SPECIES PROFILE FOR ATLANTIC GREEN SEA TURTLE *(Chelonia mydas mydas)* AND PACIFIC BLACK SEA TURTLE *(Chelonia mydas agassizii)*

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TAXONOMY

Atlantic Green Sea Turtle
Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Order: Testudinata
Family: Cheloniidae
Genus: *Chelonia*
Species: *C. mydas*
Subspecies: C. mydas mydas

Pacific Black Sea Turtle
Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Order: Testudinata
Family: Cheloniidae
Genus: *Chelonia*
Species: *C. mydas*
Subspecies: C. mydas agassizii

The green sea turtle was previously described by Linnaeus in 1758 as *Testudo mydas.* A taxonomist in 1758 named Marie Firmin Bocourt classified a new species under the genus *Chelonia*, which is the *Chelonia agassizii* or the black sea turtle. Researches were done and molecular phylogenetics found out that there is no genetic distinction between *C. mydas* and *C. agassizii*. This led to the classification of *C. agassizii*, not as a taxonomically separate species, but a subspecies of *C. mydas. C. agassizii* is recently named as *Chelonia mydas agassizii* which refers to the Pacific population. On the other hand, *Chelonia mydas mydas* refers to the original population as described by Linnaeus (Van Dijk et al., 2014).

BIOLOGY

Figure 1. Gross morphology of Green Sea Turtle (left) and Black Sea Turtle (right). *Photo lifted from Scuba Diving Magazine and Sea Turtle Camp.*

Green Sea Turtle *(Chelonia mydas mydas)*

Among all sea turtles, *Chelonia mydas* or the green turtle, as shown in Figure 1, was the most well studied. Its migration, life history, as well as the breeding habits are characterized for the past thirty years. It is the only species in the genus *Chelonia*. Its common name, green sea turtle, is rooted in the presence of its green fat located beneath its carapace (Spotila, 2004).

Relative to other sea turtle, it is considered as a large sea turtle because of its carapace length ranging from 90-120 cm. It is the second largest among marine sea turtles after the leatherback. Unlike its closely related sea turtle species, the hawksbill turtle *(Eretmochelys imbricata),* the jaws are unhooked (Spotila, 2004). The shields of its upper shell are not overlapping and two prefrontal shields are found on its head. A single claw is also observed on each limb. Its carapace has a shape of a teardrop that cover its dorsoventrally flattened body (Alcala, 1976).

The color of its carapace is olive or reddish brown with streak of yellow. The top of the head has reddish brown shields with black edges. The flippers are colored black or olive brown above while yellow or lemon below (Alcala, 1976).

Feeding Ground. Adult green sea turtles are mostly herbivorous because it devours on marine grasses, algae. But in their early stages, it feeds on mollusks, jellyfishes and crustaceans, making it an omnivore (Spotila, 2004).

Nesting. The nesting occurs between May and June where the female tend to go back to their natal beach, or to the beach where they were hatched. The courtship starts whenever the male nuzzle its head towards the female. The other behavior can be the gentle biting of the flippers and neck. If the courtship was successful, the copulation proceeds. Male would hop on to the females back and fold its tail under the female's shell. Various types of sperms are available because females have the capability of mating with different males (Godley et al., 2001). It usually lay its eggs in the sandy beaches. The clutch size is around 75-100 eggs. Some females can lay for about seven clutches in a season. The female green sea turtles move out on beaches to dig nests and lay eggs at night. After 48 to 70 days, the eggs start to hatch and swim into the water. Those that are lucky to reach maturity can live for about 80 years in the wild (Sumich and Morrissey, 2004).

Ecological Importance. According to Spotila in 2004, adult green sea turtles are perceived to be inhabiting the shallow lagoons which are rich on various species of seagrasses. By biting the tips of seagrass blades, it aids the growth of the seagrasses, keeping it healthy.

Economic Importance. Wyneken et al. (2013) reiterated that of all reptiles, the green turtle is considered to be one of the most valuable for it supplies the humans with its scrumptious turtle soup. Photo showing the sea turtle soup is labeled in Figure 5. The main ingredient is its green fat coupled with its tender flesh. Its hatchlings are often stuffed with decorative materials that are sold in souvenir shops.

