CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group

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Mauremys caspica (Gmelin 1774) – Caspian Turtle, Caspian Terrapin, West Asian Stripe-necked Terrapin

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Mauremys caspica (Gmelin 1774) – Caspian Turtle, Caspian Terrapin, West Asian Stripe-necked Terrapin

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Summary. – The Caspian Turtle, *Mauremys caspica* (family Geoemydidae), is a small freshwater turtle species widespread and plentiful throughout the Middle East. Although fully aquatic, it is often found in extremely arid habitats, where high concentrations may exist in small streams. It is rarely used for food, but due to landscape alteration, pollution and intensification of water management, *M. caspica* is increasingly threatened. The maximum straight-line carapace length (SCL) has been recorded as 25.0 cm for both sexes; however, females are usually larger on average, but males in some populations attain the same size as females.

Distribution. – Armenia, Azerbaijan, Bahrain, Georgia, Iran, Iraq, Russia (Dagestan), Saudi Arabia, Syria, Turkey, Turkmenistan.

Synonymy. – *Testudo caspica* Gmelin 1774*, Emys caspica, Clemmys caspica, Clemmys (Clemmys) caspica, Terrapene caspica, Clemmys caspica caspica, Mauremys caspica, Mauremys caspica caspica, Testudo ecaudata* Daudin 1801 *(nomen novum* and senior homonym*), Emys caspia* Rüppell *in* Gray 1830 *(nomen novum), Testudo caspia, Clemmys caspia, Clemmys caspia caspia, Emys grayi* Günther 1869 *(*junior homonym*), Emmenia grayi, Mauremys caspica siebenrocki* Wischuf *in* Maran 1996 *(nomen nudum), Mauremys caspica schiras* Wischuf *in* Maran 1996 *(nomen nudum), Mauremys caspica ventrimaculata* Wischuf and Fritz 1996*, Mauremys caspica siebenrocki* Wischuf and Fritz *in* Fritz and Wischuf 1997.

Subspecies. – None currently recognized. Two clusters of mitochondrial haplotypes (eastern and western portions of the range) and four microsatellite clusters have been delineated, defining four Management Units for conservation.

Status. – IUCN 2024 Red List: Global: Least Concern [Not Listed] (LC, assessed 1996); Regional: Europe: Vulnerable (VU A2ac+3c, assessed 2004); TFTSG Provisional Red List: Least Concern (LC, assessed 2011); CITES: Not Listed.

Taxonomy. — The Caspian Turtle was first described as *Testudo caspica* by Gmelin (1774), based upon specimens from "Bach Pusahat" near "Schamachie," in the Transcaucasus (= Pirsagat, Shemakha, Azerbaijan; see TTWG 2017). It was later allocated to the aquatic turtle genus *Clemmys* by Wagler (1830). However, McDowell (1964) determined that Old World turtles and New World turtles included within the broad genus *Clemmys* were distinctly different and resurrected the name *Mauremys* (Gray 1869) as the appropriate name for Old World forms. As a result, the three western Palearctic taxa, then considered conspecific, were assigned to *Mauremys*, i.e., *Mauremys c. caspica, M. c. leprosa,* and *M. c. rivulata.*

Fritz and Freytag (1993) and Fritz and Wischuf (1997) found limited evidence of hybridization between *M. c. caspica* and *M. c. rivulata* in parapatric areas in Turkey and the Middle East. In the face of lacking evidence of the broad-scale intergradation expected for subspecies, Fritz and Wischuf (1997) elevated the two taxa to species status, and this has been followed by essentially all later authors (e.g., Keller and Busack 2001; Wischuf and Fritz 2001; Feldman and Parham 2004; Fritz and Havaš 2007; TTWG 2007, 2017, 2021; Mantziou and Rifai 2014; Vamberger et al. 2013, 2017; Speybroeck et al. 2020). Additional supportive genetic evidence for the specific status of these two taxa was provided by Vamberger et al. (2017), who found that they only rarely hybridize along their contact zone in Turkey.

Several subspecies of *M. caspica* were proposed in an unpublished thesis by Wischuf (1995) and the manu-

Figure 1. Subadult Caspian Turtle, *Mauremys caspica*, from the foothills of Karabudakhkentsky district, vicinity of the village of Gurbuki, Dagestan, Russia. Photo by Liudmila F. Mazanaeva.

script names later published as *nomina nuda* in the popular literature by Maran (1996). Wischuf and Fritz (1996) and Fritz and Wischuf (1997) formally described two of these purported subspecies (*ventrimaculata* and *siebenrocki*), but each has subsequently been synonymized with *caspica* (Fritz et al. 2008; Vamberger et al. 2013).

Vamberger et al. (2013) confirmed the previous finding by Fritz et al. (2008) that *M. caspica* has a weak phylogeographic structure at the mitochondrial level, with one haplotype cluster in the western portion of its range and another in the east. Additional information from 14 polymorphic microsatellite loci, combined with denser sampling, however, suggested a more complicated pattern with four distinct population clusters. Using computer runs uncorrected for null alleles through the program STRUCTURE (see Pritchard et al. 2000; Porras-Hurtado et al. 2013), Vamberger et al. (2013) found Caspian Turtles from Central Anatolia, Turkey,

Figure 2. Adult female *Mauremys caspica* from Bahrain.
Photos by Anders G.J. Rhodin at the Breeding Centre for Endangered Arabian Wildlife, Sharjah, United Arab Emirates.

Figure 3. Adult *Mauremys caspica* from Maharloo Lake basin, Shiraz, Fars, Iran. Photo by Asghar Mobaraki.

Figure 4. Adult *Mauremys caspica* from Bahrain. Photo by Johannes Els.

to be distinct from all other conspecifics and to demonstrate only weak indications of genetic admixture (see Fig. 10, cluster A); Caspian Turtles from Eastern Turkey and Syria were also found to form a genetic cluster (Fig. 10, cluster B), as did those from Dagestan, Azerbaijan, and Iran (Fig. 10, cluster C), and those from Bahrain and Saudi Arabia (Fig. 10, cluster D). An 8,000 to 20,000 year-old genetic bottleneck was suggested between clusters A, B, and C, but a more recent bottleneck (4,000 years ago) was inferred for D. The inclusion of samples from Iraq might reveal further genetic diversity (Vamberger et al. 2013). Considering the current aggravation of environmental threats across the range

Figure 5. Hatchling *Mauremys caspica* from the Lake Maharloo basin, Iran. Photo by Mario Herz.

of *M. caspica* (Bayazit and Avci 1997; Beaumont 1998; Harmancioğlu et al. 2001; Garstecki and Amr 2011; Hashemi et al. 2012), Vamberger et al. (2013) suggested that all four microsatellite clusters should be treated as distinct Management Units, pending further sampling in southern and central Iran and in Iraq.

