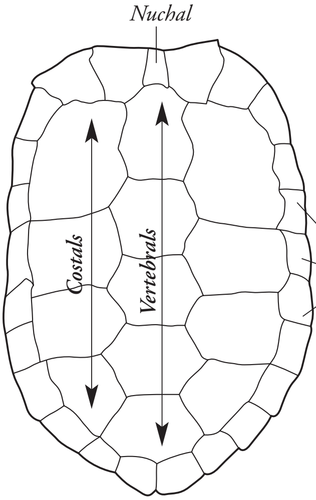
Snakes and Glass Snakes
In this book, the size of snakes and glass snakes (a group of mostly limbless lizards) is reported as total length (TL), measured from the tip of the snout to the tip of the tail.



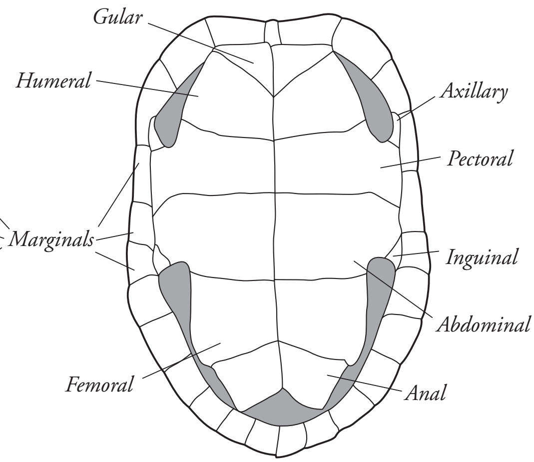
MORPHOLOGICAL TRAITS AND SCALE TYPES

Turtles, Terrapins and Tortoises

The scales (or scutes) on the hard, bony upper shell (carapace) and lower shell (plastron) of hardshelled tortoises and turtles are arranged in a specific manner and greatly facilitate identification.



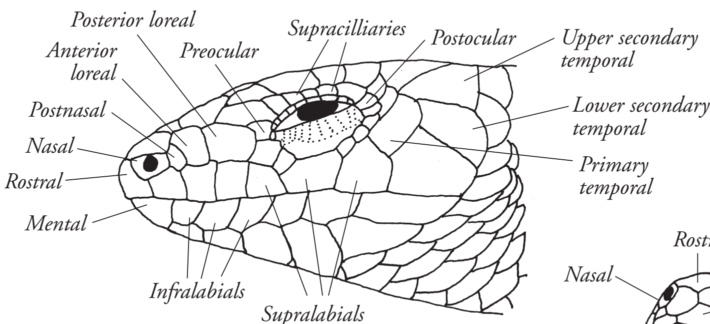
Dorsal view, showing carapace



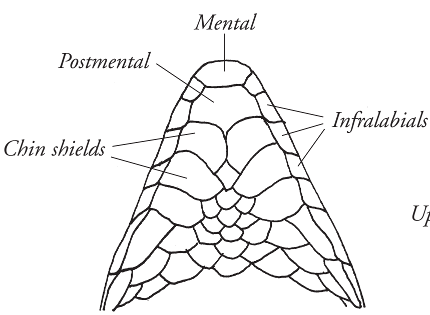
Ventral view, showing plastron

Head Scales of Lizards

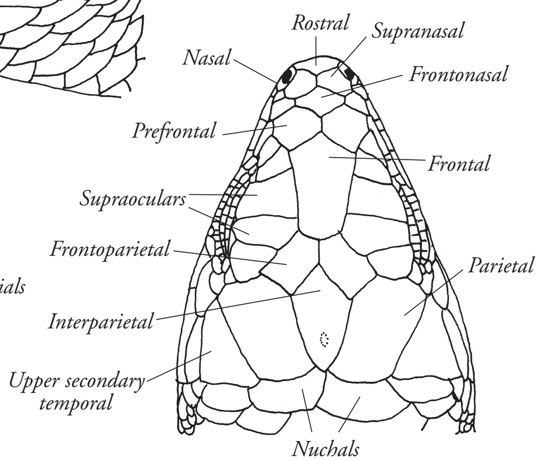
Scale position and size are useful pointers in the identification of lizards (and snakes, see page 10). The positions and names of the scales are more or less typical in most squamates.



Lateral view



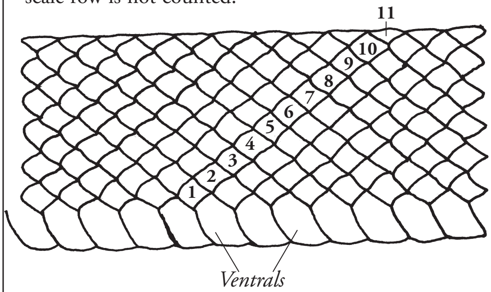
Ventral view



Dorsal view

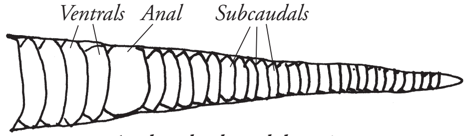
Body Scale Counts of Snakes

Counts of the number of scale rows on a snake's body are useful for identifying species. A body scale count is made midway between the head and the cloaca, where the number of rows is the highest. The ventral scale row is not counted.

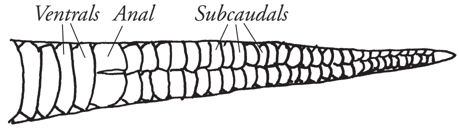


Tail Scale Counts of Snakes

The 'subcaudal scale count' is the number of scales, or pairs of scales (depending on the species) under the tail. The count is made from the first scale or pair of scales below the anal, to the scale just in front of the terminal scale at the tail-tip.



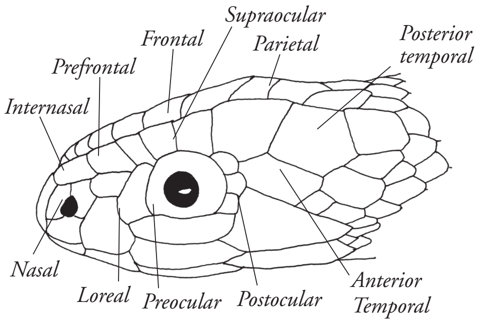
Anal and subcaudals entire



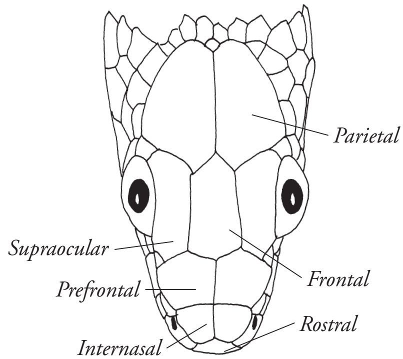
Anal and subcaudals divided

Head Scales of Snakes

The scales on the heads of lizards can be identified by their shape and relative position.



Lateral view



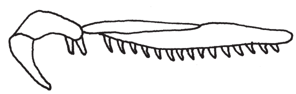
Dorsal view

Dentitional Types in Snakes

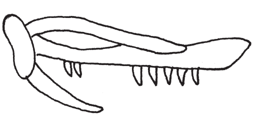
Snakes can be placed in one of four groups, according to the form of teeth they have, which is associated with the method used to capture and kill prey. Snake teeth can grow back when lost, and snakes may have several sets of teeth throughout their life – this is necessary because their teeth are often lost during feeding. In **aglyphous snakes**, which are not venomous, each tooth is more or less the same shape and size. **Opisthoglyphous snakes** are similar to aglyphous snakes, but possess weak venom, which is injected by a pair of backwards pointing, enlarged teeth at the back of the maxillae (outer front upper jawbones). The snake must bite the prey, move it to the back of its mouth in order to penetrate it and allow the venom to seep into it along grooves in the fangs. In **proteroglyphous snakes** a substantially enlarged 'fang' in front of the oral cavity points downwards and folds around a venom channel, forming a hollow needle that is injected into prey. **Solenoglyphous snakes** have the most sophisticated venom delivery method, unique to the vipers. The fangs are long and typically folded back. Vipers can open their mouths to almost 180 degrees, and the fangs swing into position to allow them to penetrate deep into prey.

Aglyphous
Unfanged
Colubridae and Pareatidae

Opisthoglyphous
Rear-fanged
Homalopsidae, Natricidae and Pseudoxenodontidae



Proteroglyphous
Immovable anterior fanged
Elapidae



Solenoglyphous
Moveable anterior fanged
Viperidae

with growth, being replaced by smooth skin in adults. Aquatic turtles tend to have webbed feet and streamlined shells, while tortoises predictably possess fingers and toes free of a web, and more rounded or elevated shells. In several highly aquatic freshwater turtles, such as the river terrapins *Batagur affinis* and *B. baska*, the snout is upturned and the nostrils are placed relatively high, permitting respiration with the rest of the body submerged.

Internal characteristics associated with the group include an akinetic (with non-moving components) skull; a complete or emarginated temporal region, lacking temporal fenestrae; reduced dermal roof elements; no parietal foramen (opening in the midline of the skull roof containing a sensory organ) and a shoulder girdle that is internal to the ribs and shell.

LIZARDS AND SNAKES

The order Squamata comprises the final grouping within the reptiles, and contains two groups – the lizards and snakes. Although these groups are externally easy to tell apart (except for the several unrelated groups of limbless lizards, and snakes with vestiges of hind limbs, mentioned below), they are united in possessing the following external characteristics: a relatively slender body covered with scales; frequently, a parietal foramen (a light-sensitive organ); paired hemipenes and numerous sharp teeth. Increased capacity of movement by their skulls and mandibles (compared to that of turtles and crocodiles) permits members of the Squamata to ingest relatively large prey.

Internal characteristics uniting members of the group include a single temporal arch (which has been lost in the gekkotans and snakes); a moveable quadrate; a single temporal fenestra and median cranial elements, including premaxillae, frontals and parietals, which are frequently fused, and show the loss of the temporal arch (the bridge-like extension of the jugal and squamosal bones).

The fundamental differences between the two groups are ecological rather than morphological – lizards are primarily predators of invertebrates, while snakes tend to consume vertebrates. Nonetheless, the numerous exceptions to the rule tend to complicate matters, and several large-growing lizards are also known to consume snakes (in addition to other, sometimes large vertebrates).

A number of lizard families have secondarily lost their limbs (or have degenerated hind limbs), most famously within the Anguidae, Dibamidae and Scincidae families. Meanwhile in members of the Pythonidae and Boidae snake families, vestiges of hind limbs exist in the form of cloacal spurs.

Snakes have a spectacle or brille covering their eyelids, giving them the characteristic 'unblinking' stare, while lizards tend to have moveable eyelids (exceptions being members of the Gekkonidae family). Snakes also lack palpebrals (enlarged scales forming the upper eyelid), a parietal eye and foramen (the 'eye' being a sensory structure opening through the top of the skull), a tympanum, a pectoral girdle and forelimbs. A number of characteristics in snakes, such as a long, thin forked tongue, recurved teeth and male combat, are shared with one group of lizards – the monitors – suggesting a close relationship.