Black Sea Turtle *(Chelonia mydas agassizii)*

There is not much distinction between both subspecies of *Chelonia mydas* except that the black sea turtle, as shown in Figure 1, is slightly smaller than the green sea turtle. It has a weight of 65-125 kg with an average carapace length of 80 cm. Its narrower carapace with steeper slope is a further distinction between both subspecies. Its overall body color ranges from gray to black with rear flippers that has more pronounce indentations than the green sea turtle. The hatchling of Pacific black sea turtles have a black coloration in its carapace and white coloration in its plastron. Its margins are also white in color (Spotila, 2004).

Similar to the green sea turtle, the tales of the male are longer than the females. Overall, most of the physical and behavioral aspects of the two subspecies are highly similar. This reflects that even in the phenotypic scale, supplied by molecular data, the two subspecies show a close genetic relationship (Spotila, 2004).

Nesting. Similar to the Atlantic green sea turtle, the Pacific black sea turtle nests at night with a typical clutch of 70-100 eggs. The intervals in the nesting period would involve 12-14 days. The incubation of eggs range from 50-55 days prior to hatching. Black sea turtle nests on wide beaches with coves that are surrounded by rocky granite cliffs. The entire nesting duration takes 1-3 hours. Sexual maturity happens between 16-30 years of age. The well-defined Temperature-dependent Sex Determination (TDSD) claims that 31°C or higher produce females ((Sumich and Morrissey, 2004).

DISTRIBUTION

The circumglobal distribution of the green turtles in tropical and subtropical waters are not well understood. However, the nesting areas were studied and more than 80 countries were involved namely American Samoa (American Samoa); Angola (Angola); Anguilla; Antigua and Barbuda; Australia (Ashmore-Cartier Is., Coral Sea Is. Territory, Northern Territory, Queensland, Western Australia); Bahrain; Bangladesh; Barbados; Belize; Bonaire, Sint Eustatius and Saba (Saba, Sint Eustatius); Brazil; British Indian Ocean Territory; China; Christmas Island; Cocos (Keeling) Islands; Colombia; Comoros; Cook Islands; Costa Rica; Cuba; Curaçao; Cyprus; Dominica; Dominican Republic; Ecuador (Galápagos);

Egypt; Equatorial Guinea (Bioko); Eritrea; Fiji; French Guiana; French Polynesia; French Southern Territories (Mozambique Channel Is.); Grenada; Guam; Guinea; Guinea-Bissau; Guyana; Haiti; India (Andaman Is., Gujarat, Laccadive Is., Nicobar Is.); Indonesia (Bali, Jawa, Kalimantan, Lesser Sunda Is., Maluku, Papua, Sulawesi, Sumatera); Iran, Islamic Republic of; Jamaica; Japan (Honshu, Nansei-shoto, Ogasawara-shoto); Kenya; Kiribati; Kuwait; Madagascar; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Marshall Islands; Martinique; Mauritania; Mayotte; Mexico (Baja California, Campeche, Michoacán, Quintana Roo, Revillagigedo Is., Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán); Micronesia, Federated States of ; Mozambique; Myanmar; New Caledonia; New Zealand (Kermadec Is., North Is., South Is.); Nicaragua; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Puerto Rico; Saint Helena, Ascension and Tristan da Cunha (Ascension); Saint Kitts and Nevis; Saint Lucia; Saint Martin (French part); Saint Vincent and the Grenadines; Sao Tomé and Principe; Saudi Arabia; Senegal; Seychelles; Sierra Leone; Sint Maarten (Dutch part); Solomon Islands; Somalia; Sri Lanka; Suriname; Tanzania, United Republic of; Thailand; Timor-Leste; Tokelau; Tonga; Trinidad and Tobago; Turkey; Turks and Caicos Islands; Tuvalu; United Arab Emirates; United States (Florida, Hawaiian Is.); United States Minor Outlying Islands (Midway Is., US Line Is.); Vanuatu; Venezuela, Bolivarian Republic of (Aves I., Venezuelan Antilles); Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Yemen. Though it is native to these countries, the green turtle was classified as possibly extinct in Israel. In Cayman Islands and Rodrigues, Mauritius it was identified as regionally extinct. Nevertheless, green turtles are reintroduced in Bermuda (Seminoff, 2004).