In addition, results from Vamberger et al. (2017) revealed limited gene flow between *M. caspica* and *M. rivulata*. In Turkey, in regions having a predominantly continental climate, a few populations of *M. caspica* have been introgressed by *rivulata* alleles (western Anatolia, Euphrates region), while coastal populations generally represent *M. rivulata*. A few populations along the south coast of Turkey and in the Levant are introgressed by *M. caspica*. In a comparison of 13 microsatellite loci between one *M. rivulata* and one *M. caspica* population from Turkey, Ilhan et al. (2021) found a differentiation level with a high F_{ST} value (0.39) between the two species. Jazayeri et al. (2020), based on cytochrome *b* gene analyses, considered 12 individuals representing *M. caspica* from Chaharmahal va Bakhtiari province, Iran, to represent an Evolutionarily Significant Unit.

Description. — *Mauremys caspica* always has characteristic wide stripes on the forelegs when compared with *M. rivulata*, and each plastral scute has a yellow-edged large dark spot and the bridge is always

Figure 6. Hatchling and young juvenile *Mauremys caspica* of unknown origin in captivity. Photos by Mario Herz.

Figure 7. Adult male and female *Mauremys caspica* from Dukan Lake, northeastern Iraq. Photo by Markus Auer.

yellow. Ocelli on the plastral submarginal surfaces of the marginal scutes along the bridge are arranged differently between the two species and serve as a diagnostic trait for differentiating the species. The submarginal scutes of *M. caspica* have two complete small ocelli or dots in the bridge region, while in *M. rivulata* the ocelli are shifted, so that each submarginal bears two half ocelli.

The following general description of *M. caspica* is based upon data provided by Boulenger (1889), Schreiber (1912), Nikolsky (1913), Mertens (1946), Busack and Ernst (1980), Fritz and Wischuf (1997), Ernst et al. (2000), Wischuf and Fritz (2001), Kuzmin (2002), and Herz (2007). A detailed description, based upon a large series of Iranian specimens, was also provided by Pritchard (1966).

The carapace is strongly depressed and has a vertebral keel. Lateral keels are more or less distinct in juveniles but disappear in subadults, although a trace of the vertebral keel usually remains, even in old specimens. The posterior margin of the carapace is not serrated and the vertebral scutes, which are almost as wide as the costals, are wider than they are long. The nuchal scute is of moderate size. The carapace is olive or olive-brown to brown above, with yellowish or whitish-gray streaks forming more or less regular "figure eights" on each costal scute. There is an ocellus on each submarginal. These markings, most distinct in the young, tend to disappear with age. The lower surface of the marginals is

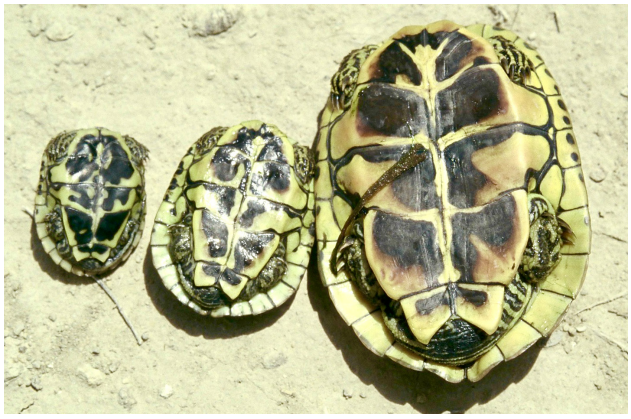

Figure 8. Juveniles and male *Mauremys caspica* from Maharloo Lake basin, Iran, showing plastral color variation. Photo by Mario Herz.

solid yellow with black sutures, and with two oval ocelli or dark spots on each marginal 3 to 7.

The plastron is wide and angularly notched posteriorly and truncated anteriorly. In the female, the plastron is flattened or convex, in the male it is slightly concave. The width of the bridge is a little shorter than the length of both femoral and anal scutes combined. The longest median suture is the interabdominal, with the interfemoral at most only slightly shorter. The axillary and inguinal scutes are well developed, with inguinals being larger. The plastral formula for males is fem > abd >> pect >> gul > hum > an; for females the plastral formula is abd > fem> pect >> gul >> hum > an.

The plastron is yellow, with each scute bearing a dark blotch. Northern *M. caspica* tend to have larger dark spots than southern ones. The dark spots in northern Caspian Turtles are often square and surrounded only by a thin yellow border, while in southern specimens the dark spots are round and the yellow border is very wide. In the endorheic Kor River and Lake Maharloo basins, Iran, another plastral pattern with several irregular spots on the same scute may occur. Aged northern turtles may have uniformly dark-colored plastra. The bridge is always yellow, with narrow dark lines following the sutures.

The head size is moderate, without the megacephaly seen in some other *Mauremys* species. It is generally olive in color; a yellow stripe is present on the margin of the snout and beneath the eye. There are no ocelli on the head. Two or three yellow stripes occur on each side of the snout, four on each temple, but none above the eye. The iris color is often dark blackish-brown, with light gray or whitish markings. The upper jaw is not hooked but has a median notch, and the width of the mandible at the symphysis is less than the horizontal diameter of the orbit. The margins of the jaws in the subadult and adult are slightly serrated.

The neck has numerous yellow, finely black-edged streaks, three of which are broad and extend to the occiput. Soft parts are streaked and handsomely marbled

with dark olive on a yellow ground color. Young turtles are beautifully marked.

Five claws are present on the forelimbs, four on the hindlimbs. All digits have thick webbing which terminates in irregularly serrated edges and extends to the claws. Tail length is 60-65% of the carapace length in the young, 50% in adult males, and 33-40% in adult females. The tail is significantly thicker in males.

