

Geoemyda japonica Fan 1931 – Ryukyu Black-Breasted Leaf Turtle, Okinawa Black-Breasted Leaf Turtle

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SUMMARY. – *Geoemyda japonica* (Family Geoemydidae), the Ryukyu black-breasted leaf turtle, is a rather small turtle endemic to three islands (Okinawajima, Kumejima, and Tokashikijima) of the Okinawa Group, Ryukyu Archipelago, Japan, and is found only in and around primary or dense secondary forests. It is threatened by deforestation within its natural habitat. The turtle has been designated as one of the National Natural Monuments of Japan; and trading and captive maintenance are strictly regulated by law, but no concrete measures for conservation have yet been carried out. There is an urgent necessity to secure and preserve the habitat. Proposed conservation measures include research on life history and population status, about which only limited information is currently available.

DISTRIBUTION. – Japan. Restricted to Okinawajima, Kumejima, and Tokashikijima islands, Okinawa Group, central Ryukyu Archipelago.

SYNONYMY. – *Geoemyda spengleri japonica* Fan 1931; *Geoemyda japonica*.

SUBSPECIES. – None. *Geoemyda amamiensis* Takahashi, Kato, and Ota 2007 from the Late Pleistocene of Tokunoshima Island, Ryukyu Archipelago, is a closely related taxon.

STATUS. – IUCN 2007 Red List: Endangered (EN A1ce,B1+2c) (assessed 2000); CITES: Not Listed.

Taxonomy. – Okada (1891) first recorded the Ryukyu black-breasted leaf turtle, as *Emys spengleri*, from Okinawajima Island, Japan. Stejneger (1907) stated that Japanese specimens could be distinguished from specimens from China (= *Geoemyda spengleri* sensu stricto) by the presence of a pair of prominent axillary scutes and a different plastral formula. Based on Stejneger's accounts, Fan (1931)

recognized two subspecies of *G. spengleri* – *G. spengleri sinensis* from the continent, and *G. s. japonica* from Japan and other Pacific islands. However, he did not refer to a nominate form, and the range he listed for the latter form was actually incorrect. Pope (1935) modified Fan's (1931) accounts and defined two subspecies – *G. s. spengleri* from the continent, and *G. s. japonica* from the Ryukyus. Over



Figure 1. Adult male *Geoemyda japonica* from Okinawajima, Ryukyu Archipelago, Japan. Photo by Yuichirou Yasukawa.



Figure 2. Adult female *Geoemyda japonica* from Okinawajima, Ryukyu Archipelago, Japan. Photo by Yuichirou Yasukawa.

half a century later, Yasukawa et al. (1992) made detailed morphological comparisons between the two forms, and demonstrated that, besides the axillary scute condition and plastral formula, there are numerous additional characters that show considerable differences between them. Based on these results, Yasukawa et al. (1992) redescribed the Ryukyu black-breasted leaf turtle as a separate species, *G. japonica*.

Yasukawa et al. (1992) also demonstrated that this species shares many features exclusively with *G. spengleri*, and assumed that these species form a monophyletic group, a view supported by the result of recent molecular phylogenetic analysis (Spinks et al. 2004). On the other hand, Yasukawa et al. (1992) argued against Moll et al. (1986), who had assigned *Heosemys silvatica* to the genus *Geoemyda*. Later, however, Yasukawa et al. (2001), on the basis of cladistic analysis of morphological data, demonstrated the sister-group relationship of this species with the clade consisting of *G. spengleri* and *G. japonica* and redefined the genus *Geoemyda* ac-

ordingly (i.e., as consisting of three species, including *silvatica*). Präsachag et al. (2006), however, separated *silvatica* from *Geoemyda* and placed it in a new monotypic genus, *Vijayachelys*, on the basis of a molecular phylogenetic analysis.

Recently Takahashi et al. (2007) described a Late Pleistocene fossil species, *Geoemyda amamiensis*, from Tokunoshima, an island ca. 120 km northeast of Okinawajima Island. This species is most closely related to *G. japonica*, but distinguished from it by the presence of a short anterior projection of the entoplastron. For *G. japonica*, no analyses have yet been attempted regarding geographic variation, and no subspecies are recognized.

