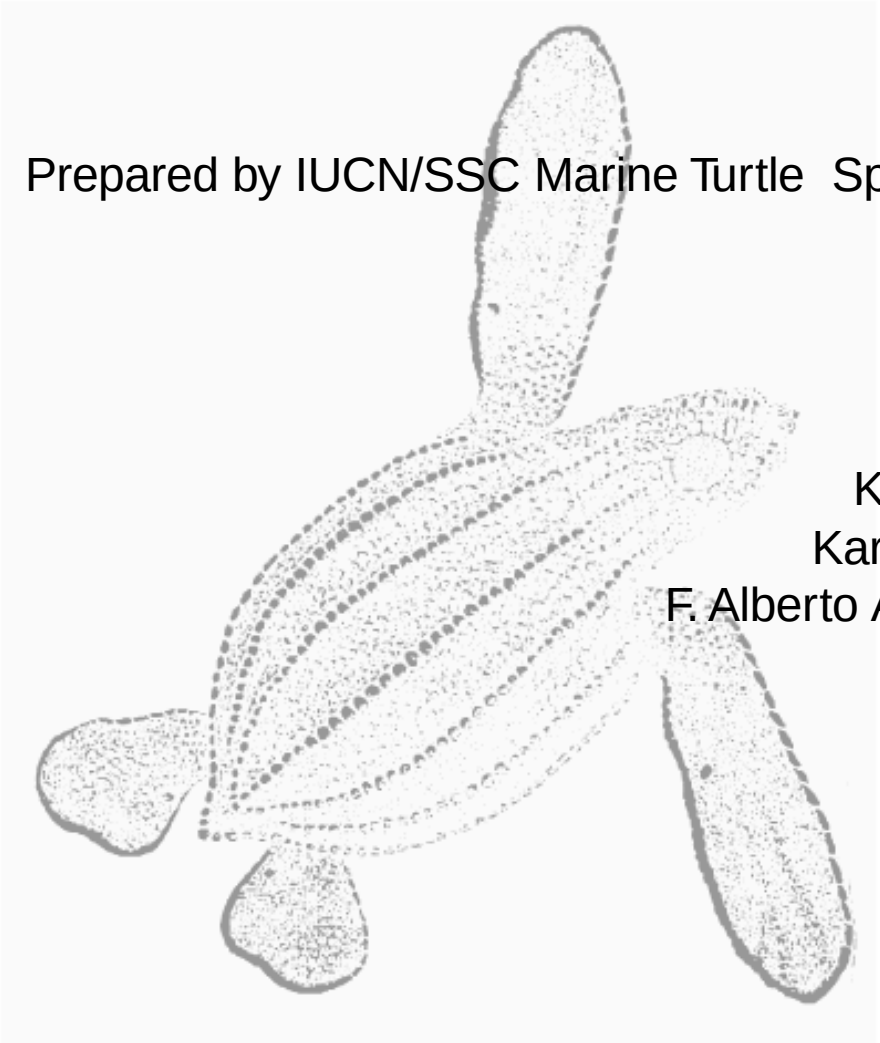
Research and Management Techniques for the Conservation of Sea Turtles

Prepared by IUCN/SSC Marine Turtle Specialist Group



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Preface

In 1995 the IUCN/SSC Marine Turtle Specialist Group (MTSG) published *A Global Strategy for the Conservation of Marine Turtles* to provide a blueprint for efforts to conserve and recover declining and depleted sea turtle populations around the world. As unique components of complex ecosystems, sea turtles serve important roles in coastal and marine habitats by contributing to the health and maintenance of coral reefs, seagrass meadows, estuaries, and sandy beaches. The *Strategy* supports integrated and focused programs to prevent the extinction of these species and promotes the restoration and survival of healthy sea turtle populations that fulfill their ecological roles.

Sea turtles and humans have been linked for as long as people have settled the coasts and plied the oceans. Coastal communities have depended upon sea turtles and their eggs for protein and other products for countless generations and, in many areas, continue to do so today. However, increased commercialization of sea turtle products over the course of the 20th century has decimated many populations. Because sea turtles have complex life cycles during which individuals move among many habitats and travel across ocean basins, conservation requires a cooperative, international approach to management planning that recognizes inter-connections among habitats, sea turtle populations, and human populations, while applying the best available scientific knowledge.

To date our success in achieving both of these tasks has been minimal. Sea turtle species are recognized as "Critically Endangered," "Endangered" or "Vulnerable" by the World Conservation Union (IUCN). Most populations are depleted as a result of unsustainable harvest for meat, shell, oil, skins, and eggs. Tens of thousands of turtles die every year after being accidentally captured in active or abandoned fishing gear. Oil spills, chemical waste, persistent plastic and other debris, high density coastal development, and an increase in ocean-based tourism have damaged or eliminated important nesting beaches and feeding areas.

To ensure the survival of sea turtles, it is important that standard and appropriate guidelines and criteria be employed by field workers in all range states. Standardized conservation and management techniques encourage the collection of comparable data and enable the sharing of results among nations and regions. This manual seeks to address the need for standard guidelines and criteria, while at the same time acknowledging a growing constituency of field workers and policy-makers seeking guidance with regard to when and why to invoke one management option over another, how to effectively implement the chosen option, and how to evaluate success.

The IUCN Marine Turtle Specialist Group believes that proper management cannot occur in the absence of supporting and high quality research, and that scientific research should focus, whenever possible, on critical conservation issues. We intend for this manual to serve a global audience involved in the protection and management of sea turtle resources. Recognizing that the most successful sea turtle protection and management programs combine traditional census techniques with computerized databases, genetic analyses and satellite-based telemetry techniques that practitioners a generation ago could only dream about, we dedicate this manual to the resource managers of the 21st century who will be facing increasingly complex resource management challenges, and for whom we hope this manual will provide both training and counsel.

Karen L. Eckert
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Editors

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Taxonomy, External Morphology, and Species Identification

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Scientific and Vernacular Names

There are a great many vernacular names for most sea turtle species, although relatively few for the more restricted species *(Natator depressus, Lepidochelys kempii).* In this section, only three examples (English, French, and Spanish) are given for each species.

Family Dermochelyidae	
Dermochelys coriacea:	Leatherback (E); Tortue luth (F); Tortuga laúd (S)
Family Cheloniidae	
Chelonia mydas:	Green turtle (E); Tortue verte (F); Tortuga verde (S)
Chelonia mydas / C. agassizii / C. m. agassizii [1]:	Black turtle (E); Tortue noire (F); Tortuga prieta (S)
Natator depressus:	Flatback turtle (E); Chelonée à dos plat (F); Tortuga aplanada (S)
Eretmochelys imbricata:	Hawksbill (E); Tortue imbriquée (F); Tortuga de carey (S)
Caretta caretta:	Loggerhead (E); Caouanne (F); Caguama (S)
Lepidochelys kempii:	Kemp's ridley (E); Chelonée de Kemp (F); Tortuga lora (S)
Lepidochelys olivacea:	Olive ridley (E); Chelonée olivâtre (F); Tortuga golfina (S)

1 *Authors Note:* Valid arguments can be presented both in favor and against the designation of the Black turtle as a full species within the genus *Chelonia*; namely, *Chelonia agassizii*. On balance, we support the full species concept because we believe it meets the traditional criteria of degree of morphological divergence and probable existence of reproductive isolation mechanisms, and because the science of objective interpretation of revealed differences in genotype and their relationship to systematics is still evolving. Others disagree. For insight into the continuing debate the reader is referred to Pritchard (1996, 1999), Bowen and Karl (1996) and Karl and Bowen (1999).

Editors Note: The systematic status and nomenclature of the Black turtle or east Pacific green turtle, sometimes referred to as *Chelonia agassizii* or *C. mydas agassizii*, remains uncertain. Recent genetic evidence supports an Atlantic-Mediterranean vs. Indian-Pacific grouping, while morphological and behavioral data suggest an east Pacific species or subspecies. Cognizant of the unfinished scientific debate and aware of the fact that the IUCN does not at the present time recognize the Black turtle as a species (or subspecies) of *Chelonia*, this manual adopts a conservative *status quo* position; namely, that there are seven species of sea turtle and the "agassizii" type is embraced within the global *Chelonia mydas* complex. At the present time the MTSG has no formal position on the ongoing debate, but is strongly supportive of research in this area.

Illustrations: Tom McFarland provided the illustrations for Figures 4-11 and 13. Figures 1, 2, 12 and 14 were modified by J. Mortimer from original illustrations by T. McFarland. The authors are most grateful for T. McFarland's contribution to this chapter.

External Morphological Structures and Taxonomic Characters

Figures 1 and 2 illustrate some of the external morphological structures used to identify sea turtles to species. These structures can also be used to reference a specific point on the body of a turtle—such as the exact location of an injury, scute anomaly, etc. Where a series of multiple scutes or scales each have the same name *(e.g.,* vertebral, marginal, etc.) individual scutes can be differentiated by numbering them from anterior to posterior and by noting right or left side of the body *(e.g.,* sixth right marginal scute).

