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Cycloderma frenatum Peters 1854 – Zambezi Flapshell Turtle, Nkhasi

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Summary. – The Zambezi Flapshell Turtle, *Cycloderma frenatum* (Family Trionychidae), is a fairly large softshell (carapace length up to about 56 cm) from southeastern Africa. It is found in rivers and lakes from southern Tanzania south to the Save River in Mozambique, extending west to Lake Malawi (Nyasa), where it is common in the shallower areas at the southern end of the lake. These are fast swimming, completely aquatic turtles of about 37–50 cm shell length, which are mostly caught as bycatch in large nets by local fishermen. In areas with human settlements, the nests are excavated during the breeding season (December–March) and the 15–25 eggs per clutch are consumed.

Distribution. – Malawi, Mozambique, Tanzania, Zimbabwe. East Africa from the Rufiji River basin in Tanzania south to the Save River basin in Mozambique and southeastern Zimbabwe, inland to Lakes Malawi, Chiuta, and Chilwa.

Synonymy. – *Cycloderma frenatum* Peters 1854, *Cyclanosteus frenatus, Heptathyra frenata*, *Aspidochelys livingstonii* Gray 1860, *Heptathyra livingstonii*.

Subspecies. – None.

Status. – IUCN 2011 Red List: Near Threatened (NT, assessed 1996, needs updating); CITES: Not Listed; South African Red Data Book: Not Listed.

Taxonomy. — Although *Cycloderma frenatum* was briefly described from material from the Zambezi River in Mozambique by Wilhelm Peters in 1854, his comprehensive description and illustrations of the species did not appear until 1882 in the *Reise nach Mossambique* series. In the meantime, J.E. Gray (1860) described *Aspidochelys livingstonii* from "tributaries of the Zambezi River, Mozambique", distinguished by the nature of the plastral callosities, but he subsequently realized that these developed with age and subsequently synonymized *A. livingstonii* with *C. frenatum* (Gray 1870).

Cycloderma frenatum is readily distinguished from its only recent congener, *C. aubryi*, by its olive-gray coloration, in contrast to the dark reddish brown of the latter. It also

Figure 1. Juvenile *Cycloderma frenatum* from Lake Malawi. Photo by Wulf Haacke.

Figure 2. Juvenile *Cycloderma frenatum* from Lake Malawi. Photo by Wulf Haacke.

differs in its reduced plastral callosities, the entoplastral one being very small and the hyo-hypoplastral callosities being separated from the xiphiplastal callosities or barely touching them. It differs from the two extinct species, *C. victoriae* and *C. debroinae*, in its very reduced entoplastral callosity and the distal border of the first costal being much longer than that of the second costal (Meylan et al. 1990).

Description. — The proboscis is projecting, the distance from its tip to the orbit equal to the orbital diameter (in young), or longer (in adults). Nostrils have papilla-like processes projecting upwards from their inframedian corner. The upper lips meet anteriorly to form a flat arch laterally, sharply angled in vertical aspect. The head and neck can be shot forward with high velocity to almost the length of the carapace. The forefeet have four or five sharp-edged crescentic skin folds on their upper surface, and another weal-like thickening on their outer aspect; whereas the hind feet have sharp-edged crescentic folds under the heel posterior to the base of the fifth toe. The tail is rudimentary, slightly projecting beyond the posterior leathery rim of the carapace in males, but not in females.

Figure 3. Adult *Cycloderma frenatum* from the Rovuma River, on the border between Tanzania and Mozambique. Photo by Stephen Spawls.

The carapace of the young has a moderate vertebral keel and numerous wavy longitudinal ridges, whereas the adult carapace is smooth in live specimens. The leathery margin is not extensive posteriorly, barely extending beyond tail. When dried, the adult carapace displays the underlying bony sculpturing. The plastron of hatchlings is smooth, without callosities (in the young these first appear as small pairs on the epiplastra, hyo-hypoplastra, and xiphiplastra, while the last to develop is the azygous element on the entoplastron). The femoral and caudal flaps of the plastron permit the concealment of hind limbs and tail.

The osteology is comprehensively described by Loveridge and Williams (1957). There are seven plastral callosities, sculptured like the carapace, and very well developed in adults. Epiplastral callosities have large oblique ovals, in contact medially. The entoplastron bears a small, crescentic to semilunar callosity, smallest of any and the last to develop. Hyo-hypoplastral callosities cover most of the surfaces of the bones and spread beyond their borders, separated medially. Hyo-hypoplastral callosities are separated from the xiphiplastral callosities, or are in contact by only a short suture. Xiphiplastral callosities have large oblique ovals, which are in contact medially (Loveridge and Williams 1957).

