

THE SPUR-THIGHED TORTOISES

For very many years, it was believed that there were four subspecies of the Spur-thighed, or Greek, tortoise. These were classified as *Testudo graeca graeca*, from North Africa, *Testudo graeca iberica*, from Turkey, Greece, Syria, Iran and Iraq, *Testudo graeca zarudnyi*, an extremely rare and little-known race with a limited distribution in Iran, and *Testudo graeca terrestris*, a form over which much confusion reigned as to description, distribution, and even the very name. To this day, debates over the taxonomy - or classification - of the Spur-thighed tortoise continue unabated. During the past ten years or so, it has become clear that the previously accepted "four-subspecies" concept is woefully inadequate to explain the variations in size, bone structure, color and markings, genetic make-up and even behavior found within the enigmatic "*Testudo graeca*" group. Several new species and subspecies have been proposed in recent years. Unfortunately, this short volume does not permit a detailed discussion of this very difficult and controversial topic. Instead, suffice to say that this author regards *Testudo iberica* as genetically distinct and separate from the North African and Middle Eastern "*Testudo graeca*" complex, which itself comprises a number of very diverse geographical races - many of which are little studied and have not been separately named. Rather than attempt to deal - inadequately - with the issues of nomenclature and genetics raised by this subject, we will instead, for purely practical purposes, discuss these fascinating tortoises with regard to their origins, preferred habitats, and captive care requirements only. For further details on tortoise taxonomy (classification), you are advised to consult the Tortoise Trust's website (<http://www.tortoisetrust.org>) and relevant Carapace Press books and videos.

Moroccan Tortoises

Moroccan *T. graeca* occur in a wide range of size and color morphs, usually linked to locality. Smaller, yellow animals occur in the hot and arid south, while larger, darker specimens may be seen in the mountains, at altitude. Tortoises with reddish colored skin and brownish-red carapaces also occur on the reddish soils of the Atlas mountains. *T. graeca* lives in a wide range of habitats, from coastal sandy dunes, to precipitous rocky slopes. Typical habitat consists of dry scrubby hillsides, with a smattering of succulent vegetation. Tortoises are most active in spring, and especially following episodes of rain. The mean SCL of adult males measured in the Souss Valley was 144.9 mm (5.7"). The mean SCL of adult females was 184.9 mm (7.28"). The mean mass of males was 672 g (21.6 oz.). The mean mass of females was 1426 g (45.8 oz.). The largest male had a SCL of 169 mm (16.65") and weighed 980 grams (31.5 oz.) whilst the largest female measured 206 mm (8.11") and weighed 1840 g (59.2 oz). Several hatchlings and juveniles of various ages were recorded. The hatchlings, which emerge in September, measured 35-39 mm SCL (1.38-1.54") and weighed 11-12 g (0.4 oz.) by mid-December.

Algerian Tortoises

Algeria is home to at least two "varieties" of spur-thighed tortoise; the "true" *Testudo graeca graeca* as described by Linnaeus in 1758, and a very much larger, unique tortoise described by Bennett in 1836 and named after the naturalist Gilbert White as "*Testudo whitei*". Although many people fail to differentiate the two, as the video demonstrates, these are very different from any Moroccan, Tunisian or Libyan *graeca* complex tortoise. While the largest Algerian specimen examined to date exceeded 300 mm SCL (11.8") and weighed 5.4 kg (14.5 lb.) In respect of captive care, however, Algerian tortoises have the same requirements as their Moroccan relatives.

Tunisian Tortoises

Tunisian tortoises belong to the spur-thighed group, but in 1990 they were described as a new species, *Furculachelys nabeulensis*, on the basis of their unique appearance and certain other morphological characteristics. In most texts, they are still referred to as '*Testudo graeca*'. Tunisian tortoises are small - adult males are usually no more than 5 1/4" (130 mm) long, adult females no more than 6 1/2" (165 mm) long. This is much smaller, say, than *Testudo graeca* from Morocco. They are very brightly colored, with a light yellow shell with striking black dots in the center of the scutes. The scales of the legs are pale cream and black, and there is usually a central yellowish mark on top of the head. These are very sensitive little tortoises. They must be kept warm, and they do not tolerate wet and cold conditions at all. They MUST NOT be mixed with ANY other species. This is vital, as they have virtually no resistance to alien diseases and they will rapidly develop serious 'runny nose syndrome' or other respiratory symptoms if allowed contact with other than their own kind.