REPTILE ECOLOGY

USE OF HABITAT

The greatest species richness of reptiles occurs in tropical rather than temperate regions of the world, due in part to the complexity of available habitats and microhabitats, greater diversity of prey types, and prevailing climatic conditions (including aseasonality, permitting year-round activity), in addition to other factors (such as geological history).

Reptiles inhabit a broad range of habitats in South-East Asia, including grasslands, freshwaters and peat swamps, dry deciduous forests, lowland dipterocarp forests, karst-dominated forests, montane forests, sea coasts and coral reefs. Within a region, more species and larger communities of reptiles are encountered in lowland forests than in the highlands or in other habitats. In moist deciduous forest settings, for instance, species space themselves out, presumably to reduce competition. Within such communities there may be terrestrial and fossorial forms, in addition to arboreal and aquatic ones.

In many natural reptile communities, habitat specialization is evident. Thus, rock-dwelling geckos equipped with specialized scansors-scales on their fingers and toes may scuttle over karst limestone regions, while arboreal snakes ascend apparently effortlessly to the forest canopy, aided by keeled ventral scales and binocular vision. In a similar setting, fossorial species may seem to effortlessly disappear into loose soil, into which they dig with their sharp snouts, resistance to their passage being reduced through the development of highly polished scales that make them appear iridescent. Adaptations in aquatic snakes include the dorsal (as opposed to lateral) placement of the nostrils and eyes, a streamlined body and, in the case of sea snakes, the flattening of the tail-tip, enabling it to function somewhat like a paddle.

TIME OF ACTIVITY

Time of activity is another dimension ecologically separating species, and two obvious categories here are diurnal (day-active) species, which have rounded pupils, and nocturnal (night-active) species, with elliptical pupils. Breaking down this division somewhat are species that are crepuscular, active during the low light associated with dawn or dusk, these tending to possess elliptical pupils.

Timing of activity may remain unchanged throughout the year in some species, or fluctuate seasonally. Certain species may display a bimodal activity pattern, depending on ambient temperature regimes or the activity of specific prey species. Other species, such as those that inhabit the tropical rainforest floor, are most active under conditions of reduced light by day.

THE SENSES

For such a diverse group of organisms, generalizations on sensory biology tend to be difficult. Within the groups, sight ranges from good in the case of the binocular vision of certain tree snakes (genus *Ahaetulla* and others), critical for judging distances, to non-existent, as in several species of burrowing blind snake (genus *Typhlops*) that lack externally visible eyes.

Hearing is similarly reduced in the reptiles, and snakes have been widely considered 'deaf', although recent experimental data shows that the relatively vocal King Cobra (*Ophiophagus hannah*) may well be capable of perceiving some sound in the form of air-borne vibrations.

Olfactory senses are better developed throughout the group, and may be critical for finding food and detecting the odour of conspecifics, particularly during the breeding season. Pit vipers also possess enlarged pits, located between the nostrils and eyes, and pythons labial pits, whose function is to detect the warmth of endothermic prey in darkness.

Finally, mention needs to be made of the Jacobson's organ, situated on the palate of snakes and some lizards, where the two-tined tongue is applied after sampling the external environment to sense its chemical nature, including the possible presence of prey and predatory species.

SOCIAL RELATIONSHIPS

Reptiles tend to be solitary. Social behaviour is the exception rather than the norm, and reptiles aggregate only seasonally, for reproduction – for example during the 'arribadas' or mass-nesting of the Olive Ridley Sea Turtle (*Lepidochelys olivacea*) – or for hibernation in communal sites (as in snakes in temperate regions). Lack of appropriate exposed sites may also force turtles to bask in large numbers on banks and on logs. Parental care is relatively rare within reptiles, and the most famous examples occur among the crocodilian species, which remain near nests and with their emergent young for a few days, much like the birds to which they are distantly related.

ANTI-PREDATOR RESPONSES

Defensive behaviour enhances survival among living organisms, and a variety of strategies is employed by reptiles. In order to stay out of sight of their enemies, a majority of reptiles have colours and patterns that can be described as 'surface mimicry' or crypsis, being hardly discernable from their surroundings. Others display warning coloration to advertise their bite (such as the venomous *Calliophis* or coral snakes). Many use flight as an effective way of rapidly escaping from a threatening situation. Still others feign death, becoming immobile to the touch or manipulation by a potential predator, turning into a ball of coils or expanding parts of their body, all with the intention of confusing the would-be predator.

Venomous snakes, especially vipers and cobras, may hiss, expelling inhaled air in an act of displeasure, while warning of a lethal bite. Cobras may additionally raise their head and spread a hood, a behaviour mimicked by a few groups of unrelated and non-venomous snakes. Some species, while non-venomous, adopt colours of unrelated venomous species, thereby gaining the advantage of protection in being mistaken for a dangerous snake.

A few groups of lizards, most famously the geckos and skinks, can readily detach their tail (caudal autotomy) at signs of danger, at a predetermined fracture plane within the caudal vertebrae. The lost tail is gradually replaced, but may differ in shape and size, and the bone is replaced by a cartilaginous rod. Caudal autotomy (but apparently without regrowth) is also known in snakes of the families Natricidae (genus *Amphiesma*) and Colubridae (genus *Sibynophis*), and occurs between the caudal vertebrae.

HEAT CONTROL IN THE BODY

A majority of the world's living reptiles display ectothermy, whereby the body temperature depends primarily on the absorption of heat energy from the environment. This is fundamentally different from the condition in birds and mammals, which employ endothermy, where the body temperature is dependent primarily on heat produced via the metabolism, and the dissipation of heat to the environment. However, the body temperature of reptiles is not controlled by a single environmental temperature, and individual reptiles are capable of actively regulating their body temperature through the selection of substrates or microhabitats that show a range of temperatures. Typically, an increase in body temperature is achieved by basking, through obtaining heat from the sun. Other ways to gain or loose heat include absorbing heat from the substratum, panting or shunting heat away from extremities exposed to the cold. Ecotherms thus need to allocate a lower proportion of the energy derived from food to maintaining an optimal body temperature, in relation to endotherms.

DIETS AND FORAGING

Few reptiles are herbivores, and those that are tend to be large in body size compared to their carnivorous relatives. One explanation for this is that, being large, reptiles cannot harvest enough animal prey food, and are thus facultatively herbivorous. The juvenile stages of these species (including iguanians, sea turtles and freshwater turtles) display carnivorous habits.

Carnivorous reptiles hunt in two distinct ways. Sit-and-wait species wait in ambush for their prey, detecting it visually. They employ relatively low levels of activity and appear to have poorly developed chemosensory systems. Examples of these species include agamid lizards and geckos. On the other hand, widely foraging species such as monitor lizards actively hunt for prey, using more developed chemosensory systems. These species show high activity levels and appear to harvest more prey calories per unit time.

Dietary specializations are relatively rare in reptiles compared to other vertebrate groups. The most widespread example is a diet of ants in flying lizards (agamid lizards of the genus *Draco*). Other specialized diet types include earthworms (colubrid snakes of the genera *Blythia, Calamaria* and *Plagiopholis*), freshwater and land snails (geoemydid turtles of the genus *Malayemys* and members of the snake family Pareatidae), softshelled crabs (homalopsid snakes of the genus *Fordonia*) and fish (crocodilians of the Gavialiidae family and the Hydrophiidae sea snakes). Some snakes have further specialization: those of the genus *Psammodynastes* consume heavily scaled vertebrates (including fish, skinks and other snakes), and one sea snake, the Beaded Sea Snake (*Aipysurus eydouxii*), eats only fish eggs.

REPRODUCTIVE DIVERSITY

A majority of reptiles reproduce sexually and produce eggs that hatch outside the mother's body. Notable exceptions include the presence of a single sex in some species, represented in the region by several geckos and the ubiquitous Brahminy Blind Snake (*Ramphotyphlops braminus*), which are all-female species. Within reptiles that produce eggs (oviparous), clutch size and offspring size are typically related to other aspects of the ecology of the species. While larger females can produce larger eggs and/or larger clutches, other considerations may be important. These include the number of times a female can breed in a season, and whether additional parental investments, such as care of the eggs and/or neonates, are required. A few species employ ovoviviparity or egg-retention within the body of the female – a form of parental care. All species of crocodilians, turtles, terrapins and tortoises are oviparous.

Foraging strategies, described earlier, are known to influence reproduction. For instance, the clutch size of widely foraging species tends to be smaller than that of sit-and-wait ones, as members of the former group cannot weigh themselves down while pursuing prey. Clutch size itself is subject to considerable variation, even within orders. Within turtles, it may range from a single, relatively large egg, as in the Spiny Hill Turtle (*Heosemys spinosa*), to more than 150 eggs in the marine turtles. Among squamates, clutch size may range from a single egg in Sauter's Keelback (*Amphiesma sauteri*), to 124 eggs in the Reticulated Python (*Broghammerus reticulatus*).

REGION COVERED

The region currently referred to as South-East Asia was variously referred to as 'Indes Orientalis' or 'Eastern India' in medieval Europe, and in even earlier times as 'Land below the Wind and Golden Khersonese' (literally, 'land of gold') by Arab and Indian seafarers. Interest in the region grew from the 1500s, fuelled primarily by the desire for spices and timber. Centralized societies existed here well before this time in north-eastern Thailand (between 1400 and 1000 BC), and these had extensive trading connections with societies in China and India. Subsequently, other important political centres developed, including Co Loa in Vietnam and Fu-Nan in Cambodia. Following the retreat of the European colonial powers around the middle of the 1900s, several nation states emerged, which formed the Association of Southeast Asian Nations (ASEAN). The members of this primarily economic block comprise Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Singapore, Indonesia, Brunei Darussalam, the Philippines and Timor Lesté.

In this work, South-East Asia refers to all political entities on the Asian mainland east of India and south of China, and bordered by the Sahul Plate to the south. (See also map on front endpapers, and map on back endpapers for topography.) Thus, the eastern islands of Indonesia, including New Guinea, have been omitted, as have the archipelagic nations of Timor Lesté and the Philippines. Brief introductions to the countries whose reptile fauna is dealt with in this work are given below.

Brunei

Negara Brunei Darussalam, total land area 5,270sq km, is located on the north-western coast of Borneo, and is divided into two parts, both wedged into the Malaysian State of Sarawak. To its north is the South China Sea, and it has a coastline of 161km. The capital is Bandar Seri Begawan. The climate is aseasonal, tropical. The coastal plains on the eastern sector rise to mountains further south; on the western sector beyond the coastal plains lie extensive lowland and hill dipterocarp forests. The highest mountain is Bukit Pagon (1,850m asl). The human population in 2008 was 381,371. Environmental problems relevant to biodiversity include logging on Brunei's borders and smoke from forest fires, resulting in haze. Important centres for protection of biological diversity include the Temburong National Park and the Pulau Selurong Nature Reserve.