Mauremys caspica is a relatively small freshwater turtle species with carapace lengths of up to about 25 cm, with females usually larger than males, but males sometimes the same size as females. Yadollahvandmiandoab et al. (2018) reported that males and females of *M. caspica* in eastern Iran do not differ significantly in maximum straight-line carapace length (SCL); however, mean SCL of males was 14.76 cm (n = 62) and for females was 15.81 cm (n = 56). Furthermore, males and females differed significantly in mass, with females being heavier on average (mean 645 g) than males (mean 462 g), and males with longer and thicker tails.

Fritz and Wischuf (1997), in a sample of 246 *M. caspica*, reported maximum SCL of males and females as identical at 24 cm (n = 117) and 24 cm (n = 129), respectively; however, calculations based on the graphs in their Figure 9 demonstrates that females are on average larger than males, with means of 12.64 cm SCL for the males and 15.57 cm SCL for the females (A.G.J. Rhodin, pers. comm.). Yazarloo et al. (2017) reported maximum and mean SCL of males and females in eastern Iran as 23.02 cm (mean = 15.67, n = 67) and 23.68 cm (mean = 14.70, n = 63), respectively.

Males examined by Busack and Ernst (1980) had the following dimensions (in cm): SCL mean = 11.50 cm (n = 56), carapace width (CW) mean = 7.84 (n = 56), carapace height (CH) mean = 3.83 (n = 56), marginal width (MW) mean = 1.31 (n = 56), bridge width (BW) mean = 3.32 (n = 56), plastron length (PL) mean = 9.94 (n = 56), and head width (HW) mean = 1.68 (n = 39).

Females examined by Busack and Ernst (1980), had the following dimensions (in cm): SCL mean = 15.48 cm (n = 44), CW mean = 10.52 (n = 44), CH mean = 5.99 (n = 44), MW mean = 1.16 (n = 44), BW mean = 5.24 (n = 44), PL mean = 14.46 (n = 44), and HW mean = 2.15 (n = 28).

Distribution. — *Mauremys caspica* is distributed in a series of partially disjunct populations from central and southeastern Turkey to northeastern Syria, eastern Iraq, eastern Saudi Arabia, Bahrain, Iran, southern Turkmenistan, and southern Russia [Dagestan] (TTWG 2017, 2021, in press; Aidek et al. 2024). Pritchard (1966) gave the distribution of *M. caspica* as "Western Persia [Iran], extending north into Armenia and Dagestan, south at least to Shiraz, and in northeast Arabia at least to Bahrain; eastwards through Iraq into eastern Turkey, where it is replaced by *M. rivulata*." Eiselt and Spitzenberger (1967) depicted details of the range in Turkey, and Fritz and Freytag (1993) provided the first record for *M. caspica* from the internally-drained endorheic basin of central Anatolia; futher records from this central Turkish population were provided by Taskavak et al. (1998) and Akman et al. (2020). The Caspian Turtle is widespread in southern Dagestan, Caucasus, Russia, along the western coast of the Caspian Sea and the adjacent foothills at altitudes between ca. 28 and 500 m. The northern extent of the species' range approaches the city of Makhachkala, Dagestan, Russia (Mazanaeva and Gichikhanova 2020).

Habitat and Ecology. — Steiner (1977) noted that half- and full-grown *M. caspica* preferred cold and fast-flowing streams in Asiatic Turkey. Old individuals, often heavily coated with algae, were most frequently found in muddy and stagnant pools of warm water. In Iran, the species inhabits running streams, ponds, and lakes in considerable numbers and may be seen basking together on riverbanks or on floating objects. Often found in cultivated areas, the greatest concentration found by Anderson (1979) was in a highly eutrophic stream. Bardeh et al. (2021) reported that climate and land cover/land use variables play an important role in habitat selection.

In southern Iraq, the species is present in East Hammar tidal mesohaline marsh (Majeed et al. 2023). Nikolsky (1913) reported specimens from the mouths of Russian rivers emptying into the Caspian Sea where salinity is low. He also cited a specimen found in a sulphur spring at 40°N latitude, which had been reported by Ménétriès (1832) (see Kuzmin 2002). In the northern Caucasus (Dagestan, Russia), *M. caspica* prefers deep water bodies with steep shores (Bannikov 1951; Kuzmin 2002), while in Azerbaijan, the species mainly inhabits stagnant and lentic waters such as lakes, swamps, irrigation channels, slow rivers, etc. (Alekperov 1978; Kuzmin 2002). Atayev (1985) reported that the species occupies not only rivers and lakes in Turkmenistan, but also mountain streams and springs with pebble bottoms. Herz (2007) noted that *M. caspica* occupies freshwater streams, canals, and ditches adjacent to and feeding the seasonal hypersaline Lake Maharloo in the highlands of Iran, but does not occur in the lake itself.

In Dagestan, *M. caspica* occurs in ponds, lagoon lakes, irrigation canals, foothill rivers, brackish water bodies in coastal areas of the Caspian Sea, and in the mouths of rivers flowing into it. In spring, the species clusters in temporary vernal pools. In dry foothills, the species occurs in river valleys in ditches and ponds. In arid foothills, concentrations of turtles are often found in anthropogenic eutrophic ponds (Mazanaeva and Gichikhanova 2020; Gichikhanova and Kakhrimanov 2021).

In Turkey, *M. caspica* occurs in a wide variety of habitats from fast flowing lotic streams to ponds and drain-