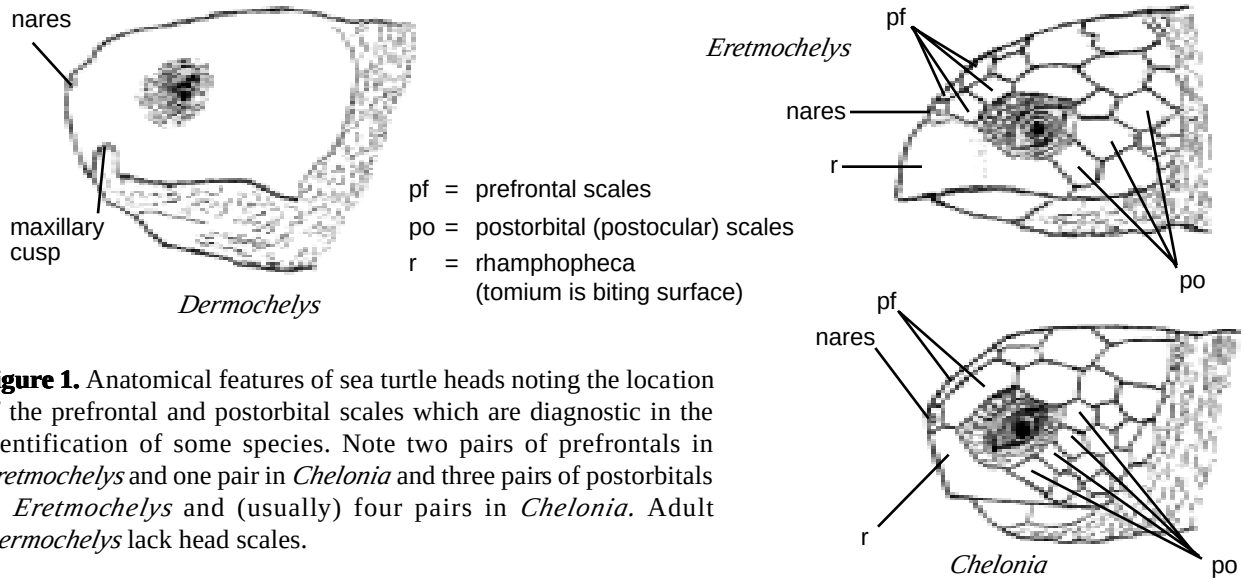


Figure 1. Anatomical features of sea turtle heads noting the location of the prefrontal and postorbital scales which are diagnostic in the identification of some species. Note two pairs of prefrontals in *Eretmochelys* and one pair in *Chelonia* and three pairs of postorbitals in *Eretmochelys* and (usually) four pairs in *Chelonia.* Adult *Dermochelys* lack head scales.

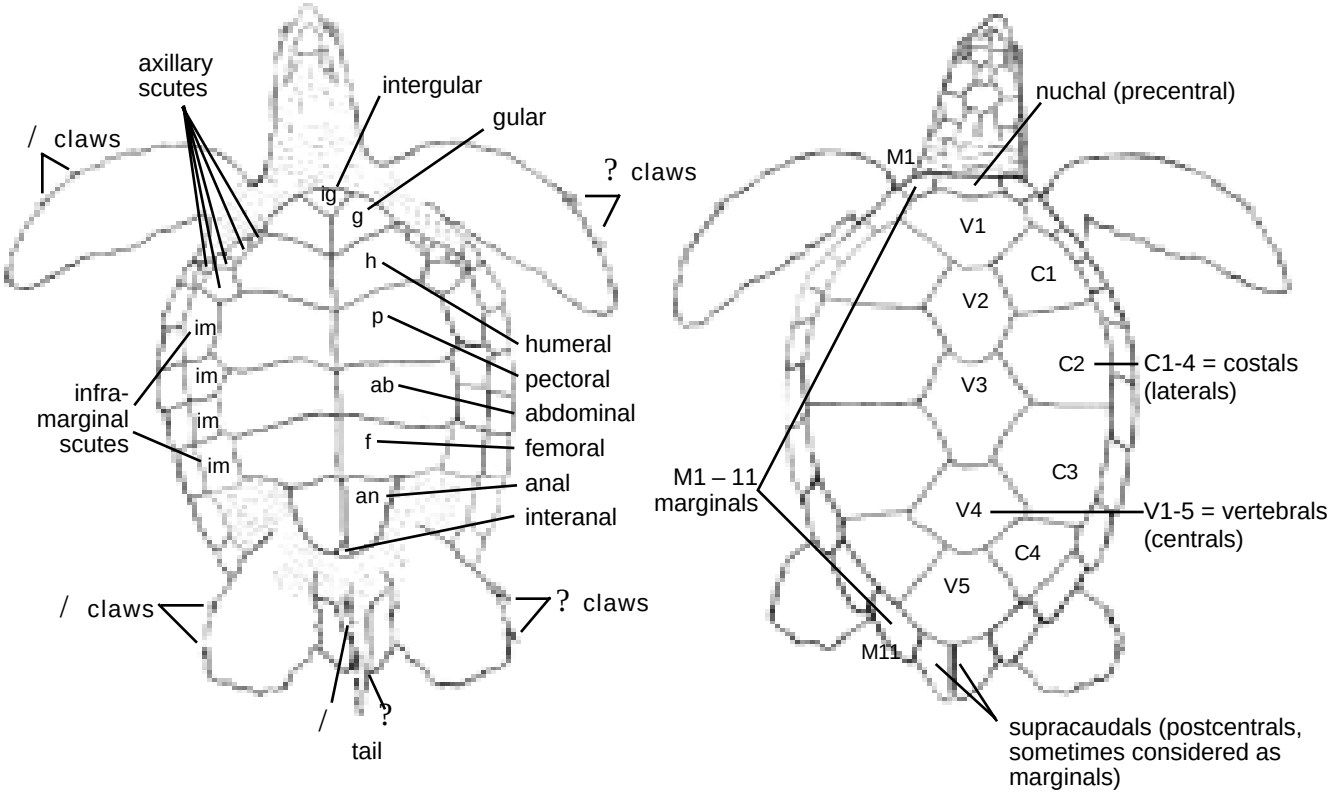


Figure 2. An illustrated guide to external morphological features of sea turtles, including scutes of the plastron (lower shell) and carapace (upper shell). Where scutes have more than one name, alternative names are provided in parentheses. The secondary sexual characteristics indicated are visible only in adult turtles. Note that inframarginal scutes span the distance between the marginal and large plastron scales (h, p, ab, f).

Simplified Key to Adult and Subadult Turtles Viewed in the Wild

The following key is designed to identify subadult or adult turtles spotted briefly at the ocean surface from a boat or an airplane, or seen by a diver underwater. To further assist such identifications, Figure 3 depicts dorsal silhouettes of the various sea turtle species.

1. Leathery, scuteless black or spotted carapace, posteriorly pointed and with prominent longitudinal ridges; carapace length to about 180 cm; all oceans, temperate or tropical ..... ***Dermochelys coriacea***

1'. Carapace hard with large scutes, rounded or elongate but not posteriorly pointed; carapace length less than 120 cm ..... see 2

2. Carapace wide and almost circular; head width to about 15 cm; dorsal coloration gray to olive-green, unmarked; maximum carapace length to about 70 cm ..... see 3

2'. Carapace not so wide as to be almost circular; coloration variable; maximum carapace length to 120 cm ..... see 4

3. Carapace very flat and wide, coloration relatively light, juveniles gray, circular in outline; maximum carapace length 72 cm; Gulf of Mexico, eastern USA, vagrant of western Europe ..... ***Lepidochelys kempii***

3'. Carapace relatively steep-sided, especially in eastern Pacific; typically dark olive; juveniles gray, circular in outline (similar to *L. kempii);* maximum carapace length 72 cm; Pacific, Indian and South Atlantic Oceans (Trinidad to Brazil; West Africa) ..... ***Lepidochelys olivacea***

4. Head very large (width up to 28 cm in adults); carapace broadest anteriorly, elongate, and posteriorly narrowed, with a "hump" at the fifth vertebral scute; color uniform reddish-brown; maximum carapace length 105 cm; usually temperate waters of all oceans, including Mediterranean and US Atlantic, occasionally in tropics ... ***Caretta caretta***

4'. Head not very large (width to 12-15 cm in adults); carapace not broadest anteriorly, lacking "hump" at fifth vertebral scute; color variable, carapace often boldly marked, typically with dark brown or black streaks, or plain olive; tropical seas ..... see 5

5. Head small, anteriorly rounded; carapace heart-shaped ..... see 6

5'. Head either very narrow and anteriorly pointed or medium and broadly triangular; carapace either relatively narrow or broadly oval ..... see 7

6. Carapace smooth and wide (modest incurving above hind limbs), coloration variable but usually with radiating streaks, or spots in some large adults; maximum carapace length 120 cm; tropics and subtropics, all oceans ..... ***Chelonia mydas***

6'. Carapace typically narrowed by strong incurving above hind limbs, color almost black, plain or spotted; carapace length to 90 cm, usually less; eastern Pacific, with rare vagrants further west ..... ***Chelonia*** sp. (Black turtle)

7. Head narrow, with pointed bird-like beak (head width to 12 cm); carapace relatively narrow and lacking upturned sides, often well marked, scute borders obvious and overlapping, posterior margin of carapace usually strongly serrated; carapace length to about 90 cm; tropical waters, all oceans ..... ***Eretmochelys imbricata***

7'. Head broadly triangular and relatively flattened (width to 15 cm); carapace broadly oval, very flat with upturned sides, without markings, scute borders often indistinct, and edges of shell smooth; carapace length to about 100 cm; tropical Australia ..... ***Natator depressus***

Identification of Sea Turtles Available for Close Examination

If the turtle is in hand, otherwise constrained, or stranded (dead) on the coast, it is appropriate to utilize the more detailed descriptions on the following pages in Figures 4-11 to confirm the identification. On very rare occasions, cheloniid turtles of different genera may hybridize. Typically, the offspring are morphologically intermediate between their parents.