Loveridge and Williams (1957) noted that Peters described his Zambezi type material as dark green in color, whereas 21 juveniles and 11 adults from Lake Malawi and the Rovuma River included pale gray to leaden hatchlings and pale to dark olive adults. Specimens from southeastern Zimbabwe are olive brown, so there does not seem to be a latitudinal trend in coloration. The carapace of Lake Malawi hatchlings ranges from pale green to leaden, the periphery usually edged with white. The plastron of Lake Malawi hatchlings is often almost white, usually with an irregular black blotch present in the umbilical region, an elongate, oblique blotch near each forelimb, a more rounded one anterior to each hind limb, and a smaller sixth spot in the anal region. The adult carapace is

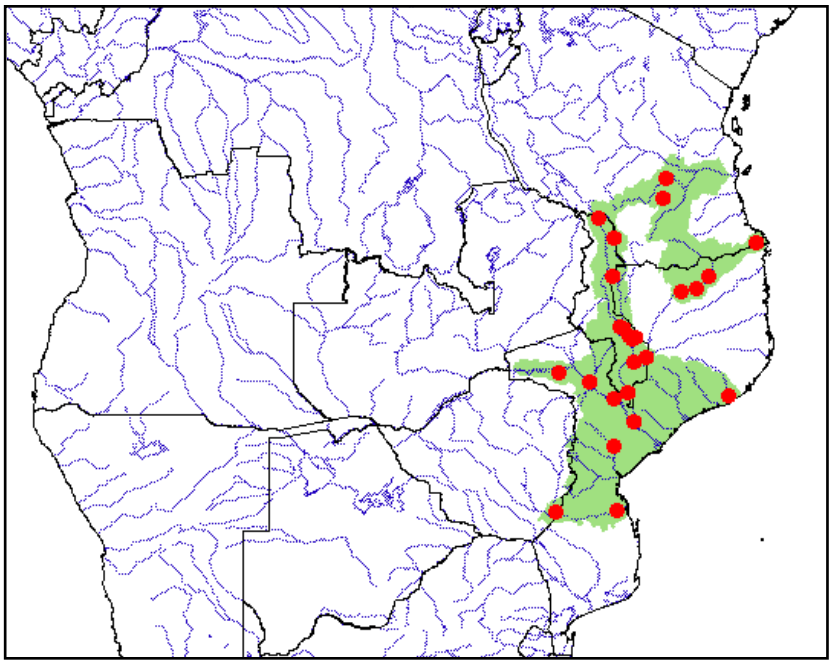

Figure 4. Distribution of *Cycloderma frenatum* in Malawi, Mozambique, Tanzania, and Zimbabwe in southeastern Africa. Red dots = museum and literature occurrence records of native populations based on Iverson (1992) and Gramentz (2008) plus more recent and authors' data; green shading = projected distribution 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. 2009), and adjusted based on authors' data.

pale to dark olive, uniform, or with a trace of blotching. The plastron of adult females is china-white to flesh-pink, almost obscured by pearly gray reticulations. These reticulations are sometimes absent in what may be males.

The head and neck in Lake Malawi hatchlings are gray with a dark, light-edged, interorbital crossbar, and five similar, but wavy and sometimes broken, longitudinal lines from near the occiput to the base of the long neck. The throat and underside of the neck are pure white, uniform, or showing some dusky streaks. The head and neck of adults are very dark olive, the dark longitudinal lines of the young turtle obscured or, more usually, absent. Peters (1882), writing of Zambezi turtles, stated that the head and neck in both age groups displayed numerous white dots. The feet are gray above and lighter below.

The curvilinear carapace length (CL) of a Zambezi male was 560 mm, the bony disk alone was 470 mm, its width 420 mm (Peters 1882), whose figures do not quite tally, for he gives the total length as 970 mm, though head and neck together were only 340 mm and the tail 65 mm. Overall linear CL of three Malawi females averaged about 560 mm, width 418 mm. The head and neck of one (MCZ 50357) measured 420 mm; the breadth of the head 100 mm. The bony disk length of the largest gravid Rovuma female (MCZ 48030) was 390 mm, its width (also without leathery margin, 310 mm (Loveridge 1942, 1953). Overall CL of 31 Lake Malawi hatchlings was 40–48 mm, their width 30–36 mm. Peters (1882) mentioned a Zambezi hatchling of 45 mm. The mass of the largest Zambezi male was 13–14 kg (Peters 1882); that of the largest Rovuma female was 11.4 kg (Loveridge 1942).