Two subpopulations are present in the green turtle: the Atlantic and eastern Pacific. Within the population's known range, each population would have a distinct genetic composition, nesting and feeding grounds. Along the continental coasts and islands between 35°N and 35°S is where the native home ranges were located. The coastal areas inhabited by the green turtle has a vast range which includes more than 140 countries. Largest populations of green turtles in the coastline are found in Hawaii and Florida. But in a global scale, the green turtle population was largest in the Great Barrier Reef in Australia and Caribbean islands (Shimada et al., 2016).

Figure 2. The distribution of green sea turtle, major nesting sites are colored red while minor nesting sites are colored yellow.

Atlantic Subpopulation. In general, a population of green sea turtle can be found all throughout the Atlantic Ocean. Figure 2 shows that few individuals were found in Canada and British Isles. The southern range would include Africa while the eastern range includes Argentina. The major nesting sites were found in the various islands of Caribbean, eastern shores of United States and South American continent, even in the isolated North Atlantic islands (Seminoff, 2004).

Figure 3. The distribution of the Indo-Pacific Black Sea Turtles nesting sites in the Eastern Pacific Ocean. (Photo lifted from www.seaturtle.org)

Indo-Pacific Subpopulation. The range of the green sea turtle population, as shown in Figure 3, has reached the southern coast of Alaska and Chile in the east. In the western Pacific, the distribution involves the northern Japan, northern tip of New Zealand and southern Pacific Coast of Russia. Even in a few islands south of Tasmania, green sea turtle population can be found. And in the Indian Ocean, its population is widely spread (Seminoff, 2004).

In the Philippines, the nesting area of green sea turtles involves the Turtle Islands from which the hawksbill turtles can also be found. Last December 30, 2007, an 80 kg, 93 cm long and 82 cm wide green turtle was caught by accident in Barangay Bolong of Zamboanga City. The breeding season of green sea turtles in the area falls every December (Shimada et al., 2016).

DIVERSITY

Species Diversity. Of the seven species of marine mammals, six were found to inhabit the northern hemisphere. The only species that is restricted in occupying the southern hemisphere was the flatback sea turtle. Other literatures would refer *Chelonia mydas agassizii* as a separate species from *Chelonia mydas,* paving way to *Chelonia agassizii*. Uncommon to the West Coast of United States, marine turtles were still sighted in the area. Reasons for the sightings would include the coldness and attenuated feeding behaviour. This, in return, would make the marine turtles sick and stop feeding. Once this behaviour perpetuates, the turtles become bouyant in the waters. With this, it would give marine turtles a hard time in swimming down for food hunting. Some sightings were due to the strong currents along the West Coast. On the other hand, many turtle nesting areas were found in the East Coast of the united States. Also, green turtles and marine turtles in general are most common in the island of Hawaii. Daily sightings were found in the beaches of Hawaii which strengthened the protection and education programs about the green sea turtle population. In the area, green sea turtles were seen to devour algae (Anderson, 2003).

Genetic Diversity. The genetic diversity of green sea turtles were affected by various factors and one of those can account to the increase in the genetic diversity of offspring. In the case of green sea turtles, the females usually lay their eggs once in every three years. The nest is located far above the high tide boundary. The nest was built through the digging of holes using its strong flippers. After the laying of eggs, the female returns to the sea and never returning back to its offsprings. Males, on the other hand, tend to inhabit in the sea throughout their entire lives (Yang et al., 2015).

EVOLUTION

For the past 20 years, the use of molecular genetics has addressed the questions directly pertinent to sea turtle conservation. Most highly variable markers (e.g. maternally inherited mitochondrial DNA and nuclear microsatellites) were the ideal markers used in elucidating a population-level of analysis in green sea turtles. Based on the study conducted by Meylan et al. (1990), a pattern of mtDNA differentiation was observed among rookeries and this led to a feature common to all marine sea turtles - the natal homing. Aside from the discovery of natal homing, the mtDNA differentiation played a vital role in determining the origin of turtles.