Description. — A rather small species of the family Geoemydidae, 65.0–155.7 mm carapace length (CL) in adults; approximately 35.5 mm CL in hatchlings. The carapace is elongate, slightly domed, with three well-marked longitudinal keels, and strong serrations along the posterior marginals. There is a distinct pair of axillary scutes. Most individuals also have a pair of small inguinal scutes. The plastron is large, elongate, rigid (except for some hind lobe mobility in mature females), and is notched anteriorly and posteriorly. The plastral formula is Pect >> Ab >> An > Fem >> Hum >> Gul in most animals. The entoplastron is posterior to the gular-humeral seam and intersected by the humero-pectoral seam.

The head is moderate in size; its dorsal surface is smooth, and lacks small scales. The upper jaw is unnotched with a medial hook, and the triturating surfaces of the upper and lower jaws are narrow without any ridges and cusps. The anterior surfaces of the forelimbs are covered with enlarged and imbricate scales, the tips of which are roundish or slightly pointed. Slightly smaller scales of similar shape cover the heels of the hindlimbs.

The skull of this turtle is relatively flattened and elongate. The two maxillae are in contact with each other anteriorly, below the premaxillae, forming a hooked beak. The



Figure 3. Adult male *Geoemyda japonica* from Okinawajima, Ryukyu Archipelago, Japan. Photo by Yuichirou Yasukawa.

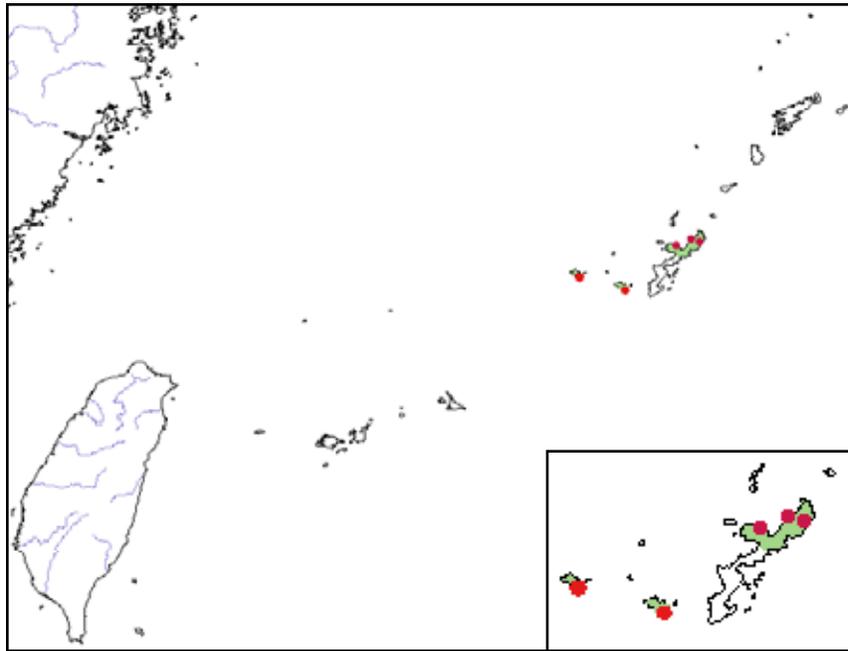


Figure 4. Distribution of *Geoemyda japonica* in the Central Ryukyu Islands, Japan (enlarged in inset box). Red points = museum and literature occurrence records based on Iverson (1992) plus more recent and authors' data; green shading = projected distribution based on GIS-defined hydrologic unit compartments (HUCs) constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al., unpubl. data), and adjusted based on authors' data.

cranial cavity is much narrowed anteroventrally, and the anterior end of the processus inferior parietalis is separated from the palatine and jugal by the pterygoid. The jugal and quadratojugal are in contact with each other, to form a weak temporal arch. The secondary palate is not well developed, and the upper and the lower triturating surfaces are narrow, ridgeless, and without serration. Processus trochlearis oticum, p. pterygoideus externus, and p. coronoideus are prominent.

Ground color of the carapace is variable but normally brownish. The soft tissue under the scutes is whitish and unpatterned. On the carapace scutes, dark lines or wedges extend along the longitudinal keels, and dark radiating or irregular spots are partially expressed in most individuals. The plastron is black or dark brown, with a light yellow or ivory margin laterally. The ground color of head and neck varies from orange-yellow to yellowish or reddish brown, with irregular reddish or yellowish lines or spots. The coloration of the limbs and tail is similar to that of the head, with a few light lines or spots. The iris is yellowish or reddish brown to reddish gold in both sexes.