The sex of adults, though not of young, may be distinguished by the fact that the tail of the male is visible in ventral view (Peters 1882, pl. I), while that of the female is concealed beneath the caudal flap (Peters 1882, pl. IIIa, Fig. 1). Peters claimed that the carapace is relatively narrower in males than in females (the relative proportions noted to be 1:1.33 and 1:1.25) and that the bridge between the carapace and plastron is longer in males than in females. When relaxed in the water, the tail tip of the male is a bit longer than the rim of the carapace and is carried bent upwards.

Distribution. — The center of the range for *Cycloderma frenatum* seems to be Lake Malawi (Mitchell 1959) in Malawi, Mozambique, and Tanzania. It extends down the Shire River into the Zambezi, but its upstream distribution in this river appears to be limited by the Cahora Bassa rapids. Athough Pitman (1934) listed this species as "believed to occur" in Northern Rhodesia (= Zambia), the remains that he observed in the Luangwa valley "which indicate that there are specimens which may attain 2 feet in length and a weight of 20 to 30 lbs" may have been another turtle species, possibly large specimens of *Pelusios sinuatus*. If *Cycloderma* occurred in the Middle Zambezi system, it would surely have been caught by fishermen and reported. Gramentz (2008) maps an alleged record of *C. frenatum* from southeastern Zambia, citing the species as occurring at Chowe, but this locality is on Lake Malombe in southern Malawi (Loveridge 1953).

The species extends south across the Mozambique Plain to the Save River and enters southeastern Zimbabwe in the Gonarezhou National Park (Broadley 1962, 1984). In the Save River, its upstream limit is the Chivirira Falls;

however, in the Runde River it has reached beyond the Chitove Falls and occurs up to the Chiviriga Falls (Broadley 1990). To the north of the Zambezi and east of the Shire River and Lake Malawi, *C. frenatum* has been reported from Lakes Chilwa and Chiuta in Malawi (Mitchell 1959), via the Lugenda River (draining Lake Chiuta) in the Niassa Game Reserve (Branch 2003), to the lower Rovuma River at Kitaya in Tanzania (Loveridge 1942). It also occurs in the the Kilombero River (a tributary of the Rufiji River) in central Tanzania (Loveridge 1942).

Fossil material of this species has been recorded from the Pleistocene Omo beds to the north of Lake Turkana (Arambourg 1947; Lapparent de Broin 1979) and from the Pliocene beds of Lothagam Hill and Koobi Fora in the Lake Turkana basin (Meylan et al. 1990). Additional fossils are known from the Pliocene Chiwondo beds towards the northern end of Lake Malawi (Meylan et al. 1990).

Habitat and Ecology. — *Cycloderma frenatum* seems to prefer sandy rather than muddy substrates (Mitchell 1959). Sachsse (pers. obs.) regards this species as a highly specialized fish-catcher, feeding on mussels only when fish are not available. The mechanism of catching fish is essentially the same as in *Chitra,* but the snapping speed is not quite as fast. Juvenile turtles lay completely concealed in the sand with only the eyes protruding, and shoot out of this position for a fish. When adult animals see prey, they approach very slowly and snap as soon as the length of the neck will allow it. The large hyoid bones support the abrupt sucking mechanism. In southern Lake Malawi, adult turtles feed to a large extent on mussels (*Caelatura nyassensis, Mutela alata*, and *M. simpsoni*) and large aquatic snails (*Lanistes ellipticus* and *L. sordidus*) (Loveridge 1953; Mitchell 1959). Such feeding habits might be age dependent. Kenmuir (1980) found that, in Lake Kariba, mussels were abundant at depths of 3–9 m, but occurred down to 11 m. Mussels probably occur at similar depths in the lakes and rivers inhabited by *Cycloderma*, so turtles are probably not common where the water is more than 10 m deep. Mussels are dug out from the substrate of rivers and lakes, using the powerful claws on the forefeet. The shells are crushed in the jaws and swallowed, but undamaged valves are sometimes defecated by newly caught specimens (Mitchell 1946). No data are available on growth or longevity for wild specimens.

In Lake Malawi, adult turtles may travel several kilometers from shore and, on days of dead calm, up to half a dozen can usually be seen floating on the surface basking in the sun (Mitchell 1959). These turtles have been found moving overland during daylight in the Gorongosa National Park in Mozambique (K. Tinley, pers. comm.) and in southeastern Zimbabwe (C. Stockil, pers. comm.)