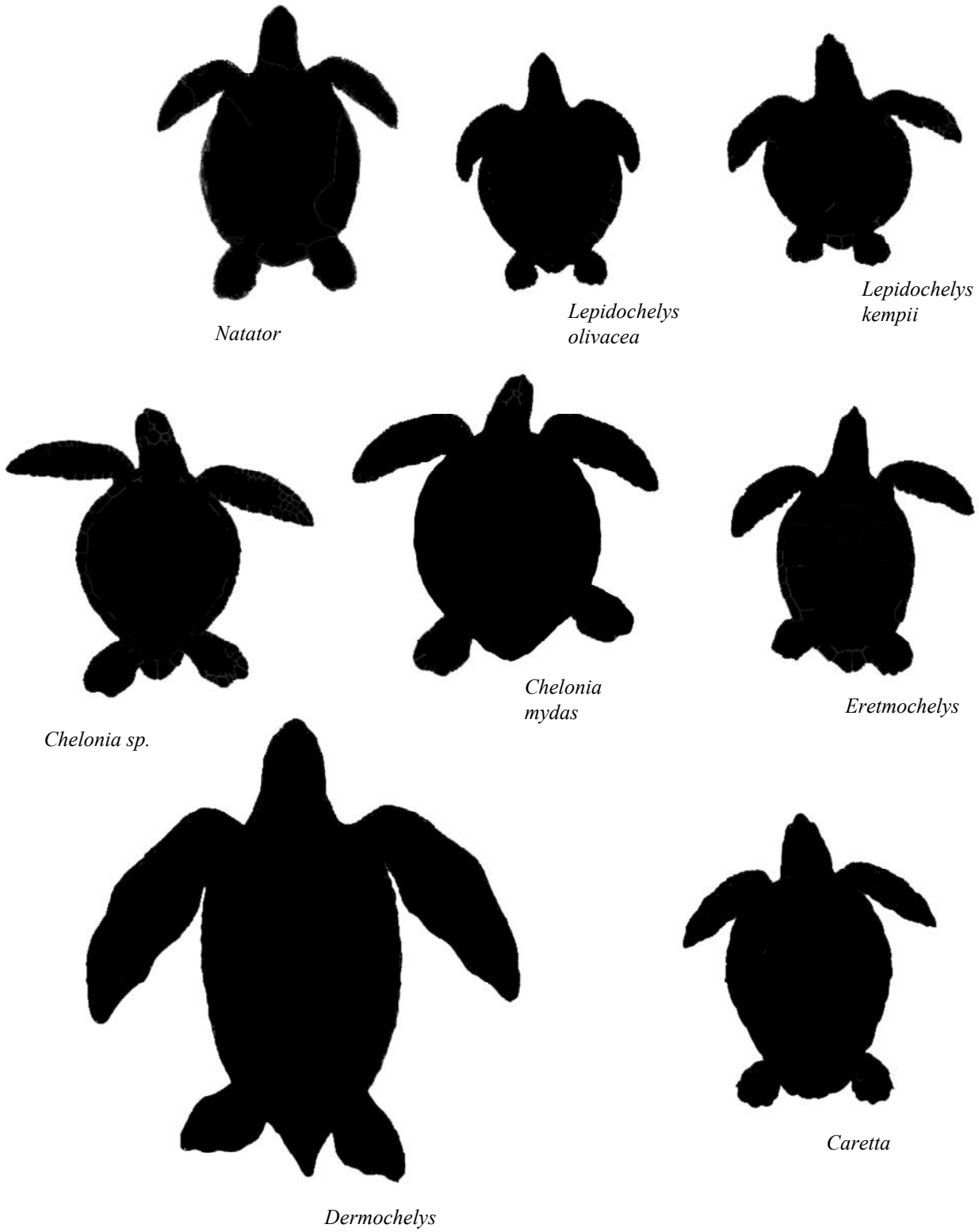


Figure 3. Sea turtle silhouettes viewed from a distance; sizes are relative for adult turtles

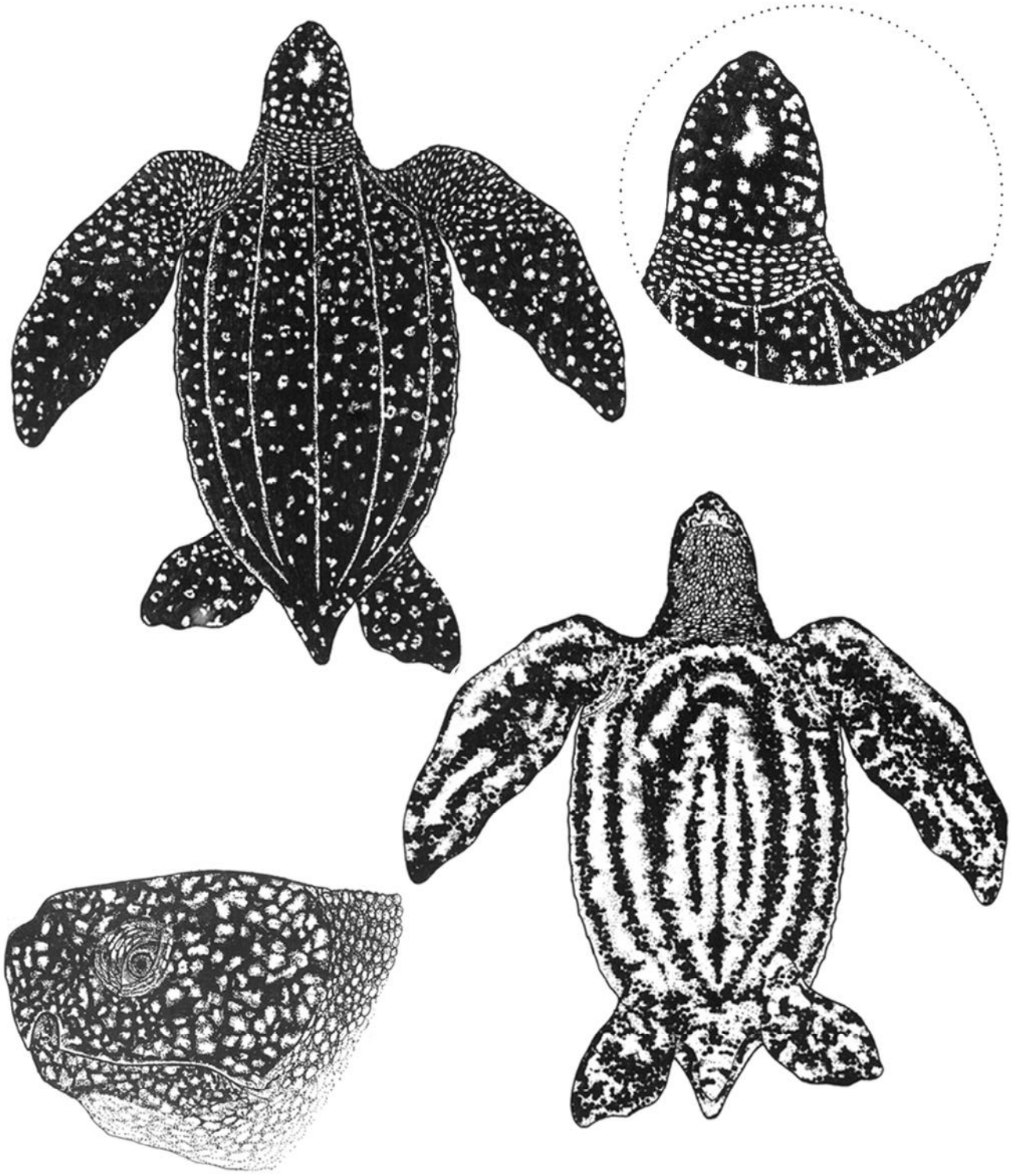


Figure 4. Leatherback turtle (*Dermochelys coriacea*).

Carapace: elongate with seven prominent longitudinal ridges (keels); scutes always absent; adults with smooth skin, but hatchlings covered with small bead-like scales; straight carapace length (SCL) to 180 cm (to 165 cm in east Pacific). **Head:** shape broadly triangular; width to 25 cm; two prominent maxillary cusps, covered with unscaled skin in adults. **Limbs:** forelimbs extremely long; unscaled skin in adults; all limbs clawless. **Coloration:** dorsally predominantly black, with variable degrees of white or paler spotting; spots may be bluish or pink on neck and base of flippers; light pigment predominating on plastron. **Plastron:** relatively small, distensible (with very little bone). **Distribution:** all oceans, sub-arctic to tropical. **Weight:** adult females to 500 kg in the western Atlantic, less in eastern Pacific.

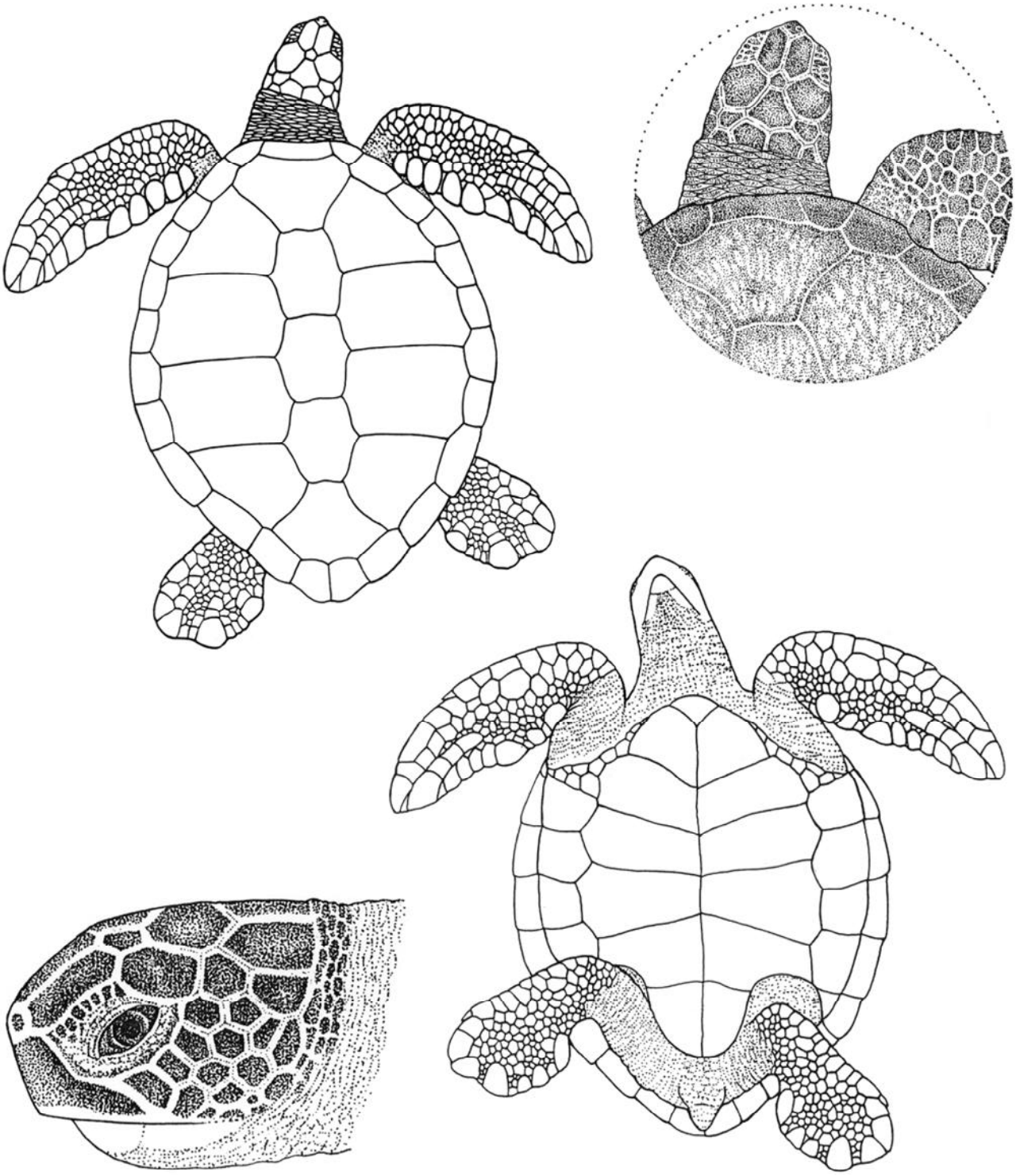


Figure 3. Green turtle (*Chelonia mydas*).