Provide warm, dry indoor accommodation over winter and in summer or spring during periods of bad weather. Daytime temperatures should be minimum 20°C (68°F) with a 28°C (82.4°F) hot spot for basking. Overnight, temperatures can fall to 15°C (59°F). We find ceramic infra-red dull emitter heating elements work well - but a standard 100W reflector bulb (spot-lamp) is also satisfactory. Additional lighting should be provided by positioning a full-spectrum fluorescent tube about 20 cm (8") above the tortoise. We find indoor wooden 'pens' better than glass tank-type vivaria for keeping these tortoises active and healthy. In fine weather, during summer, these tortoises should be housed outdoors in a secure area with plenty of natural grazing.

Special note: *This species does not hibernate. They are very thin little tortoises and do not carry adequate reserves of fat to see them through a hibernation. In the wild, they live in a coastal zone which is very hot in summer*

and warm in winter. In summer, they aestivate to escape the heat, and are most active from December to March.

Libyan Tortoises

Libyan origin *graeca* complex tortoises are easily distinguished by means of their bright yellow ground coloration, and strongly contrasting black "spots" or "flecks" - which have been likened to having been splashed with black paint. Their body shape is relatively high domed, and the rear is well rounded. Males are more elongate than females, with narrower waists and more prominent rear marginal flares. This tortoise requires a very dry substrate if shell infections are to be avoided. In the wild, both hibernation and estivation may occur, depending upon precise locality. In general, may be maintained as for Moroccan *graeca*. One interesting feature of Libyan *graeca* is that they lay the largest eggs of all North African tortoises; typically 42 mm X 31 mm (1.65 X 1.2") and weighing between 20-23g (0.6-0.7 oz.). These eggs also differ from Moroccan and Algerian tortoises by being markedly elongate, rather than generally spherical.

Turkish Tortoises

Of all Mediterranean tortoises, the most populous and widely distributed species is *Testudo (graeca) iberica* which occurs from the Republic of Georgia in the former U.S.S.R, Bulgaria, North-eastern Greece, throughout Turkey (with the exception of the Black Sea coast), Iran, Syria, Iraq and Jordan.

Specimens of *iberica* from higher altitudes tend to exhibit darker scute markings, and on occasions, entirely black specimens are found. This can be an effect of age, but self-evidently young melanistic animals are frequently encountered in some locations. In the extreme south of Turkey, in the hills of Antakya (Antioch) and extending into Syria (Aleppo), brightly marked yellow colored specimens are commonly seen. The areas where these tortoises occur are typically extremely hot in summer, and it may be that the differences in coloration noted assist the animal in thermal regulation, preventing overheating. By comparison, tortoises from high altitudes, when temperatures are lower, may find that their dark coloration is a more efficient heat absorber for basking purposes. It should also be noted that juveniles are almost always very much paler and more brightly colored than adults within the same population. It should be noted that similar habitat and climate related color shifts are also seen in North African *graeca* complex animals. The average size of an adult female *T. iberica* is circa 200 mm SCL (7.87"), while adult males are smaller at circa 180mm SCL (7.09"). In Turkey, a few years ago, I encountered one enormous female measuring 290mm SCL (11.42"), and two others one measuring 270mm SCL (10.63") and one of 280mm SCL (11.02"). Large males, measuring up to 235mm SCL (9.25"), were also encountered in this locality.