Cambodia

The Kingdom of Cambodia, total land area 176,520sq km, is part of the region popularly referred to as 'Indo-China', and borders the Gulf of Thailand in the south. Its political boundaries include Thailand to the west and north-west, Vietnam in the east and Laos to the north-east. The coastline is 443km in length. The capital is Phnom Penh. Subtropical monsoon forests characterize Cambodia, and there is a distinct dry season. The topography is essentially low and flat, with mountains in the northern and south-western parts of the country. Major wetlands include the Mekong River and the great lake of Tonle Sap. The highest mountain is Phnom Aural (1,810m asl). The human population in 2008 was 14,241,640. Issues relevant to the protection of biological diversity include loss of forest cover as a result of the removal of timber, and mining for gems. Important areas for biological diversity conservation include the Kirirom National Park, Phnom Bokor National Park and Botum–Sakor National Park.

Indonesia

The Republic of Indonesia, total land area 1,826,440sq km, straddles the archipelagos between the Indian Ocean and the Pacific Ocean. Indonesia shares just three of the 17,508 islands with other political entities – Borneo with Malaysia and Brunei, Timor with Timor Leste, and New Guinea with Papua New Guinea. It has a coastline of 54,716km. The capital is Jakarta. The climate of the islands of Indonesia is mostly aseasonal and tropical, with the highlands experiencing a cooler climate. The coastal plains give rise to tall mountains, chiefly on the larger islands. The highest mountain is Puncak Jaya (5,030m asl) on New Guinea. The human population in 2008 was 237,512,352. Major environmental problems include logging for timber, the clearing of land for shifting cultivation and industrial pollution. Areas gazetted for protection of biological diversity within the Greater Sundas include Meru Betiri National Park, Kerinchi Seblat National Park and Bentuang Karimun National Park.

Laos
The Lao People's Democratic Republic, total land area 230,800sq km, is another country of Indo-China, bordering Vietnam on the west, and is north-east of Thailand and north of Cambodia. It has a short border with China in the north, and is landlocked. The capital is Vientiane. The climate is subtropical with distinct dry and wet seasons in the north, more tropical in the south. Laos has large tracts of primary forests, and the land itself is mostly rugged with some plains. The Mekong River forms part of the western boundary, and the highest peak is Phou Bia (2,817m asl). The human population in 2008 was 6,677,534. Important issues in biodiversity conservation include deforestation and the presence of unexploded ordnance. Protected areas include the Nam Et and Phou Loei National Biodiversity Conservation Area, Phu Luang National Biodiversity Conservation Area and Khammouane Limestone National Biodiversity Conservation Area.

Malaysia
Malaysia, total land area 328,550sq km, is bisected into two parts: on the South-East Asian mainland it forms the long peninsula jutting into the South China Sea, and on the island of Borneo it occupies the twin states of Sarawak and Sabah. On the mainland it is bounded by Thailand to its north; on Borneo it is bounded by Kalimantan (Indonesia); the independent Sultanate of Brunei is wedged within the state of Sarawak. Malaysia has a coastline of 4,675km. The capital is Kuala Lumpur. The climate is primarily aseasonal, tropical, the northern states of Peninsular Malaysia showing a hint of the dry season. The land itself includes coastal plains, rising to mountains in the interior. The highest mountain is Gunung Kinabalu on Borneo (4,100m asl). The human population in 2008 was 25,274,132. Factors that threaten biodiversity include loss of forest cover as a result of commercial logging, clearance of land for shifting cultivation and perhaps also hunting. Important areas for biodiversity include Taman Negara, Bako National Park, Lambir Hills National Park and Gunung Kinabalu Park.

Myanmar
The Union of Myanmar ('Burma' up to 1989), total land area 657,740sq km, is the most north-western country in South-East Asia. It borders the Andaman Sea and Bay of Bengal to the east, sharing borders on the north and north-east with Bangladesh, India and China. To its west is a narrow contact with Laos, and in the south-east it contacts western Thailand. Its coastline is 1,930km in length. The capital is Yangon. The climate can be described as tropical monsoon, the lowlands of central Myanmar being ringed on all sides by gentle to steep mountains, including the highest mountain in South-East Asia (Hkakabo Razi, 5,881m asl). The human population in 2008 was 47,758,180. The key environmental problem related to biological diversity is loss of forest cover as a result of timber harvesting. Important protected areas include Kathapa National Park, Popa Mountain Park and Chhatin Wildlife Sanctuary.

Singapore
The Republic of Singapore, total land area 682.7sq km, is an island state located at the southern tip of Peninsular Malaysia. It has a coastline of 193km. The local climate of this city-state is aseasonal, tropical. While most of the island comprises relatively flat areas, the central plateau is gently undulating. The highest point is Bukit Timah (166m asl). The human population in 2008 was 4,608,167. Threats to local biodiversity include fragmentation and industrial pollution. Important protected areas include Bukit Timah Nature Reserve, Pasir Ris Park and Sungei Buloh Wetland Reserve.

Thailand
The Kingdom of Thailand (formerly Siam), total land area 511,770sq km, borders the Andaman Sea and Gulf of Thailand in the west and south, Myanmar to the north-east and east, northern Peninsular Malaysia in the deep south, and the Indo-Chinese countries of Laos and Cambodia on the north-east, east and south-east. The coastline is 3,219km in length. The capital is Bangkok. The climate is subtropical with a distinct dry season in the north, more aseasonal in the southern peninsula. Apart from the dry central plain and low-lying areas of the south, much of the country is mountainous, especially along the borders. The highest mountain is Doi Inthanon (2,576m asl). The human population in 2008 was 65,493,296. Factors that threaten local biodiversity include deforestation, and hunting and gathering of wildlife. Important areas for biological diversity include Khao Yai National Park, Doi Inthanon National Park and Phu Kao-Phu Phan Kam National Park.

Vietnam
The Socialist Republic of Vietnam is the largest country in Indo-China, with a total land area of 325,360sq km, and borders the Gulf of Thailand, the Gulf of Tonkin and the South China Sea. To the north it is bounded by China, in the east by Laos, and west of southern Vietnam is Cambodia. The coastline is

3,444km in length. The capital is Hanoi. The climate ranges from subtropical monsoon in the north, with distinct dry and wet seasons, to aseasonal tropical in the south. The landscape consists of extensive low-lying areas, including deltas, as well as mountains in the northern, north-western and central regions. The highest mountain is Fan Si Pan, currently known as Phang Si Pang (3,144m asl). The human population in 2008 was 86,116,560. Major factors that threaten biological diversity include agricultural practices such as slash-and-burn agriculture, and also logging. Important areas for biodiversity include Phong Nha-Ke Bang National Park, Vu Quang National Park and Cat Ba Island National Park.

THE ENVIRONMENT

The richness of plant and animal life in the region referred to as South-East Asia is attributed to two factors – geological history and present-day climate – and a number of reptile lineages are found nowhere else in the world. Several groups, especially geckos and skinks, reach their greatest diversification in the region, having terrestrial, arboreal, fossorial and even aquatic forms.

Historically, nearly all of South-East Asia was covered with humid tropical forests, although some regions, including parts of central Myanmar and Sumatra, were naturally dry and supported savannah-type vegetation. Others, such as the Annamite (Truong Son) Mountains and north-western Borneo, remained unaffected by the glacials, and thus harbour ancient lineages of animals and plants.

Starting in the 19th century, the logger and his chain-saw has been the most destructive of all to arrive in the region. Vast swathes of once-forested land have been cleared from South-East Asia, and the pace of forest-clearing stops locally only when all of the commercially valuable trees have been removed. The effects of this practice on the land's biodiversity, not to mention the soil, water and human well-being, have been nothing short of catastrophic.

REPTILE CONSERVATION

Reptile exploitation in South-East Asia ranges from the occasional capture of a gigantic python or sea turtle by indigenous groups for subsistence, to large-scale removal of turtles, lizards and snakes for the food and traditional medicine trade. Hunting pressure can be intense, and is matched only by the acceleration of habitat loss, particularly in the last 30 years. Several local species of turtle and at least two crocodilians are now seriously threatened, and the status of many more species is unclear due to lack of scientific data on identities, populations and distribution.

Few reptile species are deemed charismatic by the general public, and few are scientifically managed. Indeed, conservation and management priorities are generally set by non-biological criteria such as economic value and appeal. Nonetheless, a number of species are known to be of importance to ecosystems and local food webs, and have been identified as key to helping maintain such functions. Additionally, reptiles can aid the dispersal of plants, function as beneficial scavengers, facilitating the release of nutrients locked up in dead tissue, and help to control agricultural pests including rats and mice, and locusts and other insect pests. Unfortunately, reptiles are on the menu of other predatory vertebrates and invertebrates, including humans, several life-saving drugs are derived from snake venoms, and innumerable folk remedies and indigenous systems of medicine are based on various reptile body parts.

A number of actions can be recommended to augment the conservation of reptiles regionally. Identification of species in need of protection is an obvious first step. While progress has been substantial for turtles and crocodiles, the conservation status of most lizard and snake species remains unknown. Efforts need to be made to produce inventories of areas with intact forest cover, especially global and regional hotspots, in order to understand species' distribution and habitat association. Also needed are life-history studies on local reptile assemblages that will provide scientific information on aspects of their ecology and behaviour, which is essential for their conservation and management.

Habitat protection, especially the conservation of lowland rainforests (a majority of local reptiles are restricted to these forests), is fundamental in the conservation of reptile biodiversity. Also in need of protection are specialized forest types such as mangrove and peat swamps, montane forests and limestone karst areas, each of which harbours unique assemblages of reptile species. Efforts also must be made to connect existing protected areas in order to create potentially larger areas under natural forest cover, thus increasing the viability of populations within them.

Trade in wildlife is the earliest occupation of humans, and while a small degree of sustainable use (in non-consumptive forms, such as ecotourism) can sometimes be encouraged, large-scale organized trade, targetting selected species for overseas markets, should be strictly monitored, controlled and – in the vast majority of cases – stopped altogether.

Finally, the socio-cultural value of reptiles across the many cultures of South-East Asia is a much-neglected area of study. Important insights can be gained from such studies that can add to our knowledge of reptile biology, while at the same time enhancing conservation practice.

BOOK ORGANIZATION

This work covers all currently valid species known from the region. The cut-off date for inclusion was 31 December 2008. A majority of the species are illustrated. For each species, the following are supplied:

1. **Common English name** (coining a new name in a few cases where no common name existed).

2. **Current scientific name.**

3. **Symbols** where relevant next to the common name. These denote a species that may pose a danger to humans. The symbols are as follows:

Mildly Venomous Snake Bites from small snakes may cause slight envenomation in humans, while bites from adults of some snake species can cause mortality in humans.

Deadly Venomous Snake Bites from these snakes may cause mortality in humans.

Large-growing Reptile Adults of these species may be dangerous to humans.