Carapace: broadly oval, margin sometimes scalloped but not serrated, and not incurved above hind limbs; four pairs of costal scutes; straight carapace length (SCL) to about 120 cm. **Head:** anteriorly rounded; width to 15 cm; one pair of prefrontal scales; four pairs of postorbital scales. **Limbs:** single claw on each flipper (rarely, two in some hatchlings). **Coloration:** dorsally black in hatchlings, becoming brown with radiating streaks in immatures, very variable in adults (generally brown, buff, and other earth tones; plain streaked or spotted); underside white in hatchings, yellowish in adults. **Distribution:** all sub-tropical and tropical seas. **Weight:** to about 230 kg in the Atlantic and western Pacific Oceans, less in the Indian Ocean and the Caribbean.

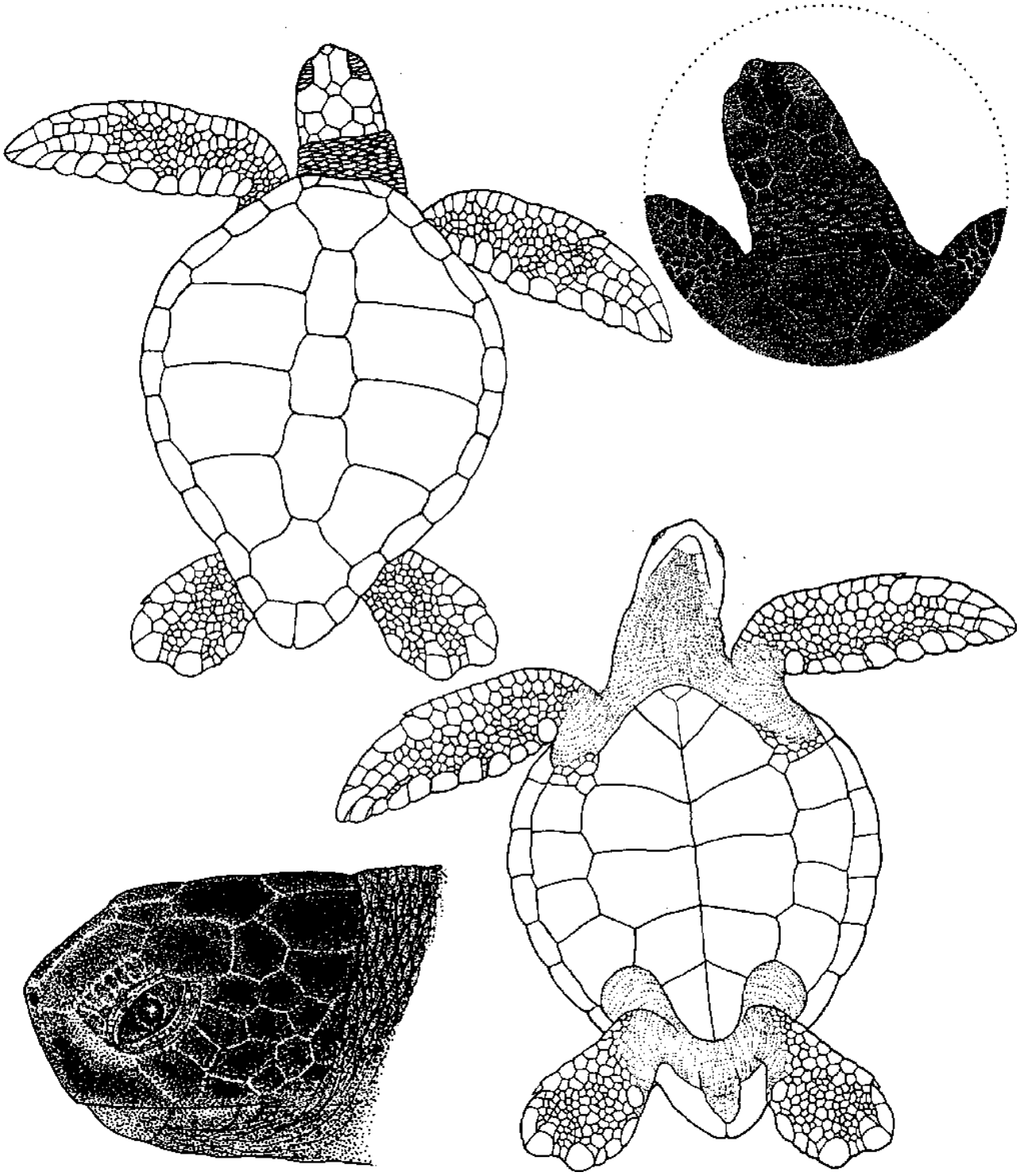


Figure 6. Black turtle *(Chelonia sp.).*

Carapace: heart-shaped and posteriorly tapered in adults; not serrated; often tectiform (tent-shaped) and flat-topped in anterior profile; four pairs of costal scutes; straight carapace length (SCL) to about 90 cm. **Head:** anteriorly rounded; width to 13 cm; one pair of prefrontal scales; four pairs of postorbital scales most common (followed by three pairs). **Limbs:** limbs may be relatively longer than in other *Chelonia* populations; single claw on each flipper. **Coloration:** dorsally black in hatchlings, remaining dark throughout life; adults may be uniformly black above or with black spots or other markings on a greyish background; underside white in hatchlings but within a few weeks or months becoming infused with gray pigment. **Distribution:** East Pacific Ocean. **Weight:** to about 120 kg (average adult about 70 kg).

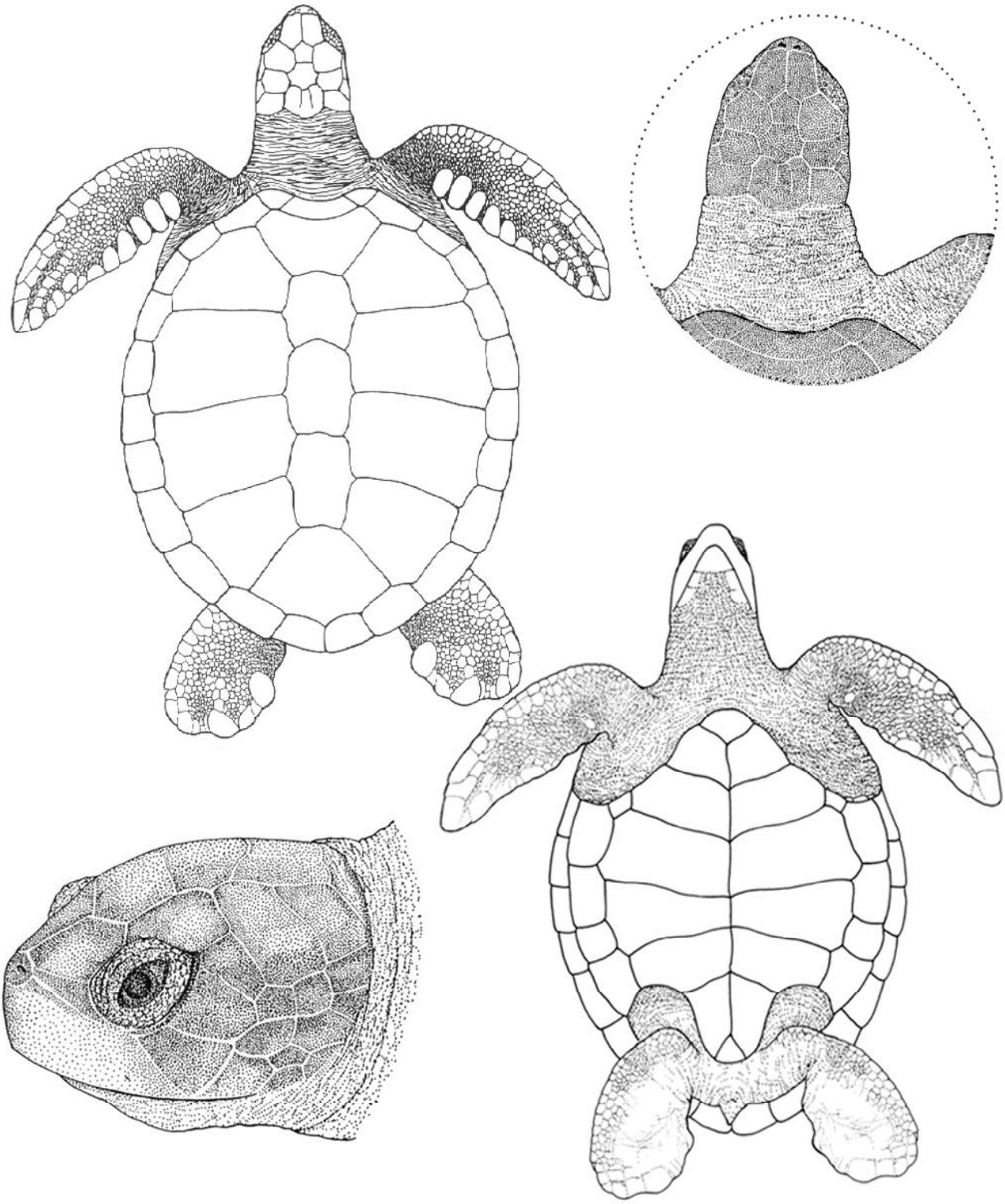


Figure 7. Flatback turtle *(Natator depressus).*

Carapace: very broad and rounded, with upturned lateral margins; four pairs of costal scutes; scutes very thin and with a softer texture than in other cheloniid turtles, with seams often disappearing in old adults; curved carapace length (CCL) to about 100 cm. **Head:** wide, broad, flat and subtriangular in shape; width to 13 cm in adults; three pairs of postorbital scales; one pair of prefrontal scales. **Limbs:** large scales present only on the edges of the front flippers, with most of the flipper covered by wrinkled skin or very fine scales; single claw on each flipper. **Coloration:** dorsally uniform olive-green in hatchlings and adults; yellowish ventrally. **Distribution:** confined to waters of tropical Australia and possibly southern New Guinea. **Weight:** to about 90 kg.