In the mountains above Fethiye, in Turkey, a nesting female was observed at an altitude of 1350m (4,429 feet) on an overcast and somewhat cool day. This particular study site is a summer pasture, surrounded by peaks on all sides, but itself gently sloping and lightly populated by Kermes Oak shrubs (*Quercus coccifera*) which with their sharp, spiny leaves are much favored by the tortoises for constructing their overnight scrapes beneath. From these scrapes, which are used by several tortoises alternately, very clear 'tortoise trails' can frequently be seen in the surrounding vegetation. The natural food plants of this tortoise, which is an exclusive herbivore, include vetches, dandelions, mallows, and numerous species of the *Leguminosae* family. Feeding was typically accomplished 'on the move', with the tortoises snapping at individual flowers and leaves as they went. Rarely would a tortoise remain grazing in a single place for long. Examination of tortoise droppings revealed that they were well formed, contained a very high proportion of fiber, and large seeds appeared to be entirely unaffected by their passage through the animal.

In coastal Turkey during spring, daytime activity typically begins at 8:30-9:30 a.m. when tortoises emerge from their overnight scrapes. Depending upon prevailing weather conditions, the next hour or so is spent basking. This is often accomplished by the tortoise braced at an angle against a convenient rock. During basking, the legs and head are typically fully extended to increase the area of exposure to the sun. Most tortoises bask within a one meter radius of their overnight scrape. By 10:30 a.m. most tortoises are actively grazing, an activity which continues intermittently until about 7.00 pm. In the heat of summer, however, mid-day activity is much reduced. From about 8.00 pm. tortoises are beginning to return to their overnight scrapes, but on dull and cold days this may occur much earlier. The same scrape is not necessarily used each night by an individual; tortoises apparently use whatever existing scrapes happen to be closest to their grazing area at close of day or create a new one. Scrapes are generally located in the steep walls of terraces, under large rocks, or among the roots of shrubs or trees. In June, temperature readings taken from the back of scrapes ranged from 11°C overnight minimum to 28°C daytime maximum. The relative humidity, measured at the same locations, ranged from 23% minimum to 65% maximum. Scrapes were also utilized by the tortoises as mid-day retreats, retirement generally taking place by 10:30 a.m. Few tortoises were to be found after 11 a.m., except on cooler days or at higher altitudes.

The eggs of *Testudo iberica* are large compared to those of North African *T. graeca* (with the exception of the Libyan race) and are oval rather than spherical - each egg typically measures some 36 X 30 mm (1.42" X 1.18") and clutch density is typically 6-8, although large females may produce 12 or more eggs. The hatchlings measure about 33 mm (1.30") in length and weigh approximately 13g (0.4 oz). Eggs are laid from May-June and the first hatchlings usually emerge with the beginning of the Autumn rains in August-September. By October-November both adults and hatchlings are entering hibernation. Tortoises dig in for hibernation under large rocks, or under the same shrubs employed for overnight scrapes.

Temperature and activity

Mediterranean tortoises' activity patterns are governed primarily by prevailing climatic conditions. At low temperatures, below about 15°C (59°F), activity is very much reduced. Below 10°C (50°F), the tortoises enter a state of hibernation (more properly defined as “brumation” in reptiles). Peak activity for all Mediterranean tortoises tends to occur in the 22-28°C (72-79°F) range. At these temperatures, physical and feeding activity is normally maximized. As maximum peak temperatures surpass 30°C (86°F), however, activity again begins to reduce, and by 35°C (95°F) activity is practically non-existent. At these higher temperatures, tortoises in the wild estivate. Throughout the range of *Testudo graeca* and *Testudo ibera*, little tortoise activity occurs during the very hot, dry summer months - none at all in some areas. The best time to observe these tortoises in the wild is in early spring, from late March through May and early June.

Hibernation does not occur in all areas inhabited by Spur-thighed tortoises. For example in southern Morocco, average monthly mean temperatures in the coolest part of the year (December and January) do not fall below 14.8°C (58.6°F) and 13.6°C (56.5°F) respectively. Average daily temperatures in winter are typically 23.8°C (74.8°F) in November, 20.8°C (64.9°F) in December and 31.1°C (88°F) in January. Air temperatures at sites where active tortoises were observed in mid-December 1994 ranged from 24-27°C (75.2-80.6°F) between 10:00 a.m. and 2:00 p.m.