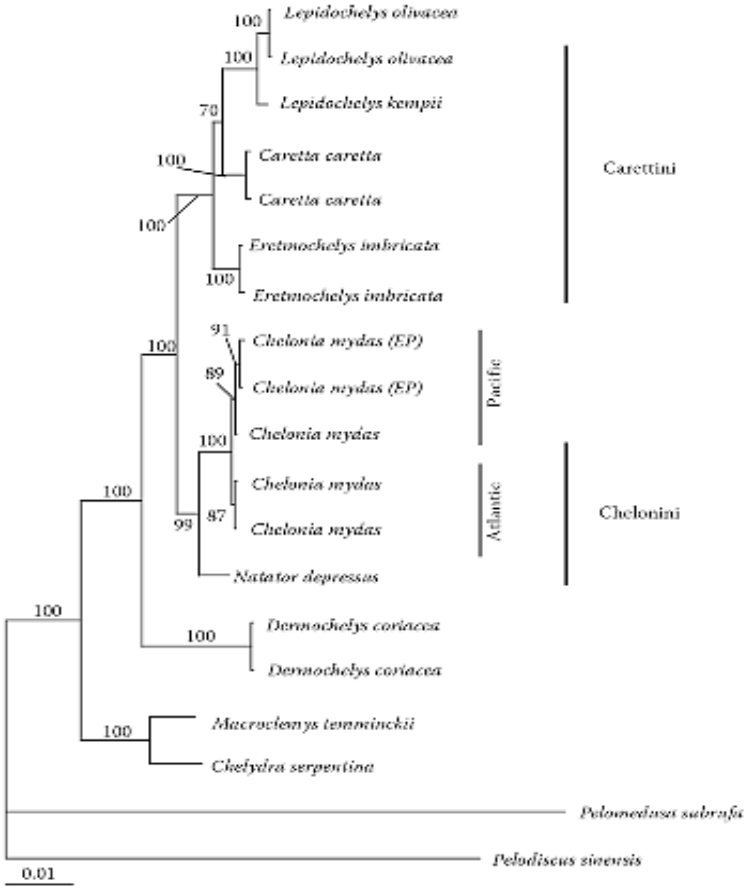

Figure 4. Phylogeny of sea turtles based on algorithms of molecular phylogenetics, maximum parsimony (MP) and Bayesian analyses sequences.

Sea Turtle Phylogeny. The phylogeny of sea turtles is shown in Figure 4. The sea turtles of superfamily Chelonioidae contains two families namely, the Cheloniidae and Demochelyidae. This superfamily forms a monophyletic group to Kinosternoidea (freshwater mud turtles) and Chelydridae (snapping turtles) as supported by the 14 nuclear- gene sequence data. Bowen et al. (1993) was able to distinguish the species with the oldest lineage relative to other marine

turtles and was observed to have the basal position, the *Dermochelys coricea*. Approximately 63 million years ago, family Chelonioidea was then split into two subfamilies, the Chelonini (*Chelonia mydas* and *Natator depressus*) and Carettini (*Lepidochelys olivacea, Lepidochelys kempi, Caretta caretta,* and *Eretmochelys imbricata*). The recent sequence data containing 7340 base pairs from the mtDNA genes 12S, 16S and four nuclear genes has revealed that *Natator depressus* is grouped with the lineages of *Chelonia mydas*. The divergence among species of flatback and green turtles was estimated to be 34 million years ago. Meanwhile, the lineages of hawksbill turtle and combined loggerhead and ridley has diverged 29 million years ago. Therefore, as the advent of sea turtle molecular genetics has progressed, new whole mitogenome analyses have placed *N. depressus* as a sister taxon to *Chelonia*. The divergence time was also estimated between two *C. mydas* lineages, Pacific and Atlantic, which happened 3.09 million years ago.