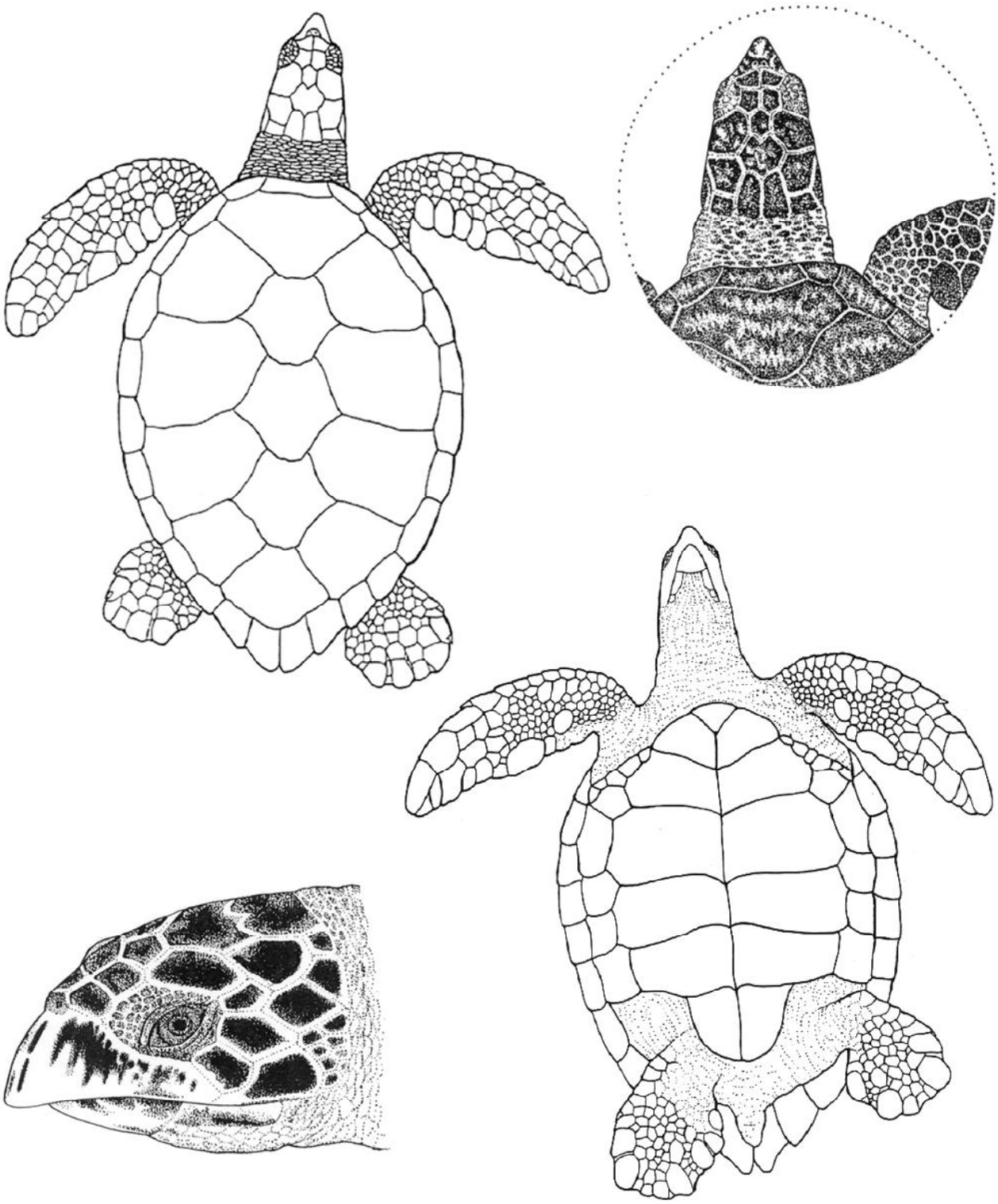


Figure 8. Hawksbill turtle *(Eretmochelys imbricata).*

Carapace: oval, with a strongly serrated posterior margin and thick overlapping (imbricate) scutes (except in hatchlings and some adults); four pairs of costal scutes, each with a slightly "ragged" posterior border; straight carapace length (SCL) to about 90 cm. **Head:** relatively narrow; width to 12 cm; with a straight bird-like beak; two pairs of prefrontal scales. **Limbs:** front flippers are medium length compared to other species; two claws on each flipper. **Coloration:** dorsally brown (dark to light) in hatchlings, often boldly marked with amber and brown variegations in juveniles and younger adults; underside light yellow to white, sometimes with black markings (especially in Pacific specimens). **Plastron:** four pairs inframarginal scutes. **Distribution:** all oceans, tropical waters. **Weight:** to about 80 kg (average about 60 kg).

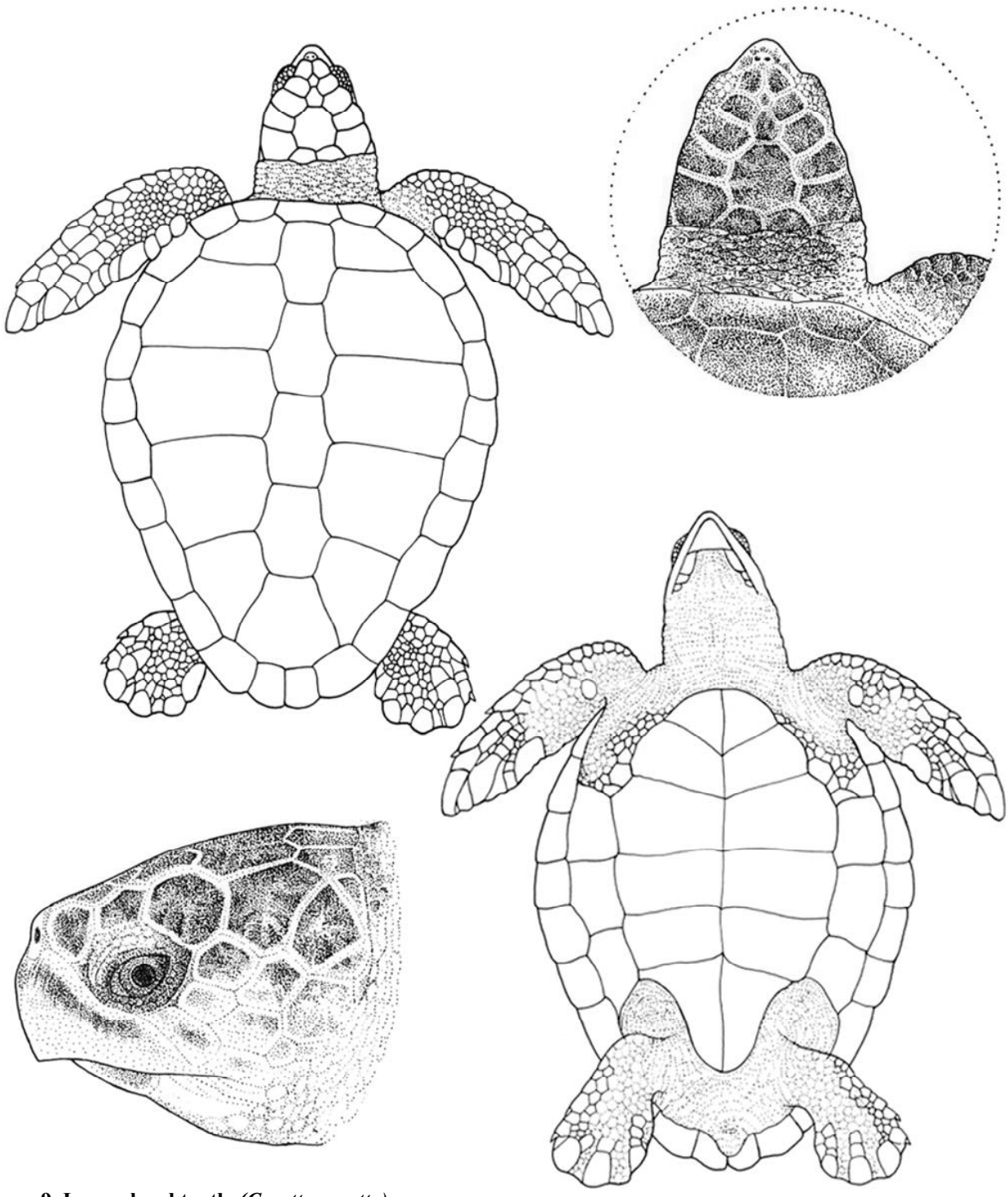


Figure 9. Loggerhead turtle *(Caretta caretta).*

Carapace: moderately broad; lightly serrated posterior margin in immatures; thickened area of the carapace above the base of the tail (at the fifth vertebral) in subadults and adults; five pairs of costal scutes, the first (anterior) pair the smallest; straight carapace length (SCL) to about 105 cm in northwestern Atlantic, smaller in some other areas, the smallest adults being in the Mediterranean (to about 90 cm). **Head:** large and broadly triangular in shape; width to 28 cm; two pairs of prefrontal scales. **Limbs:** front flippers relatively short compared to other species; two claws on each flipper. **Coloration:** dorsally light to dark brown in hatchlings, generally unmarked reddish-brown in subadults and adults; underside brown in hatchlings, yellow to orange in subadults and adults. **Plastron:** three pairs inframarginal scutes. **Distribution:** all oceans, usually temperate waters, sometimes subtropical and tropical. **Weight:** to about 180 kg in the western Atlantic and to about 150 kg in Australia; less than 100 kg in the Mediterranean.