The carapace length does not differ significantly between males and females. The male has a lower shell, a shorter and slightly concave plastron, and shorter bridges when compared with the female. The tail of the male is long and thick with the vent located far beyond the carapacial rim when the tail is extended; whereas, the female's tail is shorter and thinner, with the vent located on or only slightly beyond the rim. Sexually dimorphic plastral kinesis is present; the adult female has a fibrous connection be-

tween the hypoplastron and the carapace, whereas the male has a sutural connection.

The karyotype is $2n = 52$ (Nakamura 1949).

Distribution. — The Ryukyu black-breasted leaf turtle is restricted to Okinawajima, Kumejima, and Tokashikijima islands of the Okinawa Group, central Ryukyu Archipelago, Japan. The record from Ishigakijima Island of the southern Ryukyus (Stejneger 1907) was in error (Toyama 1985). Recently a few individuals belonging to this species have also been found on Iejima and Gerumajima islands of the Okinawa Group (T. Otani, pers. comm.; Ota and Yasukawa, pers. obs.). However, they seem to represent recent artificial introductions, considering the long absence of records of this prominent turtle from these islands.

On Okinawajima Island, the turtle is presently found only in and around primary and well-developed secondary forests of the northern part (Toyama 1985). However, upper Pleistocene fossils and Holocene skeletal remains have been found at a few sites in the southern part of the island (Oshiro 1987; Ota 2003). Furthermore, fossils are recorded also from Iejima Island (Hasegawa 1980), where the turtle does not occur naturally at present (see above). Thus, it seems that in the past this turtle was more widely distributed than it is now.

Habitat and Ecology. — Very little information is known on the life history of the Ryukyu black-breasted leaf turtle. This turtle is terrestrial but seems to prefer humid environments, and is found chiefly on the floor of primary and well-developed secondary forests, especially close to mountain streams (Nakamura and Uéno 1963; Takara 1969, 1979; Matsui 1991; Toyama and Ota 1996; Toyama

1998; Ota 2000, unpubl. data). Marby (1956) reported that captive individuals ate all types of worms, insects, and dead fish, but none of the fruit and plants offered. By contrast, Nakamura and Uéno (1963) stated that this species is herbivorous. It is now known to feed on both small invertebrates, such as arthropods, earthworms, and terrestrial molluscs, and some fruits as well (Takara 1969, 1979; Matsui 1991; Terada 2003; Ota, unpubl. data).

Takara (1979) listed the Ryukyu wild boar (*Sus scrofa riukiuanus*) and the colubrid snake (*Diniodon semicarinatus*) as predators of this turtle (the latter only for hatchlings). It is probable that feral dogs and cats, and introduced mongooses (*Herpestes javanicus*) also prey on this turtle occasionally (Ota 2000).

This species uses small caves, cracks, and crevices in large rocks, and spaces under rocks and fallen trees as shelters and sites for hibernation. Some individuals are reported to have stayed in and around the same shelters for no less than seven months (Otani 2003, pers. comm.).

Takara (1969, 1979) reported that this turtle lays 4–6 eggs, approximately 45 mm in length, in sandy slopes along mountain streams from June to August, without providing detailed data. No other information is available regarding the reproduction of this species in its natural habitat.

Yasukawa et al. (1992) reported that the smallest male (CL = 65 mm) they examined already clearly showed male sexual features, such as a long, thick tail, and a slightly concave plastron.

Population Status. — No detailed studies have been carried out on the population status of the Ryukyu black-breasted leaf turtle. However, judging from the rapid reduction of areas covered with primary and dense secondary forests on Okinawajima Island, it is highly probable that the population on this island is declining. On Kumejima Island, there are very limited areas of habitat in the northern and southern parts. Each of these surely encompasses a small population of this turtle (Ota, unpubl. data), but due to the presence of a broad, highly cultivated area between these habitats, it is likely that the two populations are completely reproductively isolated from each other. No information is available regarding the status of this species on Tokashikijima Island.

Threats to Survival. — The greatest factor responsible for the reduction of population size of the Ryukyu black-breasted leaf turtle seems to be habitat reduction caused by land development. The turtle populations on Kumejima and Tokashikijima islands could especially easily become extinct as a result of land development, since the habitats have already been much restricted and the population size seems already to be very small (Matsui 1991; Toyama and Ota 1996; Toyama 1998; Ota 2000).