In Lake Malawi, female turtles come ashore at night to lay their eggs between the end of January and April. The nest site is in the shade under trees and bushes, usually within 200 m of the water. A clutch of 17–25 eggs is laid in a shallow excavated nest hole. The eggs are hard-shelled, spherical, and 33–35 mm in diameter. The incubation period is 8–11 months and hatchlings emerge the following January. The hatching period lasts for only about three weeks, although nesting occurs over a 10-week period. Hatchlings are plentiful in January and may be found under loose stones and logs along the high-water mark (Mitchell 1959). On the Rovuma River, a female with a bony disk length of 390 mm contained 17 eggs of 32 mm diameter on 27 April, the following day another female held 19 eggs of 31 mm diameter (Loveridge 1942).

Leeches are present on turtles from the Rovuma River and Lake Malawi (Loveridge 1942, 1953). Adults are consumed by crocodiles, whereas the young are likely taken by the Nile Monitor (*Varanus niloticus*) and various predatory birds (Mitchell 1959).

Population Status. — This species seems to be common in the southern shallow half of Lake Malawi, but is rare in the deep waters of the northern half of the lake (Mitchell 1959). No declines have yet been reported anywhere in its range.

Threats to Survival. — There appears to have been reasonably common domestic capture and consumption of the species by local tribes in the past. In 1949, Loveridge saw scores of eggshells on village middens around Mtimbuka, southern Lake Malawi. When they came ashore to construct nests, female turtles were easy prey for local people (Loveridge 1953). Taylor (1962) noted that *Cycloderma* were eaten by the Shangaan tribe in southeastern Zimbabwe and adjacent Mozambique. Broadley (pers. obs.) recovered carapaces from Shangaan village middens near the Save-Runde confluence before the establishment of the Gonarezhou National Park. *Cycloderma* were netted by the Shangaans in their annual fish drives (Broadley 1962). Whether this domestic consumptiuon is still prevalent at present is unknown. There is apparently no commercial exploitation or international trade of this species at this time.

Conservation Measures Taken. — Some populations are protected in the Lake Malawi, Gorongosa, and Zinave National Parks and Niassa Game Reserve in Mozambique, as well as Gonarezhou National Park in Zimbabwe. The species is listed as Near Threatened on the IUCN Red List, having been assessed in 1996.

Conservation Measures Proposed. — Native populations need to be monitored for population size and survival status. Monitoring for potential development of international trade should be carried out opportunistically. The global status of the species on the IUCN Red List needs to be reassessed.

Although this species occurs in several National Parks, consideration might be given to introducing the species into the Middle Zambezi system, where suitable habitats are available in two large artificial impoundments, lakes Kariba and Cahora Bassa (Broadley 1990). Lake Kariba is at approximately the same level as Lake Malawi (ca. 550 m ASL), whereas Lake Cahora Bassa is lower, at ca. 400 m ASL, so climatic conditions are similar. If the Wild Life authorities in Zimbabwe or Mozambique were in favor of a

trial introduction of *Cycloderma* into either of these lakes, one of the numerous crocodile farms on both lakes could incubate the eggs and headstart the hatchlings. If such an introduction were to be considered, then ecological monitoring of potential impacts on fish and invertebrate fauna would need to be carried out.

Captive Husbandry. — Young flapshell turtles can be kept completely aquatic, as they grow they should have an island of cork bark. The water should be maintained at 24–32ºC (max. range 19–34ºC), with a tenth to half a promille of sea salt, partly filled with floating plants, for which strong illumination (natural or artificial) is necessary. The bottom of the tank should be covered by a layer of fine sand about 1.5 times the diameter of the animals. They should be fed a variety of whole fish, dead laboratory mice, and pieces of gelatin food prepared for aquatic chelonians. Mitchell found that captive hatchlings from Lake Malawi eagerly took fine strips of fish or meat from his fingers (Loveridge and Williams 1957). In captivity, they grow a bit faster than other softshell turtles, from the hatchling stage to CL = 35 cm in 20–30 years. They are very susceptible to microbial infections of uncertain origin, to which they quickly succumb. For several months, two turtles lived in a small garden pond at Salima, Malawi. Normally, they did not rise to the surface between 1600 and 0830 hrs. During the daytime, however, they spent long periods with the tips of their snouts protruding from the water. They would only try to escape during rainy weather, or when the water in the pond was changed, prompting nocturnal emergence (Mitchell 1946). When they grow large one must be carefully observe pugnacious incompatibilities.

Current Research. — None known.

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