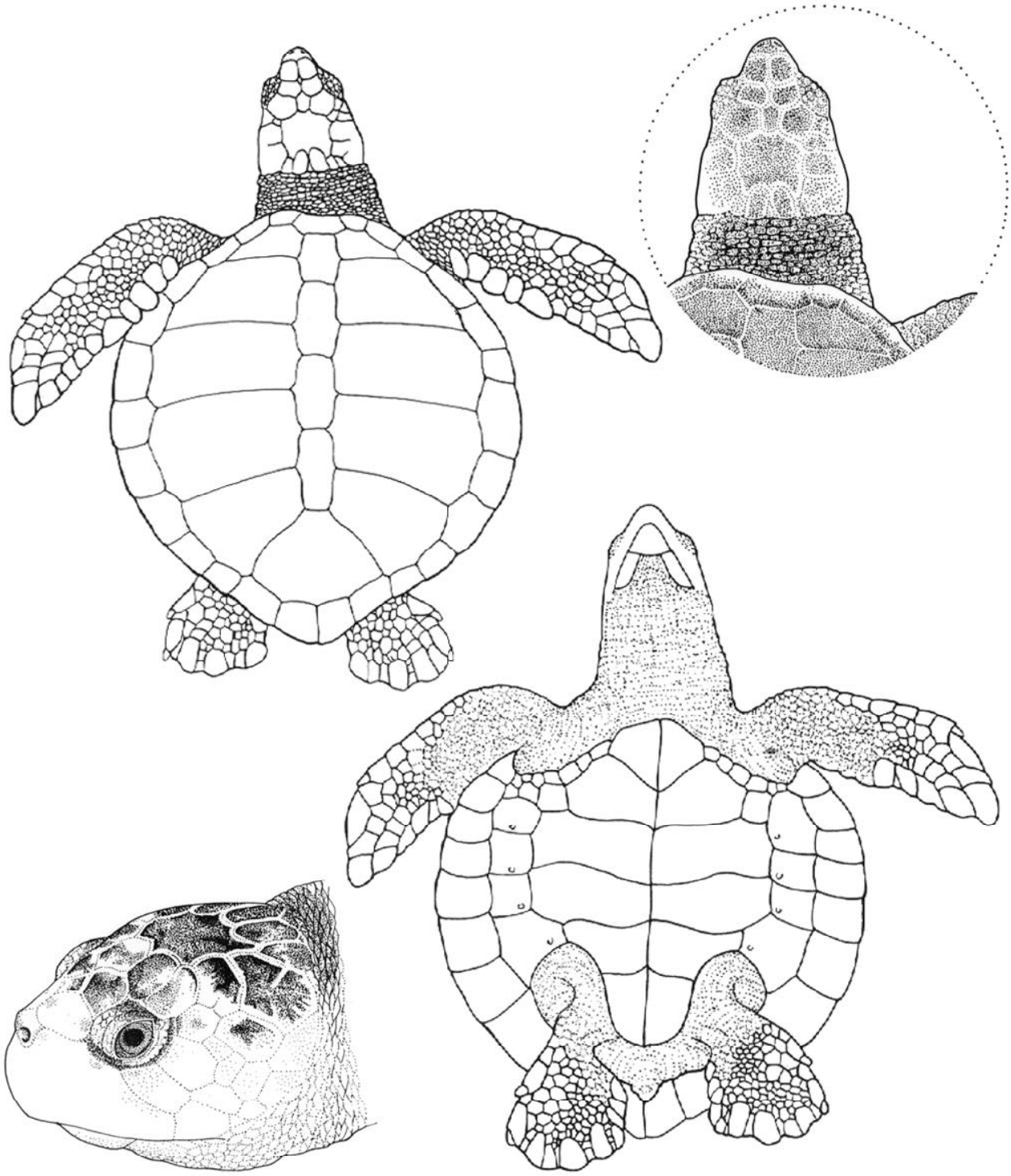


Figure 10. Kemp s Ridley turtle *(Lepidochelys kempii).*

Carapace: relatively short and wide, almost circular (wider in adults than that of *L. olivacea);* modest marginal serration or scalloping; high vertebral projections in juveniles, but carapace smooth and low in adults; carapace scutes slightly overlapping in immatures, and non-overlapping in adults; five pairs of costal scutes; straight carapace length (SCL) to 72 cm. **Head:** relatively large, subtriangular with convex sides; width to 13 cm; two pairs of prefrontal scales. **Limbs:** two claws on each flipper (some adults may lose the secondary claw on the front flippers). **Coloration:** dorsally grey in immatures, light olive-green in adults; underside white in immatures, yellow in adults. **Plastron:** a distinct, small pore near rear margin of each of the four inframarginal scutes. **Distribution:** Gulf of Mexico, eastern USA, occasionally western Europe. **Weight:** typically 35-50 kg.

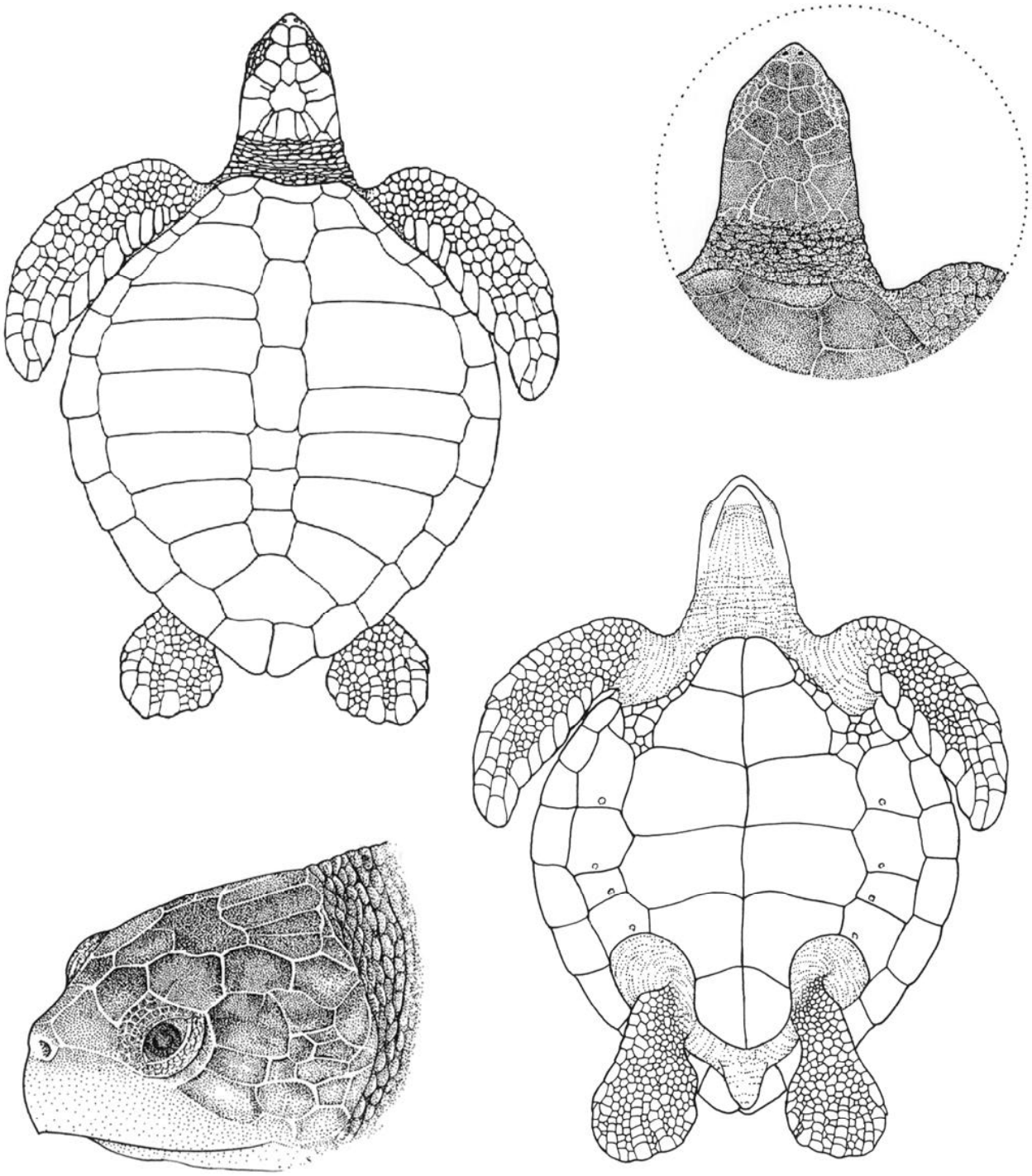


Figure 11. Olive Ridley turtle *(Lepidochelys olivacea).*

Carapace: short and wide, but narrower and higher than in *L. kempii;* high vertebral projections in juveniles; carapace smooth but elevated and somewhat tectiform (tent-shaped) in adults (especially in the East Pacific); five to nine pairs of costal scutes (usually six to eight) often with asymmetrical configuration; carapace scutes slightly overlapping in juveniles, non-overlapping in adults; straight carapace length (SCL) to 72 cm. **Head:** relatively large, triangular from above; width to 13 cm; two pairs of prefrontal scales. **Limbs:** two claws on each flipper (some adults may lose the secondary claw on the front flippers). **Coloration:** dorsally grey in immatures, mid to dark olive-green in adults; underside white in immatures, cream-yellow in adults. **Plastron:** a distinct, small pore near rear margin of each of the four inframarginal scutes. **Distribution:** tropical waters of Pacific, Indian and South Atlantic Oceans. **Weight:** typically 35-50 kg.