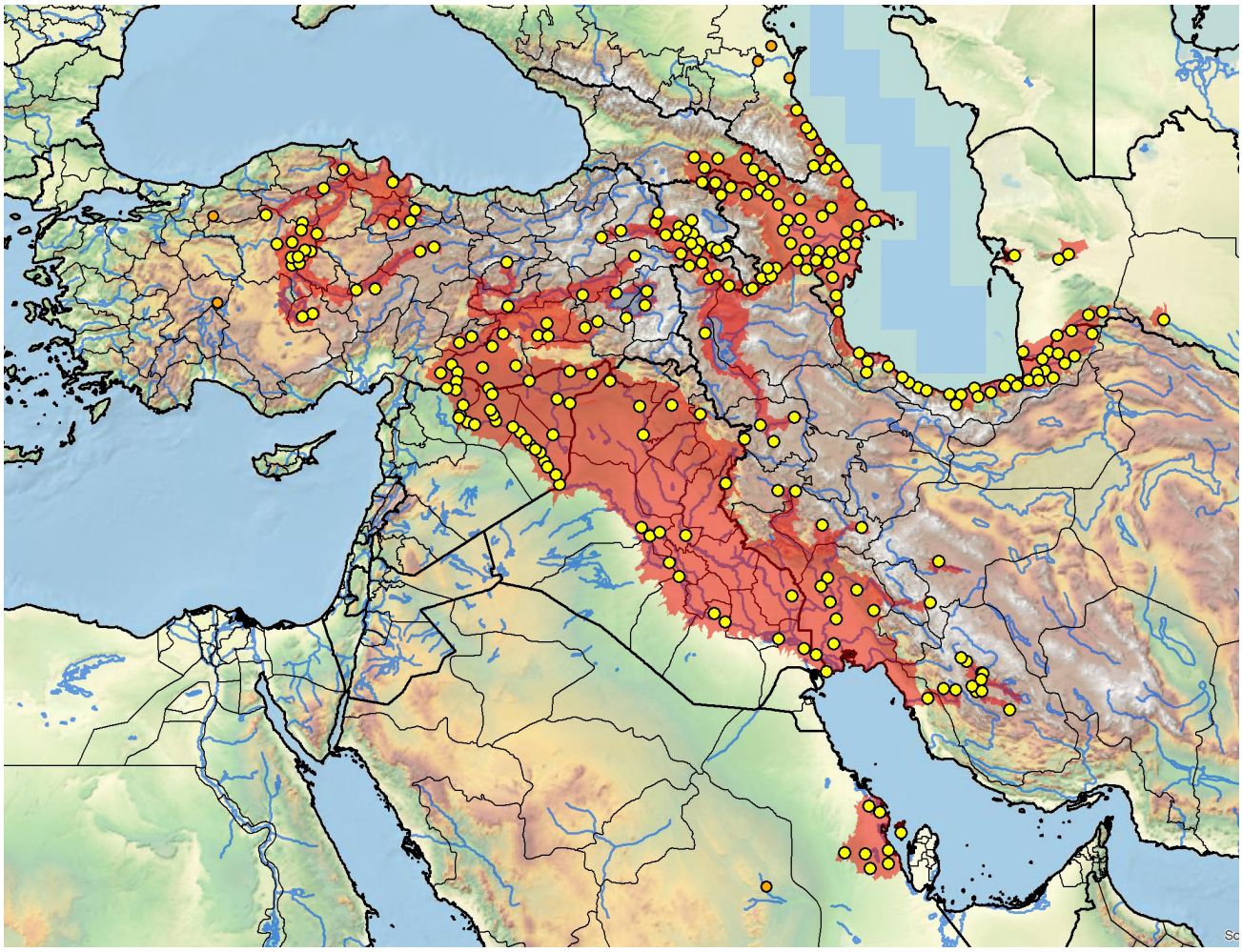

Figure 9. Distribution of *Mauremys caspica* in Turkey and the Middle East. Yellow dots = museum and literature occurrence records of native populations based on Iverson (1992), other more recent literature records (see TTWG 2017, 2021, in press), and authors' additional data); orange dots = possibly introduced or translocated specimens. Distribution based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments) 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 based on Buhlmann et al. (2009), TTWG (2017, 2021), and data from authors and other sources.

age ditches. During field studies in southeastern Anatolia, Turkey, turtles were regularly caught in the Euphrates and Tigris rivers and their branches, irrigation canals, temporary puddles and small ponds. They can inhabit very polluted streams (e.g., Nusaybin, Mardin, Turkey) where hospital wastes and city sewage are mixed (Ayaz and Mazanaeva 2005). Plant species dominant in *M. caspica* habitats are: *Populus nigra*, *Poa perennis*, *Salix alba*, *Alnus orientalis*, *Ficus carica*, *Phragmites communis*, *Ulmus minor*, *Mentha spicata,* and *Rubus caesius* (Ayaz and Mazanaeva 2005). In Saudi Arabia, *M. caspica* occurs in the Al Hasa region in oases having massive palm groves, e.g., Al Qatif, Al Hufhuf, and Al Uqayr (Gasperetti et al. 1993; Aloufi et al. 2019).

Diet. — The main part of the diet of *M. caspica* consists of plants (83–100%), with small fish fry contributing 12–66% (Kuzmin 2002). In steppe habitats, the species often eats orthopterans (Kuzmin 2002). Juvenile *M. caspica* are more carnivorous than the generally omnivorous adults. Nikolsky (1913) listed small frogs, worms, and ripe melons among items in the diet. In Dagestan, Russia, it feeds on a variety of animal foods (tadpoles, frogs, crustaceans, freshwater fish fry, freshwater insects, aquatic insect larvae, millipedes, earthworms, and detritus) as well as plant foods (algae, horsetails, sedges, reeds, wormwood, saltwort, legumes, knotweed, berries of mulberry and blackberry, and fruits of dogwood and hawthorn) (Mazanaeva and Gichikhanova 2020). Yousif (2016) reported turtles from Iraq feeding on plants, fishes, crabs, shrimp and bread, while some of the examined stomachs of *M. caspica* contained plastic refuse. *Mauremys caspica* in polluted waters may become a detritivore.

Activity. — Mertens (1960) reported that *M. caspica* is a good swimmer and Davenport et al. (1984) provided an analysis of its swimming action and performance using turtles from Saudi Arabia. On the other hand, Reed (1957) reported on the apparent loss of the ability to swim in a population from Iraq, but Gasith and Sidis

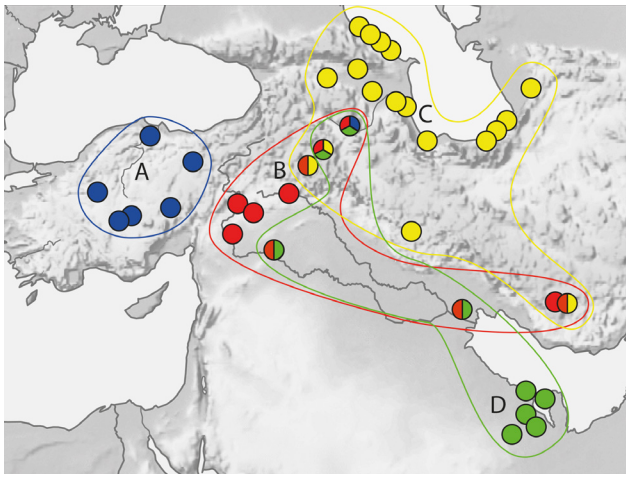

Figure 10. Map of the genetic population structuring of *Mauremys caspica* as determined based on microsatellite loci, modified after Vamberger et al. (2013, Fig. 2). Dots represent populations sampled; populations with mixed ancestries are indicated by sections of differing colors. The color coding of the sampling locations corresponds to the four genetically distinct populations that define the proposed Management Units (A-D).