4. **Maximum length attained** Straight carapace length (SCL) in turtles, terrapins and tortoises; total length (TL) in crocodilians, snakes and anguid lizards; and snout-vent length (SVL) in all other lizards. See also diagrams on page 8. Size measurements of more than 200 millimetres are provided in metres; measurements below 200 millimetres are given in millimetres.

MANAGEMENT OF SNAKEBITE

Snakes are most likely to bite humans when they have been startled, provoked and/or cornered. Make sure you familiarize yourself with the basic procedure for snakebite treatment before travelling to areas with venomous snakes.

Several well-known dangerously venomous snakes occur in South-East Asia. Among them are members of two families – the Elapidae (comprising cobras, kraits, coral snakes and sea snakes) and the Viperidae (consisting of the vipers, including pit vipers).

Venom from the Elapidae affects the nerves, hence ‘neurotoxic’ venom. It blocks the conduction of nerve impulses to muscles. Symptoms of venomous snakebite include loss of muscle control, which is manifested by drooping eyelids, a loss of muscle tone in the facial features and paralysis of the diaphragm, resulting in an inability to breathe.

Venom from the Viperidae affects the circulatory system and is called ‘haematoxic’ venom. It damages the walls of the blood vessels. Symptoms of snakebite in this case include severe local pain and swelling, non-clotting of the blood and kidney failure.

Bites from some of the larger keelback snakes (including members of the genera *Rhabdophis* and *Macropisthodon*) may also be serious enough to warrant medical treatment for envenomation.

Antivenom should be administered only by qualified physicians, when signs of local or systemic envenomation are evident. Ideally, the antivenom used should be from the same species and from the same geographical area. A hospital in the tropics should have staff knowledgeable about local snakes of medicinal importance, and the possible symptoms of their bites. They should also have access to appropriate antivenom, and epinephrine to treat anaphylaxis. Other basic facilities for treatment of venomous snakebite include a system for assisted breathing (especially for serious cases of neurotoxic envenomation) and treatment for acute renal failure (for bites from vipers, especially *Daboia russelii*).

If someone you know suffers a snakebite, bear in mind the following:

- For bites from species belonging to the families Elapidae and Viperidae, arrange to transport the person to a hospital immediately.

- A person bitten by a snake needs to be calmed and reassured, and kept immobile as much as possible, as movement can increase the systemic absorption of venom.

- In the case of a bite by an elapid species, apply a pressure bandage (as firm as you would apply to a sprained ankle) to contain the venom and prevent it from spreading. Bandage as much of the limb as possible. Apply a splint to keep the limb immobile. Do not remove the bandage before professional help is available.

- An accurate description of the snake responsible for the bite greatly aids treatment. However, do not endanger yourself or others by trying to capture the snake for identification purposes.

- Elevate the bite site. This results in reduced blood flow to and from the bite site, slowing the spread of the venom.

- Do not apply a tourniquet unless you are a doctor. Oxygen starvation of a limb can cause more damage than the envenomation, and the procedure is rarely lifesaving.

- Do not allow the patient to consume alcohol, which elevates metabolism and promotes vasodilatation (widens the blood vessels), causing a more rapid onset of symptoms. Also do not administer stimulants or pain medication.

- Do not cut open the bite site, or try to suck out the venom.

Apart from the dangers posed by venomous snakes, large-growing members of several families (especially pythons) can give a painful, crushing bite, causing severe lacerations that require stitches.

5. **Morphological characters used in identification** (see also diagrams, pages 9–10).

6. **An account of coloration in life.**

7. **Description of diagnostic characteristics of subspecies** that occur in the region, where applicable.

8. **Notes on habits and behaviour**, including habitat associations, elevational range, unique habits, diet and reproduction, where known. Elevational range is given in metres above sea level (m asl). In lizard and snake families that are known to contain both oviparous and oviviparous species, this information is given within the species accounts (where known). Where all species within a family are either oviparous or oviviparous, this is stated in the introduction to the family only.

9. **Distributional range** within South-East Asia (country-wise) and notes on occurrence in extralimital areas. Localities are arranged in geographical order, starting from Myanmar in the north, to the islands of Indonesia in the south. For each country, if the taxon is widespread, no specific localities are provided. If it is represented by a few sites (typically less than five) locally, they are listed.

10. **Conservation status**, according to the 2008 IUCN Red List of Threatened Species, Red List Categories, Version 3.1 (2001) (http://www.iucnredlist.org/). The IUCN threat categories are as follows:

Extinct (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Extinct in the Wild (EW)
A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

Near Threatened (NT)
A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable category now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Least Concern (LC)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Data Deficient (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its range and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or range are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more data is required and acknowledges the possibility that future research will reveal that threatened classification is appropriate.

Not Evaluated (NE)
A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

Lower Risk is no longer used by the IUCN in the evaluation of taxa, but persists in the Red List for taxa evaluated before 2001, when Version 3.1 of the Red List was first used, and not re-evaluated since. Before 2001, Near Threatened and Conservation Dependent were both subcategories of the category Lower Risk. Had the category been assigned with the same data today, the species would be designated Near Threatened in either case.

Plate 1. CROCODYLIDAE & GAVIALIIDAE

1. MARSH CROCODILE *Crocodylus palustris,* p. 166.
TL 5m Snout relatively broad and heavy; no longitudinal ridges anterior to eyes; no postoccipital scutes; adults grey to brown, usually without dark bands.

2. SALTWATER CROCODILE *Crocodylus porosus*, p. 166.
TL 6.2m Snout relatively broad and heavy; longitudinal ridges anterior to eyes; postoccipital scutes present; adults black spotted or blotched on pale yellow, grey or greyish-olive background.

3. SIAMESE CROCODILE *Crocodylus siamensis*, p. 166.
TL 3.5m Snout relatively broad; longitudinal ridges anterior to eyes; postoccipital scutes present; dorsum pale yellow, grey or olive-grey with black spots or blotches.

4. GANGES GHARIAL *Gavialis gangeticus*, p. 167.
TL 7m Snout slender, parallel-sided; neck armour continuous with back armour; dorsum olive to tan with dark blotches or bands on body and tail.
(4a) Female Snout-tip lacks swelling.
(4b) Male Snout-tip with distinctive knob.

5. MALAYAN FALSE GHARIAL *Tomistoma schlegelii*, p. 167.
TL 5.5m Snout slender, tapering gradually, tip rounded; neck armour continuous with back armour; dorsum brown with black spots and bands; tail with broad black bands.

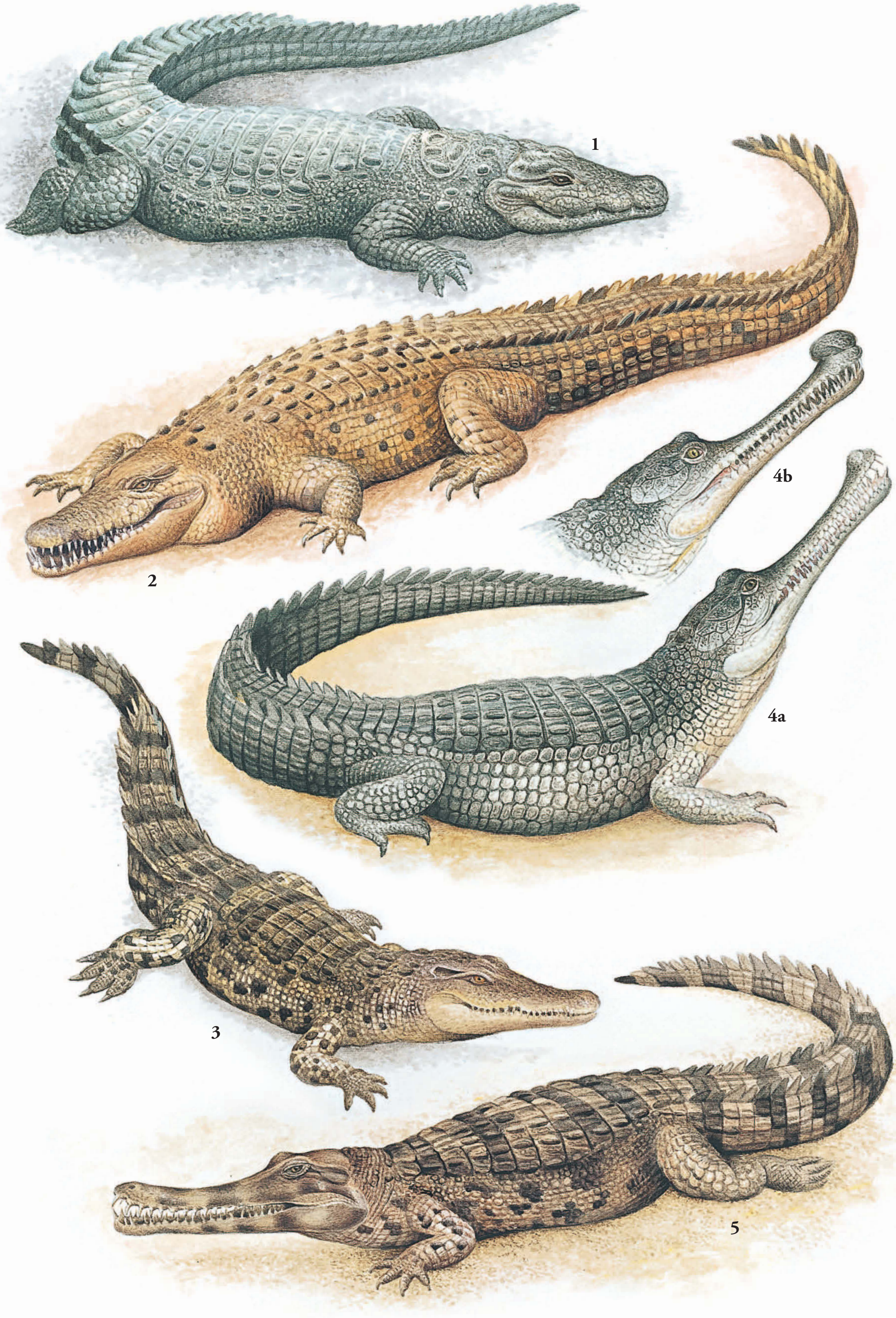

1
2
4b
4a
3
5

Plate 2. GEOEMYDIDAE

1. SOUTHERN RIVER TERRAPIN *Batagur affinis*, p. 167.
SCL 600mm Carapace domed, heavily buttressed; head small with upturned snout; 4 claws on forelimb; carapace olive-grey or brown.
(1a) Female Head brown.
(1b) Male Head black.

2. PAINTED TERRAPIN *Batagur borneoensis*, p. 168.
SCL 600mm Carapace oval, flattened; forelimbs with 5 claws; carapace light brown or olive with 3 longitudinal black stripes.
(2a) Female Forehead grey.
(2b) Male Forehead white with red stripe between eyes.