Key to Identification of Hatchlings

The key characters for identifying hatchlings (apart from color) are similar to those used for subadults and adults, although samples of hatchlings show greater variation in the numbers and configuration of the carapace scutes. Following is a species identification key for hatchling turtles. The composite drawings in Figures 12 and 13 portray relative differences in size and color among the sea turtle species as well as other diagnostic features.

1. Carapace covered with large horny plates; longitudinal carapace ridges, if present, not more than three in number and not of contrasting color; forelimbs much shorter than length of carapace; plastron color uniform or nearly so; carapace usually less than 60 mm (except in *Natator)* ..... see 2

1'. Entire surface of the animal (carapace, plastron and extremities) covered with small, soft, polygonal scales; seven longitudinal carapace ridges (including edges of shell) boldly outlined in white against a black background; forelimbs extremely long (almost as long as the carapace); plastron mottled black and white; typical carapace length (SCL) 60 mm (range 55-63 mm) ..... ***Dermochelys coriacea***

2. Ventral coloration light; costal scutes four pairs ..... see 3

2'. Ventral coloration dark; costal scutes four to nine pairs ..... see 5

3. Overall coloration light: dorsum light olive-yellow and plastron white with a peripheral yellow band; broadly oval carapace; postorbital scales three pairs; relatively large size, typical carapace length (SCL) 61 mm (range 56.5-65.5 mm); tropical Australia ..... ***Natator depressus***

3'. Carapace black or blue-black, typically with a white margin; plastron white; heart-shaped carapace (some posterior narrowing); postorbital scales usually four pairs (but sometimes three); typical carapace length smaller than *Natator;* tropical and subtropical seas including Australia ..... see 4

4. Forelimbs outlined in white; head scales blackish with narrow light (whitish) borders; postorbital scales usually four pairs; plastron pure white; typical carapace length (SCL) 49 mm (range 46-57 mm); distribution tropical and subtropical, not East Pacific region ..... ***Chelonia mydas***

4'. Forelimbs and head scales sometimes outlined in white, but white edges may be reduced or absent; postorbital scales typically four pairs (but sometimes three); plastron initially white, but soon darkens; typical carapace length (SCL) 47 mm (range 41-52 mm); distribution Galapagos Islands and Meso-America ..... ***Chelonia*** sp. (Black turtle)

5. Color brown (dark to light) above and below; inframarginal scutes typically three or four pairs ..... see 6

5'. Color very dark gray to black above and below; inframarginal scutes typically four pairs ..... see 7

6. Costal scutes four pairs; oval carapace; inframarginal scutes typically four pairs; typical carapace length (SLC) 42 mm (39-46 mm) ..... ***Eretmochelys imbricata***

6'. Costal scutes five pairs; carapace broader in shoulder region than in *Eretmochelys;* inframarginal scutes typically three pairs; typical carapace length (SLC) 45 mm (38-50 mm) ..... ***Caretta caretta***

7. Costal scutes usually five pairs; typical carapace length (SLC) 43 mm (38-46 mm); expected distribution of hatchlings Tamaulipas, Vera Cruz and South Texas (rare strays in southeastern USA) ..... ***Lepidochelys kempii***

7'. Costal scutes usually six to nine pairs (sometimes five); typical carapace length (SLC) 42 mm (38-50 mm); distribution circumtropical, mostly mainland shore, not Gulf of Mexico and east USA ..... ***Lepidochelys olivacea***

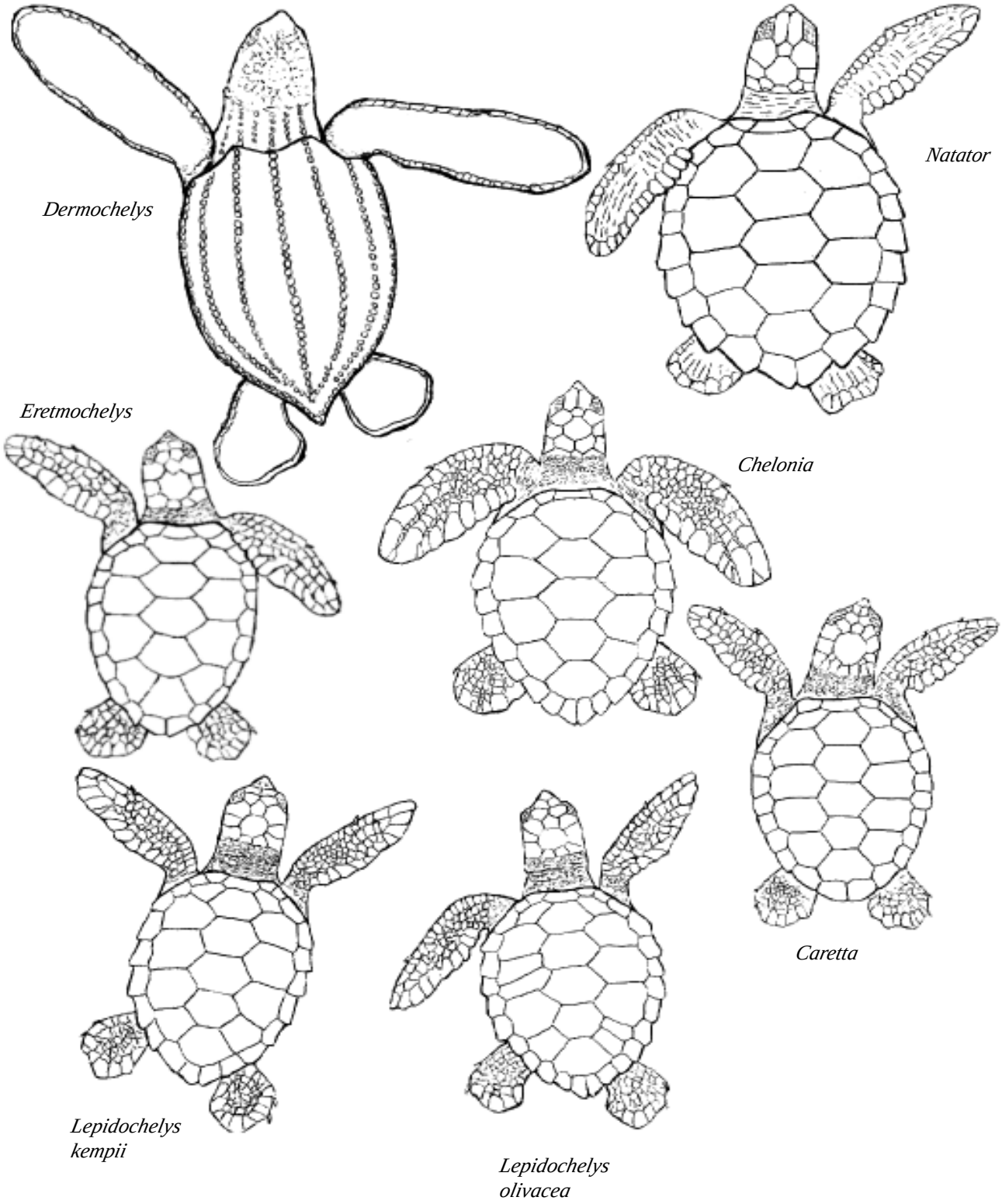


Figure 12. Sea turtle hatchlings of seven species. Sizes are 80% of actual size.

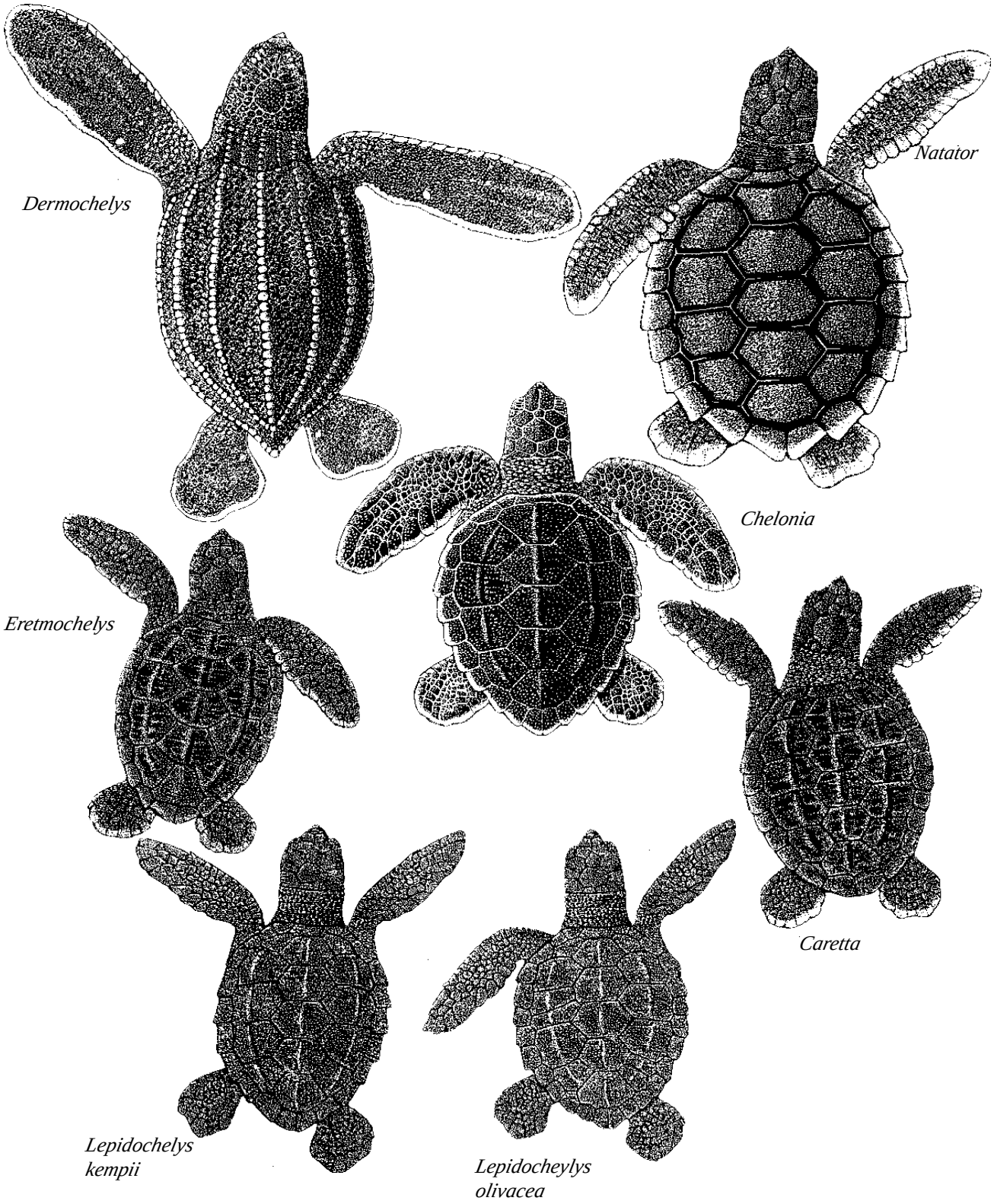
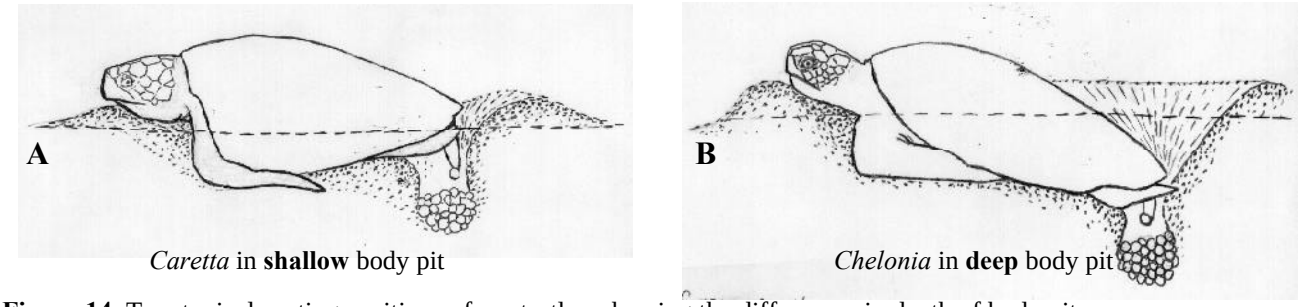