(1982) suggested for *M. rivulata* from Israel that the inability to swim may have been due to lung abnormalities and that this could also be true for *M. caspica*. While carefully noting that this would not explain non-swimming behavior of an entire population, Gasith and Sidis (1982) reported that both lungs of one non-swimming individual, and one lung of another, were found to be filled with hardened material similar to connective tissue. However, Reed and Marx (1983) dissected a preserved specimen from Iraq and showed that its lungs were completely healthy.

In the northern part of its range, *M. caspica* hibernates in winter at the bottom of water bodies, digging into the mud in October and November (depending on weather) at an air temperature of ca. 6–8°C (Kuzmin 2002; Mazanaeva and Gichikhanova 2020), and emerges from hibernation in early March (in Dagestan) at an air temperature of 15–17°C and water temperature of 9–11°C (Mazanaeva and Gichikhanova 2020). In warmer areas of Georgia, *M. caspica* is sometimes active even in February (Muskhelishvili 1970; Kuzmin 2002) and under much warmer conditions in Turkmenistan, hibernation is very short, sometimes in warm winters and springs the species does not hibernate at all (Atayev 1985; Kuzmin 2002).

Predation. — Nikolsky (1913) cited reports that the Egyptian Vulture (*Neophron percnopterus*) preys on the species. Anderson (1979) reported that in Iran many Caspian Turtles are killed each year by humans, who obtain their eggs to use in treating various eye ailments. In addition, storks and vultures depredate both juveniles and adults.

Parasites. — Haemogregarine hemoparasites (Apicomplexa, Haemogregarinidae, *Haemogregarina stepanowi*) are known from *M. caspica,* extending throughout the western Palearctic as far eastward as Iran (Krasilnikov 1965; Dvořáková et al. 2014; Javanbakht and Sharifi 2014; Rakhshandehroo et al. 2016).

Al-Barwari and Saeed (2007) reported finding *Serpinema microcephalus* (Camallanidae) in small intestines of *M. caspica* at infection rates of 31.8% for males and 34.8% for females, along with mean intensity rates of 67.9% for males and 63.8% for females in 45 road-killed terrapins (22 males and 23 females) in Iraq (Hareer [Erbil Governorate] and Sar-Jinar [Salah ad Din Gouvernorate]. Also included within these collections were *Telorchis stunkardi* (Telorchiidae) at small intestine infection rates of 18.2% for males and 21.7% for females (mean intensities of 41.8% for males and 32.0% for females) from Alton-Kopri (Kirkuk Governorate) and Rabia (Nineveh Governorate).

Shubber et al. (2020) found *Serpinema microcephalus* in 2 males and 8 females (mean intensity 4.3%), *Telorchis assula* in 3 males and 5 females (mean intensity 7.8%), *Falcaustra araxiana* (Kathlaniidae) in 7 males and 9 females (mean intensity 15.8%), and *Contracaecum* sp. (Anisakidae) in 1 female, for a total infection rate of 78.6% from 22 of 28 (11 males and 17 females) road-killed *M. caspica* from Al-Diwaniya Province, Iraq.

Yousesfi et al. (2013) reported *Telorchis assula* from one unsexed specimen in a sample of 43 turtles from Mazandaran province, Iran. In a later, more complete, analysis of trematode and nematode infection also from Mazandaran province, Youssefi et al. (2014) reported on a sample of 34 road-killed *M. caspica* in which 17 (50%) were parasitized. In this sample, 14 males and 20 females were inspected for trematode or nematode infection. Overall infection rate was 14.7% for males and 35.2% for females. Youssefi et al. (2016) reported on three nematodes in the Caspian Turtle in Iran: *Serpinema microcephalum* (Camallanidae), known already from Hoseini et al. (2015), *Falcaustra armenica* (Kathlaniidae), *Oxyuridae* sp., and one digenean *Telorchis* sp. (Telorchiidae). An adult trematode (*Telorchis* sp.) was found in the small intestine of 1 male (reported prevalence for male *Telorchis* sp., 2.9% in this sample). Adult representatives of the nematode *Serpinema microcephalus* were found in the small intestines of 3 (21.4%) males and 8 (40%) females; larval *Falcaustra armenica* were found in the ileum, caecum, and colon of 3 (21.4%) males and 4 (20%) females, and unidentified representatives of the family Oxyuridae (Class Chromadorea, Order Rhabditida) were found in the large intestine of one female turtle (2.9%).

Rakhshandehroo et al. (2020) recovered specimens of roundworms, *Falcaustra* and *Spiroxys,* from the large intestine and stomach of Caspian Turtles from Iran. In addition, the ectoparasite *Placobdela costata* was record-