Chigira (1989) surveyed small vertebrates, including the Ryukyu black-breasted leaf turtle, trapped in steep-sided gutters along mountain roads in the northern part of Okinawajima Island, and reported that the number of individuals of *G. japonica* trapped per year ($n = 41$) was greater than those of any other reptiles. He also

stated that the turtle, once trapped, seemed to be unable to escape from the gutter by itself, and that such steep-sided gutters along roads running through forests could make effective barriers to obstruct the natural movement of the turtle. On mountain roads, this species is also subject to a certain level of highway mortality (Ota, pers. obs.).

Also, results of recent field surveys indicate that this species is very rare, sometimes completely absent, from agricultural farms where insecticides and herbicides had been heavily used (T. Otani, pers. comm.). This suggests that *G. japonica* is vulnerable to the effect of these chemicals as well as the deforestation.

It is also assumed that illegal collection of *G. japonica* for the pet trade (or for private pet keeping), as well as the deployment of insecticides over its habitat to control pine beetles, both cause stress to populations of this turtle (Matsui 1991; Toyama and Ota 1996; Ota 2000).

Two other geoemydid turtles, *Cuora flavomarginata* and *Mauremys mutica*, recently artificially introduced to Okinawajima Island, seem to be establishing feral populations there (Ota 1999; also see accounts for these species). Because the preferred habitats and foods of these species supposedly more or less overlap with those of *G. japonica*, these invasive species may also become serious threats to the Okinawajima population of this turtle in near future.

Conservation Measures Taken. — The Ryukyu black-breasted leaf turtle was first designated as one of the Local Natural Monuments by Okinawa Prefecture in 1973, and then redesignated as one of the National Natural Monuments designated by the Japanese Government in 1975. Handling of the species, including purchase, sale, and captive maintenance, are strictly regulated by law (Takara 1979). This measure may have reduced collection of the turtle, but it is highly probable that some illegal collection still occurs. Because the turtle is sometimes found in the urban areas of the southern part of Okinawajima Island where it did not originally occur, it appears that such animals have been transported from their natural habitats (Toyama 1985; Toyama and Ota 1996).

The Japan Ministry of Environment and the Japan Fisheries Agency list *G. japonica* (as *G. spengleri japonica*) as a vulnerable species (Matsui 1991; Toyama 1998; Ota 2000). No other effective plans for the conservation of the species have yet been formulated.

The IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (1989) rated the species (as *G. spengleri japonica*) as Action Plan Rating 3, implying some need for conservation action. We conclude that it is more appropriately rated Action Plan Rating 2, a restricted species in need of status investigation. The IUCN Red Lists (Baillie and Groombridge 1996; Hilton-Taylor 2000; IUCN 2007) have listed the species as Endangered.

Conservation Measures Proposed. — The most urgent and essential measure for the conservation of the Ryukyu black-breasted leaf turtle is to secure and preserve

the natural forests and mountain streams which are its primary remaining habitats.

To construct effective procedures for conservation, detailed research on its life history, especially on the habitat use and reproductive ecology of this species, are strongly recommended. For this purpose, mark-recapture and radio-telemetry studies would be effective. The size and density of the population should be estimated for each of the three islands where the turtle occurs.

Captive Husbandry. — Takara (1969) stated that the Ryukyu black-breasted leaf turtle readily habituates to captive environments, and husbandry is very simple. Presumably the species could also be bred in captivity without difficulty.

Otani (1989) reported two cases of captive breeding of this turtle at Zoo Okinawa. In one case, a single egg (46.1 x 29.2 mm, 15.8 g) was laid on 7 April, and hatched on 31 July of the same year, the hatchling measured 35.5 x 33.2 x 17.2 mm in length x width x height, and weighed 8.8 g. Another egg (46.3 x 23.2 mm, 16.1 g) was laid on 1 May, and hatched on 14 July. The hatchling of the latter measured 35.6 x 28.1 x 17.0 mm, and weighed 8.9 g. These single-egg clutches call in question the much larger clutch size reported by Takara (4–6 eggs; see above). Toyama (1995) also reported a case of captive oviposition in which only a single egg was laid.

Current Research. — Long-term monitoring projects on Tokashikijima and Okinawajima populations of this turtle, planned by the Japan Environment Agency, have been initiated and have the support of the local people.

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