Figure 13. Sea turtle hatchlings of seven species. Sizes are approximately 80% of actual size.



Caretta in **shallow** body pit

Chelonia in **deep** body pit

Figure 14. Two typical nesting positions of sea turtles, showing the differences in depth of body pits.

Identification of Tracks and Nests

The following descriptions of tracks and nests typical of each species will serve as a guide for field workers trying to identify the tracks they encounter. Nevertheless, the tracks of different species can be difficult to tell apart—especially those of *Caretta, Lepidochelys,* and *Eretmochelys.* Differences in beach substrate can alter the appearance of tracks made by the same individual, and morphological variation *(i.e.,* body size, flipper length, etc.) between individuals or populations of the same species can produce differences in track widths. Thus, we encourage field workers to spend time watching nesting turtles and to note the characteristics that distinguish the tracks made by local populations of each species.

Important diagnostic features used to differentiate turtle tracks by species include track width (cm), body pit depth (deep vs. shallow), and whether the diagonal marks made by the front flippers are symmetrical or asymmetrical. Some turtles *(Caretta, Eretmochelys, Lepidochelys and Natator)* dig little or no body pit (Figure 14A). Others *(Dermochelys, Chelonia)* leave conspicuous body pits (Figure 14B) after the female has displaced large amounts of sand while constructing and covering her nest. A symmetrical track is formed when the front flippers move together synchronously to pull the turtle over the surface of the sand, resulting in a track in which the right and left halves are almost mirror images. An asymmetrical track is formed when the front flippers move alternately (right, left, right, left, etc.) to carry the turtle forward.

Various other large animals sometimes leave tracks on the beach. Crocodiles, monitor lizards, and iguanas leave toe and claw prints and heavy tail drags. Because fresh water turtles are usually smaller than adult sea turtles, they walk with their plastron clear of the ground. Thus they tend to leave narrow tracts (less than 50 cm wide) comprising a series of isolated foot prints and no drag mark. In the Galápagos islands, Hawaii, and a few other places seals or sea lions may leave tracks that are superficially similar to those of sea turtles.

Species Tracks and Nest Descriptions

Dermochelys coriacea

Track width: 150-230 cm (less in the eastern Pacific than elsewhere).

Type of track: very deep and broad, with symmetrical diagonal marks made by the forelimbs, and usually with a deep incised median groove formed by dragging the relatively long tail.

Preferred beach type: wide, long, tropical beaches with steep slope, deep rock-free sand, and an unobstructed deep water or soft mud bottom approach.

Egg size and number: diameter of full-size (yolked) eggs averages 51-55 mm. Clutch size averages 80-90 eggs throughout most of the range but only 60-65 in the eastern Pacific. Few clutches exceed 120, not including a variable number of yolkless undersized eggs found in every nest.

Geographic location of nesting beaches: isolated mainland beaches in tropical (mainly Atlantic and Pacific; few in Indian Ocean) and temperate (south west Indian Ocean) oceans. Some low density nesting on islands (Greater and Lesser Antilles, Solomon Islands, and islands of the Bismarck Sea).

Chelonia mydas

Track width: typically about 100-130 cm but variable.

Type of track: deeply cut, with symmetrical diagonal markings made by the forelimbs. Straight, central tail drag marks present, either as a solid or a broken line.

Preferred beach type: ranges from large, open beaches to small cove beaches; preferably with an open offshore approach.

Egg size and number: egg diameter typically 40-46 mm. Clutch size averages 110-130.

Geographic distribution of nesting beaches: large colonies nest on both mainland beaches and remote oceanic islands. Tropical and occasionally subtropical beaches in all oceans (Atlantic, Pacific, and Indian oceans; Mediterranean and Red seas).

Chelonia sp. (Black turtle)

Track width: 70-90 cm.

Type of track: relatively deeply cut, with symmetrical diagonal markings made by the forelimbs. Straight, central tail drag marks present, either as a solid or a broken line.

Preferred beach type: small to intermediate sized mainland and island beaches; may use beaches with rocky outcrops or rocks exposed by low tide.

Egg size and number: egg diameter typically 40-45 mm. Reported mean clutch size ranges from 66-75 in Mexico to 81 in the Galápagos Islands and 87 in Pacific Costa Rica.

Geographic distribution of nesting beaches: principal nesting grounds in Michoacan (Mexico), Pacific coast of Costa Rica, and the Galápagos Islands (Ecuador).

Natator depressus

Track width: about 90 cm.

Type of track: relatively lightly cut, with either symmetrical or alternating marks made by the forelimbs.

Preferred beach type: fairly large open beaches, on mainland or large islands; reef habitat avoided.

Egg size and number: egg diameter typically 50-52 mm. Clutch size averages about 50-55 eggs.

Geographic location of nesting beaches: northern Australia.

Eretmochelys imbricata

Track width: typically 70-85 cm.

Type of track: shallow, with alternating (asymmetrical), oblique marks made by the forelimbs. Tail drag mark may be present or absent. Nests and tracks can be difficult to distinguish from those of ridleys, but the two species prefer different beach-types, and rarely nest together. Hawksbills frequently nest under overhanging vegetation (unlike ridleys which usually nest in open areas) and often wander extensively before nesting. Individual flipper prints of hawksbills are deeper than those of ridleys.

Preferred beach type: almost exclusively tropical; often use narrow beaches on islands or mainland shores with reefs obstructing offshore approach. Hawksbill nesting habitat is often separated (spatially or temporally) from that used by other turtle sea species.

Egg size and number: egg diameter typically 32-36 mm. Average clutch size varies from 70-90 in the Arabian peninsula to 110-180 elsewhere.

Geographic location of nesting beaches: tropical mainland and island beaches in the Atlantic, Pacific, and Indian oceans, and Red Sea. Nesting colonies worldwide are depleted from over-exploitation. The largest remaining populations occur in Australia, Mexico, Seychelles, and Indonesia.

Caretta caretta

Track width: typically 70-90 cm.

Type of track: moderately deeply cut, with alternating (asymmetrical) diagonal marks made by the forelimbs. Typically no tail drag mark.

Preferred beach type: generally extensive mainland beaches and barrier islands; moderately steep beach profile preferred.

Egg size and number: egg diameter typically 39-43 mm. Average clutch size ranges from about 90-110 in the Mediterranean to 100-130 elsewhere.

Geographic location of nesting beaches: nests most abundantly in subtropical and temperate areas (southeast USA, Oman, temperate Australia, South Africa, eastern and southern Mediterranean, Japan, southern Brazil), occasionally in the tropics (Belize and Colombia), and sometimes on islands (New Caledonia, Solomon Islands).

Lepidochelys kempii

Track width: 70-80 cm.

Type of track: very lightly cut, may be quickly obliterated by wind; alternating (asymmetrical) oblique marks made by the forelimbs. Tail drag mark lacking or inconspicuous.

Preferred beach type: wide, extensive, and continuous beaches with scrubby dune vegetation on mainland shores and barrier islands.

Egg size and number: egg diameter typically 37-41 mm. Average clutch size is 104 eggs.

Geographic location of nesting beaches: primarily near Rancho Nuevo, Tamaulipas, Mexico; occa-

sional nesting in Veracruz and Campeche Mexico, in southern Texas, and rarely elsewhere. Formerly highly aggregated in nesting groups known as arribadas, but over-exploitation and incidental mortality in trawl nets has reduced *arribada* sizes to dozens or a few hundred rather than thousands.

Lepidochelys olivacea

Track width: 70-80 cm.

Type of track: similar to that of *L. kempii* (above).

Preferred beach type: tropical mainland shores and barrier islands, often near river mouths.

Egg size and number: egg diameter typically 37-42 mm. Average clutch size ranges from 105 to 120.

Geographic location of nesting beaches: eastern Pacific (Baja California and Sinaloa, Mexico to Colombia), south Atlantic (Guyana to Brazil and West Africa), northern Indian Ocean (especially Orissa India), and western Pacific (Malaysia and Thailand). Nesting often solitary or in small groups; but in India, Costa Rica, and Mexico arribadas of many thousands of animals may come ashore at once.

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