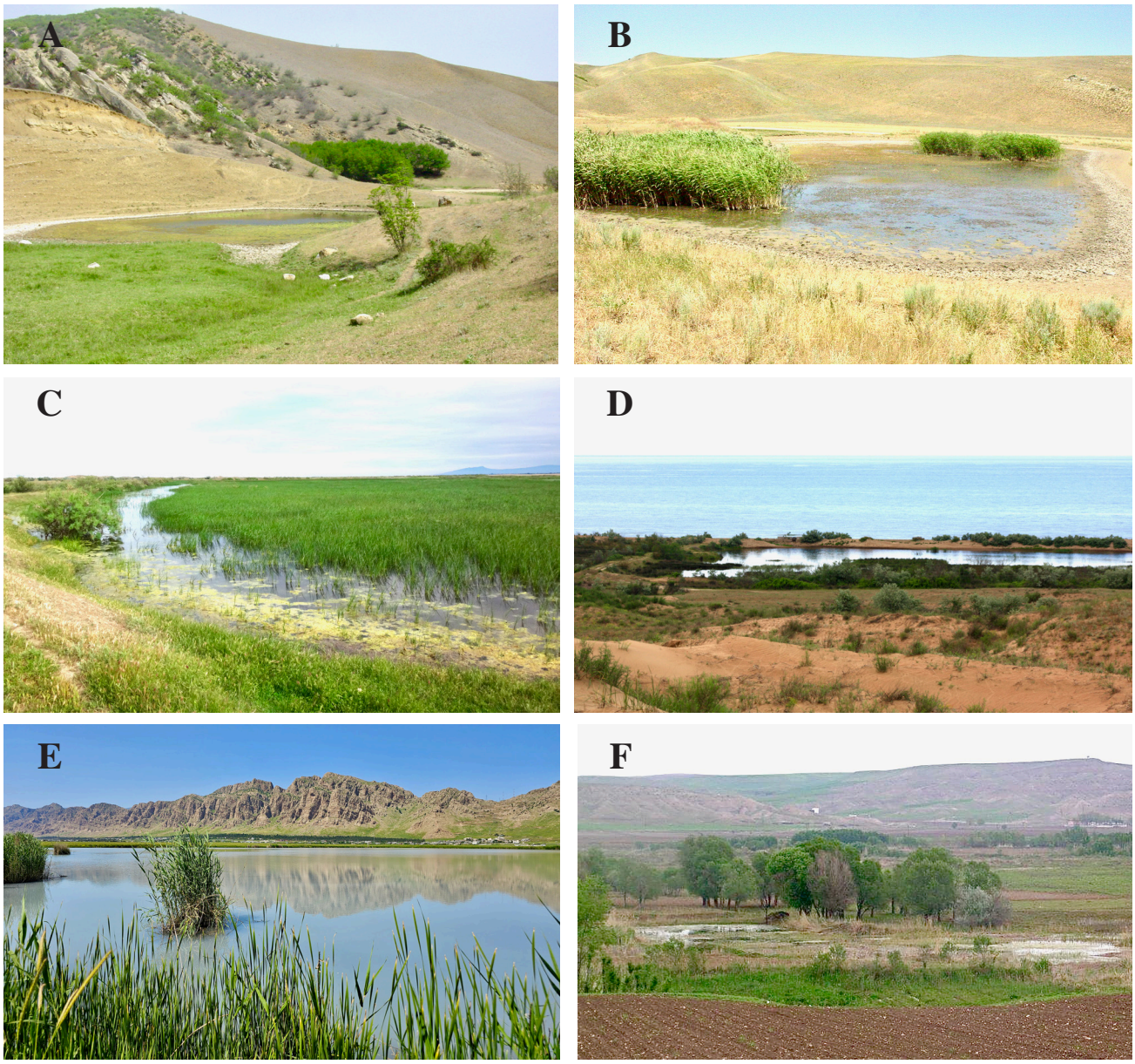

Figure 11. Representative habitats of *Mauremys caspica*. **A–B.** Foothills of Karabudakhkentsky district, vicinity of the village of Gurbuki, Dagestan, Russia. Photos by Liudmila F. Mazanaeva. **C–D.** Western coast of the Caspian Sea in Kayakentsky district in the vicinity of Lake Papas, Adzhi, Dagestan, Russia. Photos by Liudmila F. Mazanaeva. **E.** Dukan Lake, eastern Iraq. Photo by Markus Auer. **F.** Bismil, Diyarbakır, southeastern Turkey. Photo by Dinçer Ayaz.

ed in *M. caspica* from northern Iran (Kami et al. 2012; Bashirichelkasari and Yadollahvandmiandoab 2017).

Serology. — Ayaz et al. (2006) found differences in both total fractions of serum proteins and distribution of globulin fractions between *M. caspica* and *M. rivulata* by using polyacrylamide disc-electrophoresis. *Mauremys caspica* comprised a different high-density fraction with single peak in addition to globulin fractions at the C region. However, *M. rivulata* contained two joined fractions with generally lower density at the C region. The qualitative comparison of electrophoretic pattern of blood-serum proteins verified a significant difference between *M. caspica* and *M. rivulata* and supports their status as distinct species. Romanova et al. (2022) studied the leukocyte blood composition of *M. caspica* and the cohabiting species *Emys orbicularis* from Dagestan (Russia) and identified lymphocytes as the predominant cells in the blood of females and males of both species.

Cytogenetic characteristics of *M. caspica* in Golestan and Mazandaran provinces in the northern part of Iran show that the chromosome number is 2n = 52 and the arm number NF = 78 (Yadollahvand et al. 2013). The karyotype consisted of 9 metacentric, 1 submetacentric, 3 subtelocentric, and 13 telocentric chromosome pairs with an average total length of the chromosomes of 65.27 µm (Yadollahvand et al. 2013).

Age at Maturity and Longevity. — Salehi et al. (2023) studied a population of *M. caspica* in Iran and

reported the age of sexual maturity for both males and females to be 4 years. In a population in Golestan Province in Iran, males could be differentiated from females when reaching a SCL of 8 cm, while females could already be sexed at a SCL of ~5.5 cm (Yazarloo et al. 2017). Fritz and Wischuf (1997), however, showed that both sexes can be differentiated when the turtles have reached a carapace length between 7 to 9 cm. In the majority of studied populations a 1:1 sex ratio was recorded (Kami et al. 2012; Yazarloo et al. 2020).

In a skeletochronological study, Yazarloo et al. (2019) calculated the median age of *M. caspica* in Golestan Province, Iran, to 9.6 years (range, 4–12) for males, and 10.2 years (range, 4–13) for females. Salehi et al. (2023) used the same method for a population from Karoon River Ahvaz region in Iran and calculated the average age for males as 6.5 years (range, 3–11) and for females 6.9 years (range, 2–12). Maximum longevity of *M. caspica* in captivity was reported as 17.6 years in the Animal Ageing and Longevity Database (Tacutu et al. 2013).