3. BURMESE PAINTED TERRAPIN *Batagur trivittata*, p. 168.
SCL 580mm Carapace low with distinct vertebral keel; head with pointed, slightly upturned snout; 5 claws on forelimb; carapace olive-green with 3 longitudinal black stripes; forehead turns crimson with lozenge-shaped black area in males; carapace dark brown, forehead and neck greenish-olive with black crown patch in females (illustrated).

4. INDO-CHINESE BOX TURTLE *Cuora galbinifrons*, p. 169.
SCL 190mm Carapace high-domed and smooth; plastron with transverse hinge behind pectoral and abdominal scutes; face with narrow dark stripes.
(4a) Carapace Narrow yellow or cream vertebral stripe.
(4b) Plastron Yellow or brownish-yellow with dark blotches.

5. MALAYAN BOX TURTLE *Cuora amboinensis*, p. 168.
SCL 216mm Carapace high-domed and smooth; plastron with transverse hinge behind pectoral and abdominal scutes; face with longitudinal yellow stripes.
(5a) Carapace Olive, brown or nearly black.
(5b) Plastron Yellow or cream with single black blotch on each scute.

6. KEELED BOX TURTLE *Cuora mouhotii*, p. 169.
SCL 180mm Carapace elongated, tricarinate, distinctly flat-topped; marginals serrated posteriorly; weak transverse plastral hinge in adult females.
(6a) Carapace Dark or light brown.
(6b) Plastron Yellow or light brown with dark brown blotches on each scute.

7. THREE-STRIPED BOX TURTLE *Cuora trifasciata*, p. 169.
SCL 230mm Carapace elevated, arched and elongated; plastron with transverse hinge behind pectoral and abdominal scutes; head with black postorbital stripe enclosing brown or olive triangle behind eye.
(7a) Carapace Light brown with 3 longitudinal black stripes; scutes with thin radiating black pattern.
(7b) Plastron Yellow; scutes black with yellow border.

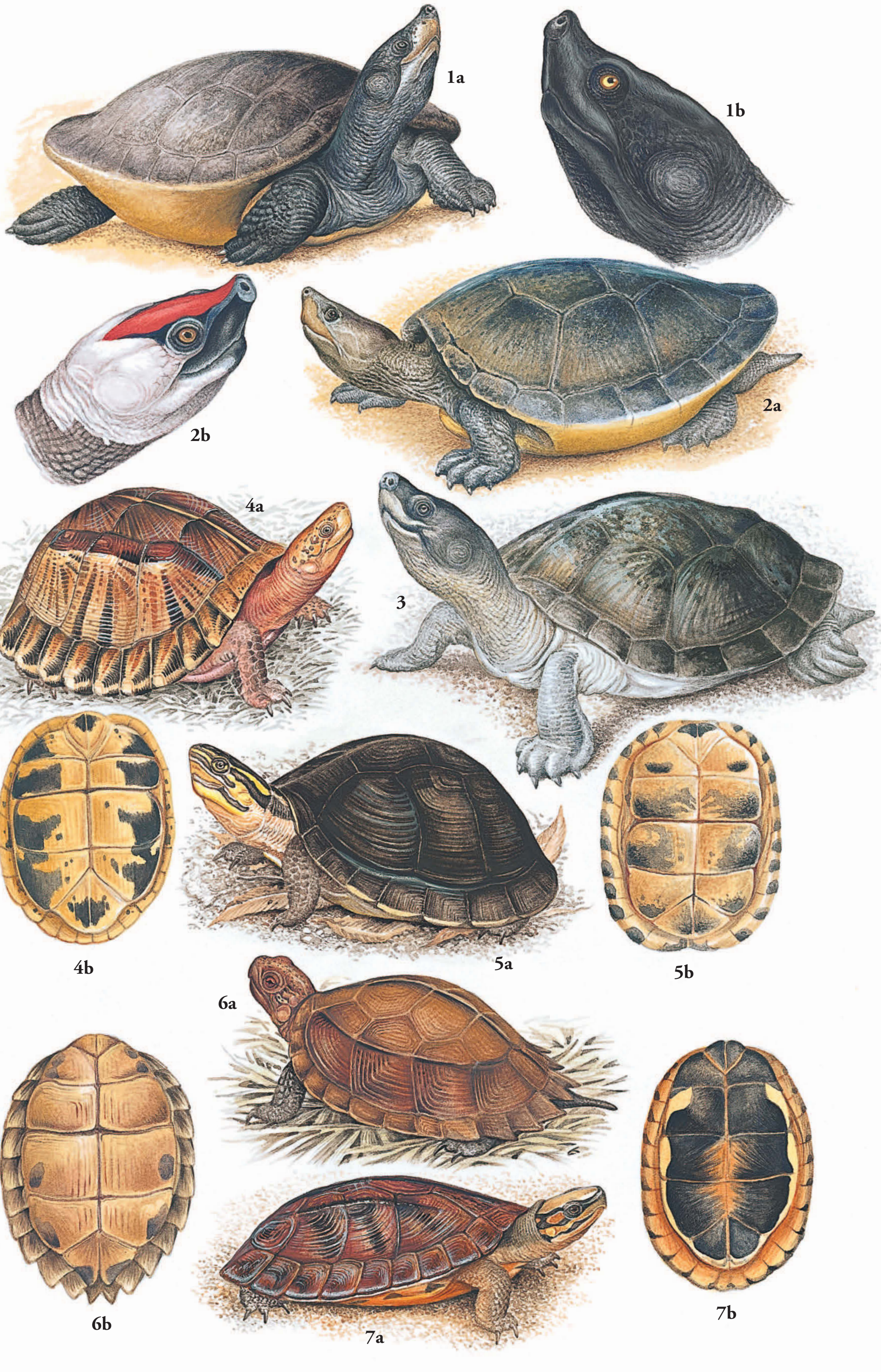

1a
1b
2b
2a
4a
3
4b
5a
5b
6a
6b
7a
7b

Plate 3. GEOEMYDIDAE

1. BLACK-BRIDGED LEAF TURTLE *Cyclemys atripons,* p. 169.
SCL 236mm Carapace ovoid, elongated, depressed, tricarinate; forehead with enlarged scales; femoral midseam shorter or equal to anal midseam; anal notch narrow to wide.
(1a) Carapace Chestnut-brown, unpatterned or with fine radiating black lines; head and neck striped; forehead spotted or speckled with black.
(1b) Plastron Hinge in adults; femoral midseam shorter or equal to anal midseam; anal notch narrow to wide; yellow with radiating dark pattern.

2. COMMON LEAF TURTLE *Cyclemys dentata,* p. 169.
SCL 210mm Carapace oval, depressed, tricarinate; forehead with enlarged scales; femoral midseam shorter than anal midseam; anal notch narrow, acute-angled.
(2a) Carapace Dark brown, unpatterned or with fine black lines; forehead dark speckled; temples and neck with dark stripes.
(2b) Plastron Yellow, unpatterned or with radiating dark pattern; plastron of juveniles mottled with black.

3. GRAY LEAF TURTLE *Cyclemys fusca*, p. 170.
SCL 242mm Carapace oval, depressed, tricarinate; forehead with enlarged scales; femoral midseam greater or equal to anal midseam; anal notch wide.
(3a) Carapace Dark brown, sometimes with radiating dark lines; forehead greenish-yellow, lighter than temporal region; neck dark, lacking stripes.
(3b) Plastron Dark brown to black, sometimes with radiating dark lines.

4. OLDHAM'S LEAF TURTLE *Cyclemys oldhamii,* p. 170.
SCL 254mm Carapace rectangular, depressed, tricarinate; forehead with enlarged scales; femoral midseam greater or equal to anal midseam; anal notch wide.
(4a) Carapace Dark or light brown; forehead speckled; neck with or without stripes;
(4b) Plastron Dark brown, black or yellow, sometimes with radiating dark lines; juvenile plastron brown or yellow, with large central plastral figure and ocellated pattern along submarginal seams.

5. VIETNAMESE LEAF TURTLE *Cyclemys pulchristriata,* p. 170.
SCL 227mm Carapace oval, elongated, depressed, tricarinate; forehead with enlarged scales; femoral midseam shorter or equal to anal midseam; anal notch narrow to wide.
(5a) Carapace Chestnut-brown or pale brown with wide radiating dark lines or thick black speckling; forehead with dark speckling; temples and neck with distinct stripes.
(5b) Plastron Yellow with short, thick radiating dark lines; juvenile plastron with large dark brown specks and ocellated pattern along submarginal seams.

6. BLACK-BREASTED LEAF TURTLE *Geoemyda spengleri,* p. 170.
SCL 125mm Carapace depressed, tricarinate; anterior marginals serrated; eyes large; upper jaw hooked; outer faces of forelimbs with enlarged scales.
(6a) Carapace Dark reddish-orange, orange-yellow, olive or light brown with black lines or wedges over keels; forehead brown with yellow postocular stripe; tympanic region and throat yellow-spotted.
(6b) Plastron Dark brown, edges yellow.