Phylogeography and Natal Homing. Several studies have stated the occurrence of strong natal homing in sea turtles. A significant genetic differentiation was found in green turtles between two rookeries located 225 km apart in Northwestern Australia. In Taiwan, genetic differentiation was also found between two islands of Taiwan, approximately 250 km apart (Rieser, 2012).

Phylogeography and Population History. A substantial variation was found in the estimated divergence times among the haplotypes within species. These kind of divergences are due to genetic bottlenecks within ocean basins and bottlenecks that happen in a global scale. Interestingly, populations of green turtles, together with the hawksbill turtles, follow high levels of genetic diversity and phylogeographic structure. This was observed in a number of basins which include the Indo-Pacific, Atlantic, and Mediterranean basins. Higher levels of genetic diversity would indicate greater chances for the species to survive in the long run (Rieser, 2012).

Colonization History and Long-Distance Dispersal. According to Wyneken et al. (2013), there were major geographic shifts that happened in the rookeries of these marine turtles. This has been the turtle's mechanism in response to climate change. Examples would include the green turtles which were found on beaches not existing until the past 8000 years. This would mean that it took 200-250 generations of turtle time to colonize a specific rookery. To adapt to the changing climate, sea levels, and oceanic current patterns for over 110 million years ago, marine turtles tend to undergo series of regional colonization and extinction events. Another feature in the evolution of sea turtles would be the occasional long-distance dispersal. Moreover, green sea turtles show evidence to this long-distance dispersal that has happened in the past.

Dethmers et al. (2006) proved the existence of a green turtle haplotype in Micronesia that was also found in the Australian rookeries as well as the Pacific and Indian Oceans.

CONSERVATION STATUS

Figure 5. Green Sea Turtle Soup sold in the market. Photo lifted from Bucket List Travel Club.

Throughout the years, the green turtle *(Chelonia mydas)* has been the most heavily exploited marine turtle species. And this led to classifying green sea turtle as endangered. Tracing the history of its conservation status, it is essential to note that in 1968, the International union for Conservation of Nature (IUCN) Red List has classified green turtle as globally threatened. But under the US law, endangered green turtles are only those that belong to the two population nesting on the Pacific Coast of Mexico and East Coast of Florida. Those remaining populations were only considered as threatened. The classification of *Chelonia mydas* still remains elusive for scientists are still debating on whether green turtle should still be classified as globally endangered. Some turtle scientists would debunk the idea of commercial exploitation of green turtle until its marine ecosystem is restored. Nevertheless, the upbringing of prohibitory policy on the exploitation of green turtle was necessary to prevent its extinction (Rieser, 2012).

Major Threats in the Population. Aside from the fact that green sea turtles are slaughtered for their skin, meat, eggs and shells, the population face a destruction of its habitat caused mainly by humans. There were also cases of accidental capture that cause stress to the green sea turtle. Even on the nesting sites, climate change effects are evident for it alters the

temperature of the sand which is involved in the sex determination of green sea turtles (Spotila, 2004).

Certain conservation actions were done so as to increase the sea turtle nesting rate and population. Under a number of treaties and laws, the green turtles receive a legislative protection. This law is highly relevant to the countries designated with Endangered by the World Conservation Union, Annex II of the SPAW Protocol to the Cartagena Convention or the protocol for protected areas and wildlife, Appendix I of CITES (Convention on International Trade in Endangered Species of Wilf Fauna and Flora, and Appendices I and II of the Convention on Migratory Species. Memorandums such as the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia and Memorandum of Agreement on the Turtle Islands Heritage Protected Area (TIHPA) benefit the green turtles (Seminoff, 2004).

Consequently, the passing of these memorandums and designations pose intentional impacts to uplift the population. Through the nesting beach conservation efforts, coupled with the initiatives of the communities, slowed down the poaching of eggs and adults. However, despite all the conservation efforts, the human impacts still remain all throughout the globe. Up until now, substantial direct and indirect mortality was detected in fisheries and pelagic areas near nesting areas. Uncontrolled development in coastal and marine habitats pose major threats in the green turtle population. Because of such, the call for effective monitoring is prominently sound (Spotila, 2004).

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