Reproduction. — The male annual reproductive cycle of a population from Iraq was divided into three periods by Lofts and Boswell (1961). The following description is based on their study except as otherwise indicated. The period of spermatogenesis, typified by the recrudescence of spermatogenetic activity, begins in April and continues into September. There is much intra-tubular lipid at the initiation of spermatogenesis and this lipid rapidly disappears; seminiferous elements are without sudanophil material by the time the first primary spermatocytes are formed. The new generation of Leydig cells arising in the interstitium has not yet begun its seasonal accumulation of lipid, the epididymides have discharged their spermatozoa, and the epididymal canals remain empty for most of the period. These events are coordinated with increasing day length and rapidly rising temperatures. Peak spermatogenetic activity occurs around the summer solstice and high levels of activity are maintained during July and August while day length is decreasing; the rhythm ceases when temperatures begin falling.

From October to March the testes become morphologically quiescent and show no spermatogenetic activity. Although testis size is reduced to a minimum, this period is one of profound change. Spermatozoa leave the tubules and are stored in the epididymal canals, the Sertoli cytoplasm becomes filled with dense lipoidal material, and the cells themselves enlarge and eventually completely block the tubule lumen. Leydig cells in the interstitium slowly accumulate small lipid droplets and become heavily lipoidal by the end of the period. When spermatozoa leave the seminiferous tubules to be stored in accessory ducts, the interstitial cells show a cycle similar to, but out of phase with, the spermatogenetic cycle (Lofts 1968). Epididymal canals become densely packed with free spermatozoa and enlarge to achieve their maximum size. These processes begin under decreasing day-length and temperature but continue as temperatures rise and day-length increases slowly through March.

The period of actual reproduction and copulation occurs from late March to early May; spermatozoa are discharged from the epididymal canals and, as a result, the epididymal canals become reduced in size. Leydig cells show their maximum secretory condition during this period. Sperm discharge is followed by the spermatogenetic cycle and rehabilitation of the interstitium. These events occur at a time when temperatures are rapidly rising and the photoperiod is increasing.

The spermatogenetic cycle in *M. caspica*, which begins as environmental temperatures rise sharply (April) and ends as temperatures decrease (September), closely parallels environmental temperatures. The interstitial cycle, however, closely parallels photoperiodicity and this suggests that, while temperature may influence spermatogenesis, photoperiod influences testicular secretions.

In females, follicular enlargement occurs throughout March and April, enlargement of the oviducts parallels that of the ovary (February and March), and ovulation (April and May) coincides with the discharge of spermatozoa.

Maximum ovarian size coincides with minimum testicular size; during ovarian quiescence, from May to September, the testes show a recrudescence of spermatogenesis and the seminiferous tubules enlarge. The epididymis stores motile sperm, which presumably are active for up to 6 months before mating and fertilization of ova; for most of this time the ovaries are in a state of regression. A rapid enlargement and maturation of the follicles occurs during February and March, soon followed by fertilization during April and May.

There may be geographic differences in the timing of the onset of reproduction; Nikolsky (1913) reported mating during April in the Transcaucasus, while Anderson (1963) reported copulation during late October in Iran. Studies in the northern Caucasus revealed that the end of mating takes place before mid-May (Bannikov 1951; Kuzmin 2002).

Egg deposition during June was reported at Talysh, Azerbaijan, by Nikolsky (1913), and noted during June by Anderson (1963) in Iran. Kuzmin (2002) reported that three generations of eggs matured in the gonads at different times, with the first clutch deposited in May–June, the second at the end of June, and the third at the end of July.

The whitish, elliptical eggs (Lortet 1887) average 20 x 35 mm (Ewert 1979) and 22 x 36.6 mm (Kuzmin 2002), but Anderson (1963) reported 30 x 40 mm as the size of the brittle-shelled eggs he found in Iran. For Dagestan, Bannikov (1951) reported eggs with measurements of

39–44 mm in length, 20–25 mm in width, and a weight of 9–10 g. Freshly deposited eggs are slightly pinkish and soft-shelled and harden afterwards (Kuzmin 2002).

Moll (1979) reported a clutch size for *M. caspica* of 5–7 eggs (but unclear whether he was referring to *M. c. caspica* sensu stricto or to *M. c. rivulata* or *M. c. leprosa*). Lortet (1887) reported a clutch size of 8–12 (but once again, unclear whether he was referring to *M. c. caspica* sensu stricto or *M. c. rivulata* or *M. c. leprosa*). Bannikov (1951) reported the first clutch in Dagestan to have an average of 10 (range 5–14) eggs, a second clutch with 9 (4–12), and a third with 8 (2–12) eggs, and that clutch size correlates with age and size of the female. Kami et al. (2006) reported that in northeastern Iran mating takes place in May with egg laying in June or July, and that one clutch of 4 or 5 eggs is laid every year on average, with the largest egg measuring 38.7 mm long and 24.1 mm wide.

An incubation period of between 95 and 101 days was reported by Mell (1938), but an earlier, and possibly less accurate, report (Lortet 1887) stated that the young hatch 25 days after oviposition. Bannikov (1951) observed that the incubation in natural conditions took more than 2.5 months in Russia. Hatchlings had a mean carapace length of 32.4 mm (n = 7) with a mean plastral length of 27.9 mm (Ewert 1979).

Krueger and Janzen (2023) reported the presence of temperature-dependent sex determination (TSD) pattern Ia for several species of the genus *Mauremys* (*M. reevesii, M. nigricans, M. japonica, M. sinensis, M. mutica,* and *M. annamensis*), suggesting that this could also be present in *M. caspica*.

Embryonic Development. — Pasteels (1957) described gastrulation, Bannikow et al. (1977) studied ontogenetic changes in the shell, and Zusamann and Iskenderov (1976) investigated sensitivity of early embryos to temperature. The percentage of embryos that can survive 10 days at 18–19°C and 2 hours at 32-34°C increases through cleavage until the onset of gastrulation. After gastrulation, survival ability under these temperature conditions remains stable until the initiation of organogenesis.

Population Status. — Honegger (1981) cited several unpublished sources of *M. caspica* population status information. The species is generally widespread and abundant, but with some evidence of decreasing populations in Turkey. It is very abundant in Iran. In Dagestan, viable populations of the Caspian Turtle with good reproductive potential occur in the low-lying southeastern part of the Caspian Sea coast in the lower reaches of the Rubas, Gul'gerichay, and Samur rivers, as well as in reed thickets along the perimeter of the lagoon lake Ozero Papas in Dagestan, and in irrigation canals. In the arid hilly foothills adjacent to the lowlands, small local population groups occur in the oases (Mazanaeva and Gichikhanova 2020).