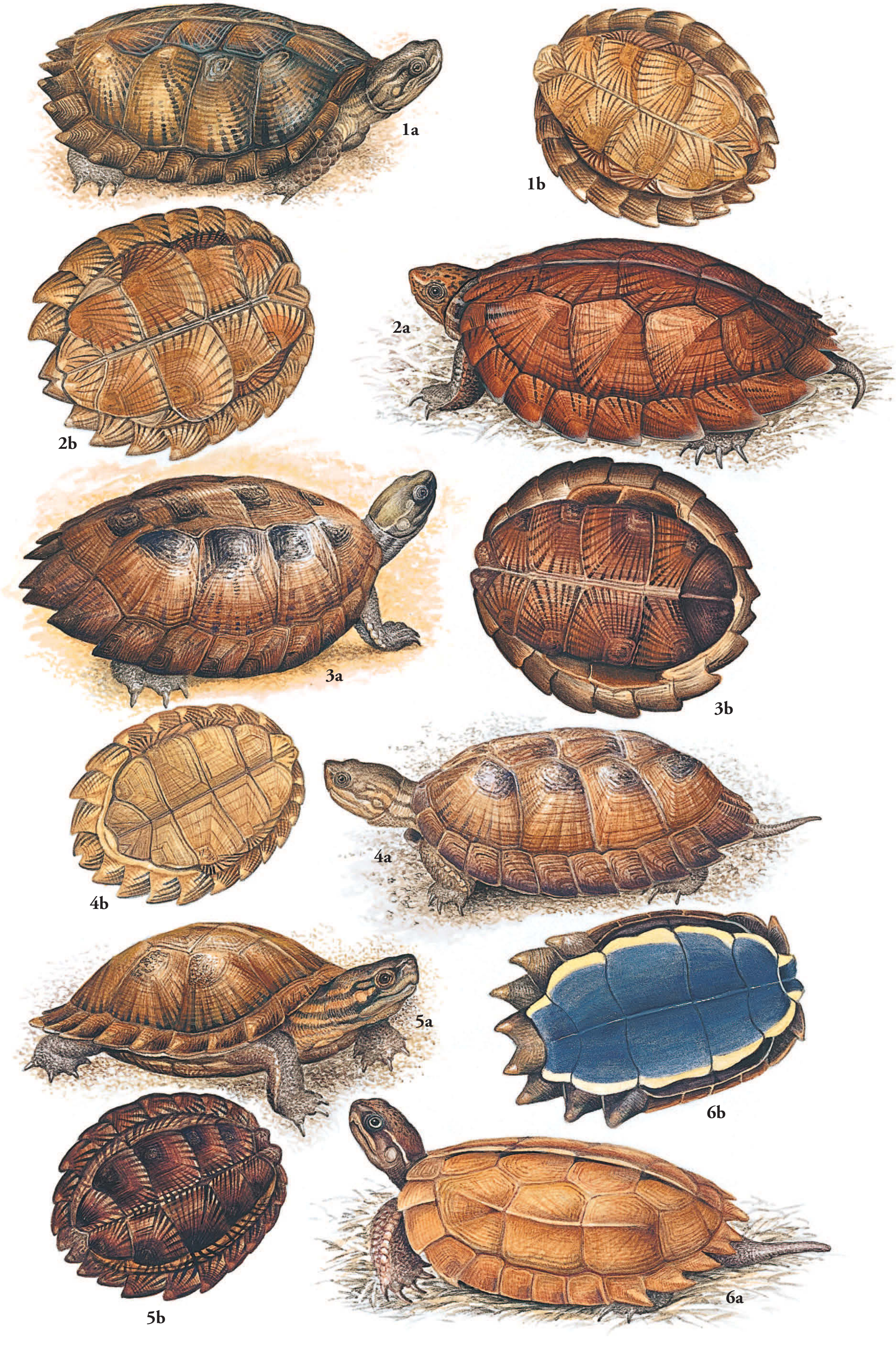

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Plate 4. GEOEMYDIDAE

1. YELLOW-HEADED TEMPLE TURTLE *Heosemys annandalii*, p. 170.
SCL 506mm Carapace elongated, raised, flat-topped in adults; shell outline rounded; posterior marginals serrated.
(1a) Carapace Black with orange lines near marginals and on vertebral keel in juveniles.
(1b) Plastron Pale orange with grey vermiculations, turning pale grey and eventually to black.

2. ARAKAN FOREST TURTLE *Heosemys depressa*, p. 170.
SCL 242mm Carapace depressed; vertebral region flattened with obtuse keel; posterior marginals serrated; toes with rudiments of webs.
(2a) Carapace Light brown, sometimes with dark brown mottling.
(2b) Plastron Yellowish-brown with black blotches or radiating lines on each scute.

3. GIANT ASIAN POND TURTLE *Heosemys grandis*, p. 171.
SCL 480mm Carapace tricarinate, elevated in adults, depressed in juveniles; lateral keel does not extend across fourth costal.
(3a) Carapace Dark brown, lighter around marginals; keels yellowish-orange or brown.
(3b) Plastron With radiating pattern emerging from darker blotch in each scute in juveniles.

4. SPINY HILL TURTLE *Heosemys spinosa*, p. 171.
SCL 220mm Carapace oval, arched in adults; strong vertebral keel; marginals of adults smooth; those of juveniles with greatly expanded marginals bearing distinct spines.
(4a) Carapace Brown.
(4b) Plastron Brown, scutes with radiating lines.

5. MALAYAN SNAIL-EATING TURTLE *Malayemys macrocephala*, p. 171.
SCL 300mm Carapace tricarinate; head large, especially in old females.
(5a) Carapace Dark brown with black areoli and yellow rim.
(5b) Plastron Yellow, each scute with large black blotch.

6. MEKONG SNAIL-EATING TURTLE *Malayemys subtrijuga*, p. 171.
SCL 210mm Carapace tricarinate; head large, especially in old females.
(6a) Carapace Dark brown with black areoli and yellow rim.
(6b) Plastron Yellow, each scute with large black blotch.

7. VIETNAMESE POND TURTLE *Mauremys annamensis*, p. 171.
SCL 170mm Carapace oval, low, tricarinate in juveniles; lateral keels indistinct in adults; posterior marginals weakly serrated.
(7a) Carapace Carapace dark grey-brown.
(7b) Plastron Yellow or yellowish-orange, each scute with large black blotch.

8. ASIAN YELLOW POND TURTLE *Mauremys mutica*, p. 171.
SCL 194mm Carapace oval, depressed, tricarinate; vertebral keel low; nuchal, small axillary and inguinals present.
(8a) Carapace Yellow-brown or brown; marginals dark.
(8b) Plastron Yellow, each scute with square or rectangular dark blotch.

9. CHINESE STRIPE-NECKED TURTLE *Mauremys sinensis*, p. 171.
SCL 240mm Carapace oval, moderately flattened, not depressed; juvenile carapace tricarinate, keels low and discontinuous, keels disappear in adults; Vertebrals IV and V wider than long.
(9a) Carapace Reddish-brown to greyish-brown.
(9b) Plastron Yellow, each scute with large blackish-brown blotch.


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Plate 5. GEOEMYDIDAE

1. INDIAN BLACK TURTLE *Melanochelys trijuga*, p. 172.
SCL 280mm Carapace elongated, high in adults, depressed in juveniles; tricarinate; short snout.
(1a) Carapace Brown or blackish-grey.
(1b) Plastron Dark with pale yellow border (except in old individuals).

2. BURMESE EYED TURTLE *Morenia ocellata*, p. 172.
SCL 155mm Carapace domed, smooth-shelled; vertebral keel low (juveniles) or absent (adults); posterior marginals unserrated; head small with pointed snout.
(2a) Carapace Greenish-brown or olive; vertebrals and costals with large yellow ocelli with dark brown centre.
(2b) Plastron Unpatterned yellow.

3. MALAYAN FLAT-SHELLED TURTLE, *Notochelys platynota*, p. 172.
SCL 400mm Carapace flat with low, interrupted vertebral keel; 6–7 vertebrals; weak plastral hinge.
(3a) Carapace Olive, yellowish-brown or brick-red (adults); bright green (hatchlings).
(3b) Plastron Yellowish-orange, each scute with black blotch.

4. MALAYAN GIANT TURTLE *Orlitia borneensis*, p. 172.
SCL 800mm Carapace narrow, humped (juveniles) or smooth (adults); head large; band-like scales on outer faces of forelimbs.
(4a) Carapace Unpatterned black, brown or grey.
(4b) Plastron Yellowish-orange or brown, sometimes with dark flecks.

5. BEALE'S FOUR-EYED TURTLE *Sacalia bealei*, p. 172.
SCL 143mm Carapace elongated, unicarinate, slightly depressed; posterior marginals not serrated; vertebral keel low; plastral buttresses weak.
(5a) Carapace Yellowish-brown to chocolate-brown; anterior margin with numerous black or dark brown speckles.
(5b) Male plastron Yellow to light olive, sometimes with dark vermiculations.
(5c) Female plastron Yellow to light olive, sometimes with dark blotches.

6. FOUR-EYED TURTLE *Sacalia quadriocellata*, p. 172.
SCL 140mm Carapace elongated, unicarinate, slightly depressed; posterior marginals not serrated; vertebral keel low; plastral buttresses weak.
(6a) Carapace Dark brown with radiating dark lines; anterior region lacks dark speckling, or speckling much reduced.
(6b) Male plastron Yellow with solid black patches.
(6c) Female plastron Cream with dark vermiculations and stippling.

7. BLACK MARSH TURTLE *Siebenrockiella crassicollis*, p. 173.
SCL 200mm Carapace oval with serrated posterior marginals; vertebral region flattened, unicarinate (adults) or tricarinate (juveniles).
(7a) Carapace Dark grey or nearly black.
(7b) Plastron Pale grey with large dark areas in each scute.

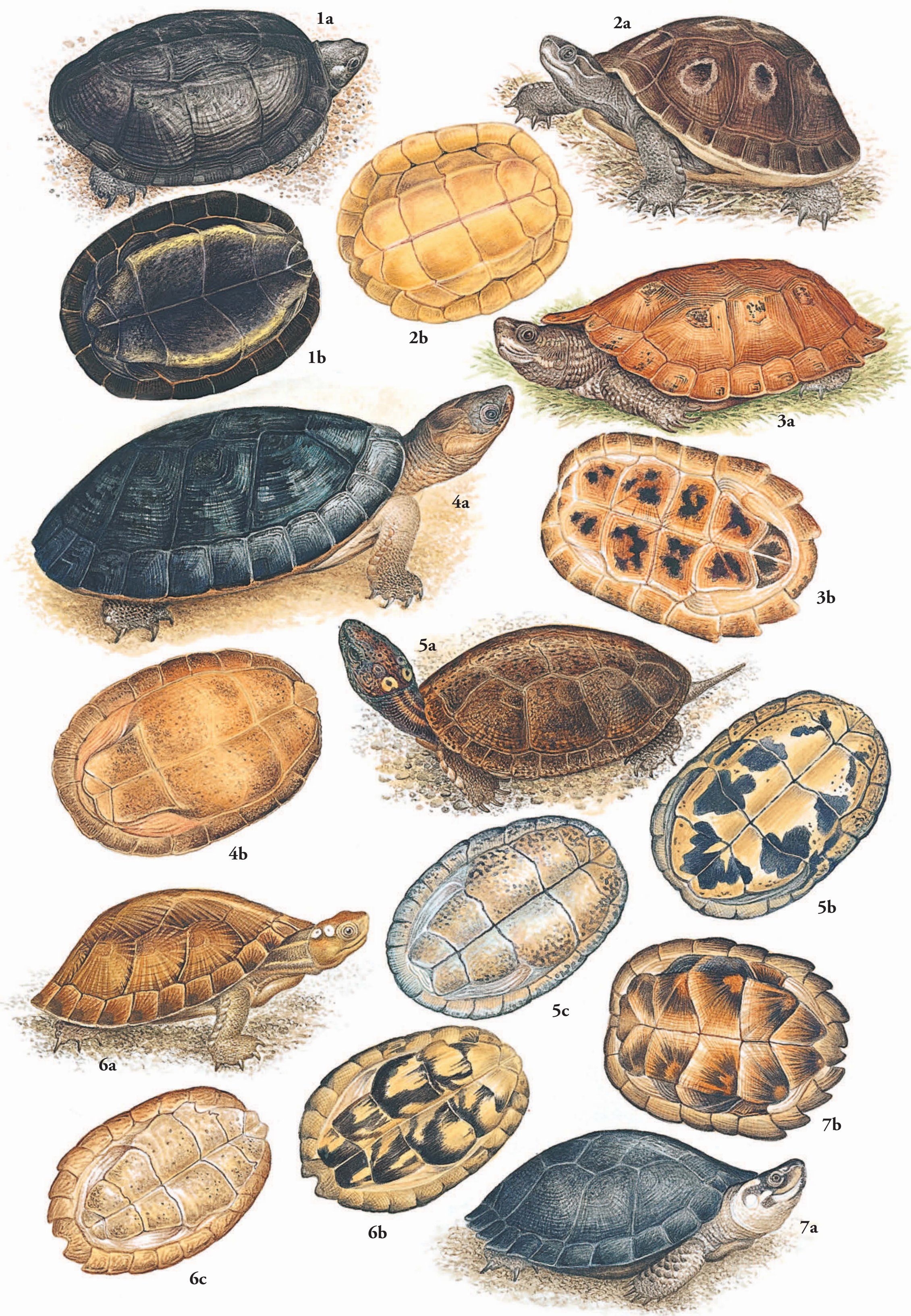
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Plate 6. CHELONIIDAE & DERMOCHELYIDAE

1. LOGGERHEAD SEA TURTLE, *Caretta caretta*, p. 173.
SCL 1,200mm Carapace elongated with tapering end; costals 5 pairs, infralabial scutes lack pores; 13 marginal scutes.
(1a) Carapace Reddish-brown.
(1b) Plastron Yellowish-brown or yellowish-orange.
(1c) Hatchling Lateral keels.

2. GREEN TURTLE *Chelonia mydas*, p. 173.
SCL 1,400mm Carapace heart-shaped; paired prefrontals; scutes non-overlapping; upper jaw without hook.
(2a) Carapace Olive or brown with radiating dark pattern.
(2b) Plastron Pale yellow.
(2c) Hatchling No lateral keels.

3. HAWKSBILL SEA TURTLE *Eretmochelys imbricata*, p. 173.
SCL 1,000mm Carapace heart-shaped; 2 pairs of prefrontals; scutes overlapping; upper jaw relatively narrow, elongated.
(3a) Carapace Olive-brown; juveniles with darker blotches.
(3b) Plastron Pale yellow (adults) or dark grey (juveniles).
(3c) Hatchling No lateral keels.

4. OLIVE RIDLEY SEA TURTLE *Lepidochelys olivacea*, p. 173.
SCL 80mm Carapace heart-shaped; scutes juxtaposed; 5–9 pairs of costals; inframarginals with pores; upper jaw hooked.
(4a) Carapace Olive-green or greyish-olive.
(4b) Plastron Greenish-yellow (adults) or cream (juveniles).
(4c) Hatchling Lateral keels.

5. LEATHERBACK SEA TURTLE *Dermochelys coriacea*, p. 174.
SCL 2.5m Carapace elongated, tapering; 7 ridges on carapace and 5 on plastron; shell covered with skin; limbs paddle-like and clawless.
(5a) Carapace Black or blackish-blue with pale flecks.
(5b) Plastron Pale grey or pinkish-grey.
(5c) Hatchling Carapace covered with tiny scales.

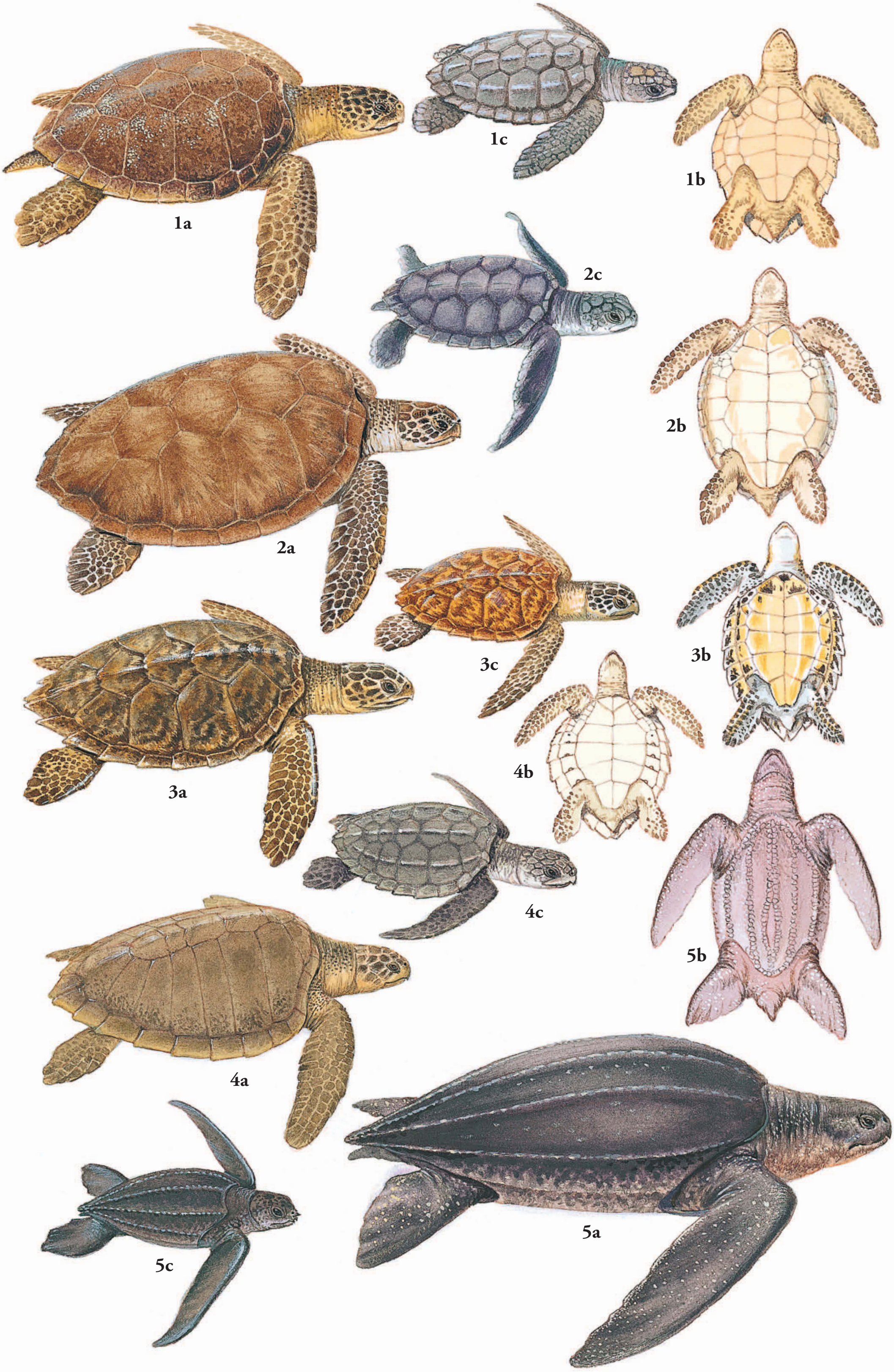
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Plate 7. EMYDIDAE, PLATYSTERNIDAE & TESTUDINIDAE

1. RED-EARED SLIDER *Trachemys scripta*, p. 174.
SCL 280mm Shell rounded with nearly smooth outline; plastron lacks hinge; carapace green with yellow lines, turning darker with growth; orange or red patch on temples.
(1a) Adult Carapace olive-grey; males with elongated claws on fingers; plastron with dark speckles.
(1b) Juvenile Carapace green with narrow yellow lines; plastron with rounded patches.
(1c) Hatchling plastron Dark ocelli on scutes.
(1d) Adult plastron Yellow with solid dark mark on each scute.

2. BIG-HEADED TURTLE *Platysternon megacephalum*, p. 174.
SCL 200mm Head large and covered with undivided scales; jaws hooked; throat with flattened rounded tubercles.
(2a) Adult Shell oval, depressed; tail covered with squarish scales; lines on forehead.
(2b) Head subspecies *P. m. peguense* Black-bordered pale postorbital stripe.
(2c) Plastron subspecies *P. m. peguense* Dark plastral seams.
(2d) Head subspecies *P. m. shiui* Heavy speckling of yellow, orange or pink.
(2e) Plastron subspecies *P. m. shiui* Speckling of yellow, orange or pink on shell.
(2f) Juvenile Shell flattened; tail long, slender.

3. BURMESE STAR TORTOISE *Geochelone platynota*, p. 175.
SCL 260mm Shell convex; no nuchal scute.
(3a) Carapace Black or dark brown, vertebral and costal scutes with yellow centres and radiating lines.
(3b) Plastron Yellow with scutes with dark patches.

4. ELONGATED TORTOISE *Indotestudo elongata*. p. 175.
SCL 330mm Carapace domed; flattened dorsally with arching sides; plastron elongated with deep notch posteriorly; nuchal scute narrow.
(4a) Carapace Yellowish-brown or olive with scattered dark blotches.
(4b) Plastron Yellowish-brown or olive with scattered dark blotches.

5. ASIAN GIANT TORTOISE *Manouria emys*, p. 175.
SCL 500mm (*M. e. emys*); 580mm (*M. e. phayrei*) Shell low; vertebral region depressed; distinct growth rings on carapace scutes; posterior marginals weakly serrated; outer surfaces of forelimbs bear large scales; pair of tuberculate scales on thighs.
(5a) Carapace subspecies *M. e. emys* Medium brown.
(5b) Carapace subspecies *M. e. phayrei* Blackish-brown.
(5c) Plastron subspecies *M. e. emys* Pectoral scutes small and separated.
(5d) Plastron subspecies *M. e. phayrei* Pectoral scutes large and fused.

6. IMPRESSED TORTOISE *Manouria impressa*, p. 175.
SCL 302mm Shell low; vertebrals and costals concave; posterior marginals strongly serrated; outer surfaces of forelimbs bear large scales; single tuberculate scale on each thigh.
(6a) Carapace Scutes translucent brown to yellowish-orange with streaks.
(6b) Plastron Yellowish-brown with radiating dark lines.


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Plate 8. TRIONYCHIDAE

1. ASIAN SOFTSHELL TURTLE *Amyda cartilaginea*, p. 176.
SCL 750mm Carapace with rounded sides; head narrower; tubercles at anterior carapace margin.
(1a) Carapace Greenish-grey or olive, sometimes with yellow-bordered black spots or radiating streaks.
(1b) Plastron Cream (males); grey (females).

2. MAINLAND NARROW-HEADED SOFTSHELL TURTLE *Chitra chitra chitra*, p. 176.
SCL 1,220mm Carapace rim smoothly joins cartilagineous part to skin of neck; head small with tiny proboscis; indistinct dark speckling and ocelli on chin; broad costal markings.
(2a) Carapace Brown or yellowish-brown with dark-edged, bright yellow, greenish-yellow or tan stripes, including an inverted chevron-like marking on anterior of carapace and neck.
(2b) Plastron Cream or pale pink.
(2c) Head No X-shaped figure between eyes.

3. JAVANESE NARROW-HEADED SOFTSHELL TURTLE *Chitra chitra javanensis*, p. 176.
SCL 1,220mm Carapace rim smoothly joins cartilagineous part to skin of neck; head small with tiny proboscis; ocelli in eye region absent; bold black speckling and ocelli on chin.
(3a) Carapace Dark brown; midline and lateral vertebral carapacial stripes missing; distinct bell-shaped mark on carapace anterior.
(3b) Head X-shaped figure between eyes.