Threats to Survival. — As summarized in Vamberger et al. (2013), the species is still common in many parts of its range, while landscape alteration, pollution, and intensification of water management are increasingly threatening the survival of many populations in Turkey (Bayazit and Avci 1997; Harmancioğlu et al. 2001), Syria and Iraq (Beaumont 1998; Garstecki and Amr 2011), and Iran (Kinzelbach 1986; Biricik and Turğa 2011; Hashemi et al. 2012; Yadollahvand and Kami 2014).

Of special conservation concern are the Arabian populations (Anonymous 2003) that are confined to Bahrain, and the oasis complexes of Al Qatif, Al Hufhuf, and Al Uqayr, Saudi Arabia (Gasperetti et al. 1993). In Saudi Arabia, the species faces the additional threat of rapid urbanization of its habitat, unsustainable use of freshwater, and increased desertification associated with climate change. In Saudi Arabia, the number of reproductive sites for *M. caspica* was reduced from 159 in the early 1970s to about 19 in 2009, due to destruction of natural springs and construction of cemented canals, along with agricultural expansion (Aloufi et al. 2019). Genetic evidence by Vamberger et al. (2013) clearly contradicted previous speculations by Gasperetti et al. (1993) that the isolated Arabian populations might have resulted from ancient introductions.

In Dagestan, in the low-lying southeastern part of the coast, turtles die in poaching nets. In the arid hilly foothills, turtles die due to the drying up of oases as a result of the increasing aridization of the climate of the northeastern Caucasus. The number of turtles dying is influenced by the transformation of natural landscapes, pollution and intensive water extraction by the human population in connection with increasing urbanization of the turtle's habitat. Often turtles are killed by people in the mistaken belief that they feed exclusively on fish (Gichikhanova and Kakhrimanov 2021).

Mauremys caspica is one of the most abundant of the aquatic freshwater turtles in Turkey. However, road and dam building activities (e.g., Atatürk and Karakaya dams) will restrict its natural habitats more and more in the near future. *Mauremys caspica* is also threatened by increasing agricultural activities; as a tertiary consumer, the species is undoubtedly under serious negative impact from various biocides used in increasing regularity in agriculture (Ayaz and Mazanaeva 2005). Environmental pollutants such as heavy metals, pesticides, and radioactive wastes have been shown to pose threats (Matson et al. 2005; Adel et al. 2017). Poaching and harvesting of turtles, use of pond turtles as pets, the collecting of turtle eggs (Yadollahvand and Kami 2014, Jazayeri et al. 2020), and introduction of invasive species (Mozaffari et al. 2014) are threatening Caspian Turtles.

Ashrafzadeh et al. (2022) showed in model projections that, due to climate change, between 26–33% of currently suitable habitats will be unsuitable by 2070.

Although recent data are not available, this turtle was previously documented as having been imported into the United States by the U.S. Fish and Wildlife Service. Eighty individuals were imported in 1970 and 31 were imported in 1971 according to a report (Busack 1974) based on a summary of amphibians and reptiles reported at the time. Because aquatic turtles are among the most favored by adults and children desiring to own an exotic pet, it is most likely to continue in today's international pet trade.

Conservation Measures Taken. — *Mauremys caspica* is not currently listed on the IUCN Red List, as it was considered to be Least Concern (LC) when first assessed in 1996 by the IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG) (Behler 1996). A provisional reassessment of the species by the TFTSG in 2011 also categorized it as LC (TTWG 2017, 2021; Rhodin et al. 2018).

The species is included in the third edition of the Red Data Book of the Republic of Dagestan, as a rare species on the northern border of the range (category 3 VU) (Mazanaeva and Gichikhanova 2020).

Although the species is under legal protection in Turkey, the laws have not been effectively implemented for years. However, many lakes where the species live have been granted National Park status, with the results of some studies being reported to authorities (Ayaz and Mazanaeva 2005). *Mauremys caspica* occurs in protected areas in central, southeastern, and eastern regions of Turkey (e.g. Lake Van).

In Dagestan, *M. caspica* is protected in the regional specially protected area, Coastal Natural Complex "Papas" (located in the coastal lowland that includes the large lagoon lakes Ozero Papas and Ozero Adzhi and a system of irrigation canals). It is also protected in the delta of the Samur River in the border areas with Azerbaijan, in the federal specially protected area "Samursky" National Park and the flat cluster coastal section "Delta of the Samur".

Conservation Measures Proposed. — Considering the ongoing deterioration of the environmental situation throughout the range of *M. caspica* (Bayazit and Avci 1997; Beaumont 1998; Harmancioğlu et al. 2001; Garstecki and Amr 2011; Hashemi et al. 2012), Vamberger et al. (2013) suggested that four distinct Management Units should be defined based on the microsatellite results, pending further sampling in southern and central Iran and in Iraq. The four currently recommended Management Units are as follows: 1) central Anatolia, Turkey, 2) eastern Turkey and Syria, 3) Dagestan (Russia), Azerbaijan, and Iran, and 4) Bahrain and Saudi Arabia (Vamberger et al. 2013).

Ongoing monitoring of some populations, especially in protected areas, should be carried out to gauge population trends, and more natural history and life strategy studies would be helpful in terms of improved understanding of the species' ecology and for planning possible future conservation interventions that might eventually be needed. The presence of the species in the international pet trade should also be monitored.

Captive Husbandry. —Mertens (1971) noted that captives readily fed on bananas, and Seelentag and Lehmann (1972) found Supronal emulsion effective against the bacteria that attacks skin and shell. Pawlowski (2015) reported that *M. caspica* in captivity in southwestern Germany lays up to two clutches between June and July with 6 to 11 eggs per clutch; juveniles grow up to 10 cm in one year and the activity period in outdoor enclosures is between April and October. Herz (2023) reported activity of *M. caspica* in outdoor enclosures in Berlin, Germany, between March and October, laying 3 to 10 eggs between June and the beginning of August, and hatchlings measuring 2.97 to 3.30 cm SCL and weighing 5 to 6 g.

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