4. BURMESE NARROW-HEADED SOFTSHELL TURTLE *Chitra vandijki*, p. 176.
SCL 412mm Carapace rim smoothly joins cartilagineous part to skin of neck; head small with tiny proboscis; eyes situated close to snout-tip.
(4a) Carapace Chocolate-brown or olive-green; no dark vertebral stripe.
(4b) Plastron White or pale pink.
(4c) Head Transverse, light dark-bordered bar connecting eyes, and 1–2 pairs of light dark-bordered ocelli posterior to transverse bar between or behind eyes.

5. MALAYAN SOFTSHELL TURTLE *Dogania subplana*, p. 176.
SCL 350mm Carapace with straight sides; head large, bearing down-turned snout; adults with carapace hinge.
(5a) Carapace Dark olive or brown with dark median stripe.
(5b) Plastron Cream or grey.
(5c) Head Dark postocular stripe.
(5d) Juvenile Carapace dark yellow or olive with 2–3 pairs of black-centred eye-like spots.

6. INDIAN FLAPSHELL TURTLE *Lissemys punctata*, p. 176.
SCL 370mm Carapace oval, domed; plastron with 7 callosities; paired flaps cover hind limbs when retracted; entoplastral callosity small in adults.
(6a) Carapace Olive-green with dark yellow blotches.
(6b) Plastron Cream or pale yellow.
(6c) Head Yellow spots.

7. BURMESE FLAPSHELL TURTLE *Lissemys scutata*, p. 177.
SCL 370mm Carapace oval, domed; plastron with 7 callosities; paired flaps cover hind limbs when retracted; entoplastral callosity large in adults.
(7a) Carapace Brownish-olive, sometimes with fine black spots or reticulations.
(7b) Plastron Yellow.
(7c) Head Dark postocular stripe bounding a paler one.


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Plate 9. TRIONYCHIDAE

1. BURMESE SOFTSHELL TURTLE *Nilssonia formosus*, p. 177.
SCL 650mm Carapace rounded, smooth (adults) or with longitudinal rows of tubercles (juveniles); series of enlarged blunt tubercles above neck.
(1a) Carapace Olive-grey to brown with dark reticulations (adults); 4 dark-centred, light-bordered occelli (juveniles).
(1b) Plastron Unpatterned cream.

2. WATTLE-NECKED SOFTSHELL TURTLE *Palea steindachneri*, p. 177.
SCL 426mm Carapace oval; anterior carapace tuberculate.
(2a) Carapace Unpatterned olive, brown or grey.
(2b) Plastron Cream or yellow.
(2c) Hatchling Anterior carapace bears raised tubercles.

3. ASIAN GIANT SOFTSHELL TURTLE *Pelochelys cantorii*, p. 177.
SCL 1,500mm Carapace flattened; head short; eyes close to tip of snout; proboscis extremely short and rounded.
(3a) Carapace Olive or brown, sometimes spotted or streaked with lighter or darker shades with lighter outer edge.
(3b) Plastron Unpatterned white, sometimes with pink blotches.

4. CHINESE SOFTSHELL TURTLE *Pelodiscus sinensis*, p. 177.
SCL 250mm Carapace oval, longer than wide, smooth (adults) or with longitudinal rows of low tubercles (juveniles).
(4a) Carapace Unpatterned olive to greyish-green (adults); light-bordered spots (juveniles).
(4b) Plastron Unpatterned cream, grey or yellow.
(4c) Hatchling Plastron pinkish-red with large black blotches.

5. INDO-CHINESE GIANT SOFTSHELL TURTLE *Rafetus swinhoei*, p. 177.
SCL 600mm Carapace oblong; 2 plastral callosities.
(5a) Carapace Olive-green with numerous yellow spots encircled by yellow dots, sometimes forming stripes, especially in juveniles; pattern lost in adults.
(5b) Plastron Unpatterned pale olive-grey.

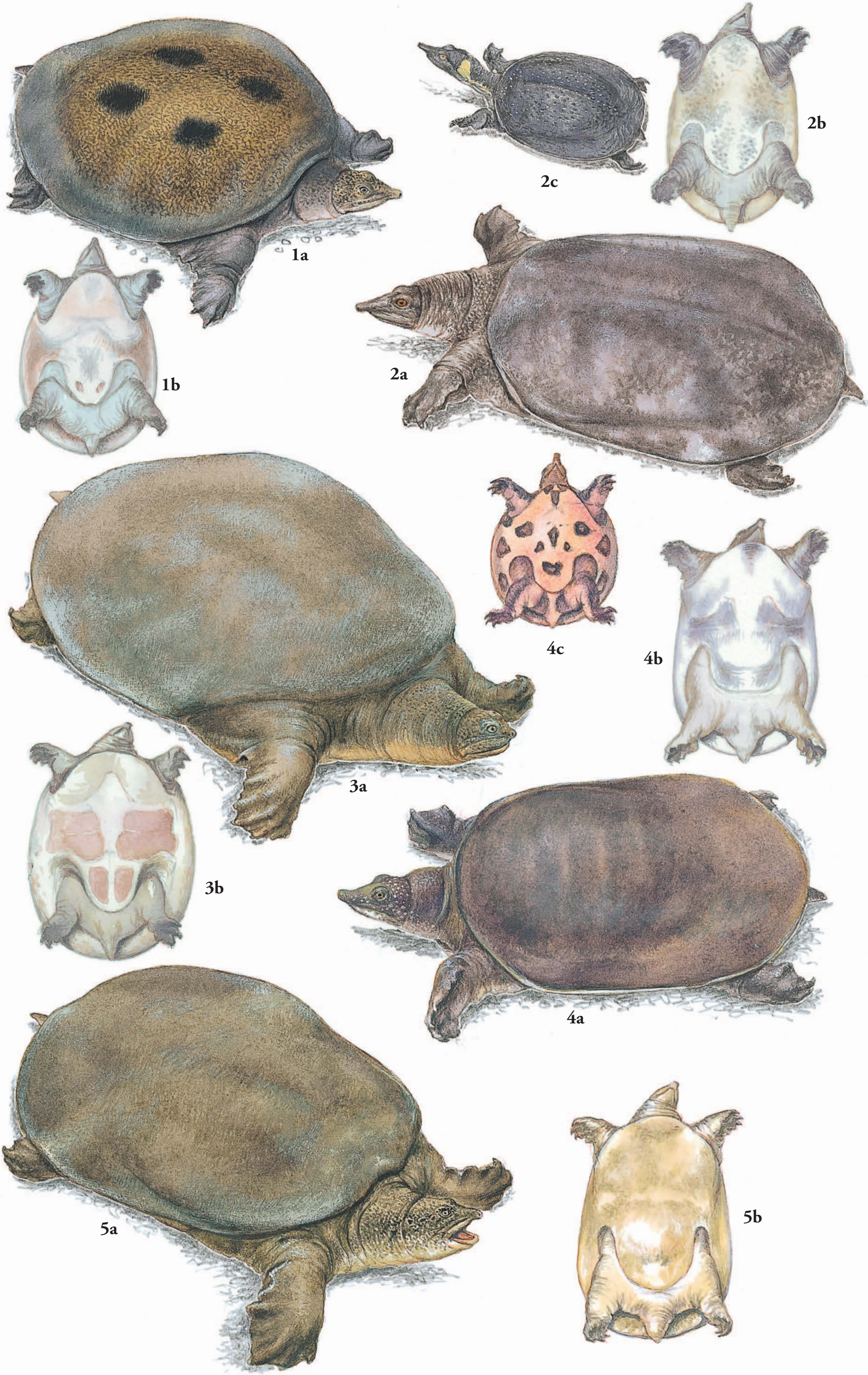
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Plate 10. AGAMIDAE

1. GREATER SPINY LIZARD *Acanthosaura armata*, p. 178.
SVL 140mm Superciliary and occipital spines reach level of nuchal crest; nuchal crest separated or joined to dorsal crest; dorsum grey, brown to nearly black, with darker marbling; diamond-shaped mark on axilla; triangular patch covers eye.
(1a) Male Head and dorsum brighter.
(1b) Female Head and dorsum paler.

2. INDO-CHINESE SPINY LIZARD *Acanthosaura capra*, p. 178.
SVL 137.9mm Occipital spine between tympanum and nuchal crest; nuchal crest comprises broad lanciform scales; dorsal and nuchal crests separate, comprising short scales; dorsum green or olive with black spots and yellow spots encircled with black.
(2a) Male Head green, gular pouch bluish-green.
(2b) Female Head greenish-yellow; gular pouch yellow with green streaks.

3. CROWNED SPINY LIZARD *Acanthosaura coronata*, p. 178.
SVL 137.5mm Occipital spine between tympanum and nuchal crest; nuchal and dorsal crest continuous, low, comprising triangular scales.
(3a) Male Head and dorsum light green with grey-brown mottling; dorsum with dark cross-bars.
(3b) Female Head and dorsum brownish-red; dorsum with dark cross-bars.

4. MASKED SPINY LIZARD *Acanthosaura crucigera*, p. 179.
SVL 140mm Nuchal crest tall, separated from low dorsal crest; spines of nuchal and dorsal crests broad basally; dorsum greenish-yellow with indistinct dark network of enclosing pale yellow spots; dark facial mask.
(4a) Male Gular pouch pale brown.
(4b) Female Gular pouch dark.

5. SCALE-BELLIED SPINY LIZARD *Acanthosaura lepidogaster*, p. 179.
SVL 111mm Nuchal crest comprises 6 conical scales; dorsal crest low, composed of subtriangular scales; dorsum bright green changeable to dark brown; indistinct diamond-shaped black mark on nape.
(5a) Male Head and dorsum brighter.
(5b) Female Head and dorsum paler.

6. NATALIA'S SPINY LIZARD *Acanthosaura nataliae*, p. 179.
SVL 158mm No occipital spine above tympanum; nuchal and dorsal crests distinct, comprising lanceolate scales pointing posteriorly, separated from each other.
(6a) Male Dorsum yellowish-brown changeable to red, brown or yellow; head, nuchal and dorsal crests and limbs red; black mask covers orbit and tympanum; dark brown postocular stripe.
(6b) Female Head and dorsum emerald-green.

7. LONG-SNOUTED SHRUB LIZARD *Aphaniotis acutirostris*, p. 179.
SVL 72mm Snout acute, longer than eye diameter; projecting convex scale above rostral; dorsum brown with darker variegation.

8. BROWN SHRUB LIZARD *Aphaniotis fusca*, p. 179.
SVL 67mm Snout rounded, not longer than diameter of eye; dorsum dark brown or brownish-olive.

9. ORNATE SHRUB LIZARD *Aphaniotis ornata* , p. 180.
SVL 57mm Snout rounded; dorsum medium brown to brownish-red; small yellow spot on each side of eyelid.
(9a) Male Snout-tip with fleshy conical appendage; low nuchal crest comprising erect scales.
(9b) Female Snout-tip without fleshy appendage; no nuchal crest.