Estivation is a type of behavior that allows the tortoise to cease almost all activity during extreme heat, drought or periods where forage is absent. In this, it is outwardly similar to hibernation, but does not involve the almost complete shutdown of biological functions that true hibernation (or brumation) entails. Tortoises normally retreat into deep burrows or scrapes during the hottest and driest parts of the year for the purposes of estivation. In southern Morocco, estivation typically begins in June and ends in September. The precise timing is affected by prevailing temperature and, especially, by rainfall. In drought years, aestivation may be considerably extended. Tortoises are invariably aestivating during July and August where average mean monthly temperatures are 22.2°C (72°F) and 22.5°C (72.5°F), respectively. Peak daily temperatures during these months can exceed 48°C (118.4°F). It should be stressed that tortoises in northern Morocco have a reversed annual activity cycle compared to these in the south, with up to five months hibernation during the cold, wet winter and peak activity during the spring and early summer. A very similar pattern of behavior is seen in the case of *Testudo ibera*, in Turkey. Northern populations undergo prolonged hibernation periods, while southern populations hibernate for very much shorter periods, or not at all, and also engage in summer estivation.

Accommodation requirements

Suitable outdoor and indoor accommodation for Mediterranean tortoises is shown in detail on the accompanying video. Do ensure that outdoor pens are secure, that they offer a well drained substrate, slopes for basking, and retreats for use in inclement or excessively hot weather. Avoid “fish-tank” type vivarium accommodation for Mediterranean tortoises. These species are not suited to vivarium maintenance. They require extensive outdoor and indoor accommodation. If you cannot provide this, please reconsider keeping these tortoises.

Heating

For basking heat, overhead sources are necessary. Natural sunlight is unrivaled as a safe and effective heat source. Of artificial basking lamps, Metal Halide types offer significant advantages over ordinary incandescent or mercury vapour types. Heat mats, or pads, are not suitable heat sources for Mediterranean species. They restrict thermoregulation, contribute to dehydration, and fail to provide the overhead heat source so necessary for these species. Numerous health problems, including digestive tract disorders, have been noted in tortoises maintained on heat pads.

Substrates and health

Substrates are a critically important and often overlooked factor in tortoise maintenance. Tortoises live in very close contact with whatever substrate is provided, and it is vital that it meets their needs. Maintaining a tortoise from a warm, arid environment on a damp or worse, damp *and* cold substrate is simply asking for trouble; common substrate-related problems include an increased incidence of SCUD (‘Septicemic Cutaneous Ulcerative Disease’) or “shell rot”, especially affecting the plastron, and respiratory problems. Greek tortoises are almost invariably found on well well-drained substrates in the wild; slopes and sandy areas infiltrated by the roots of scrub and thorny plants are particularly well favored. In certain regions, such as the extreme south of Morocco, in Spain, in Tunisia and in Libya, tortoises also occur in stabilized dune habitats. In such instances, the tortoises can truly be said to be living on more or less pure sand. This is by no means typical of all tortoise populations, but I have also found populations of *Testudo ibera* living in very sandy, coastal habitats. Other substrate types encountered in the wild include very rocky slopes, and the edges of pine forests. The single property that these all share is that they are extremely well drained. The substrate also tends to be loose, and easily excavated. Slopes tend to be chosen because these are much less liable to flood and because they also offer enhanced opportunities for basking.

Tortoises use their natural substrate to create burrows and scrapes; these in turn provide microclimates, shielding

the tortoise from extremes of temperature and humidity. Keeping tortoises in pens or terraria where they cannot create these microclimates deprives them of control over their immediate environment. In Morocco, the temperature recorded in scrapes and shallow burrows occupied by tortoises was typically 75-79°F (24-26°C) and the relative humidity there ranged from 48-60% compared to 20% or less in exposed areas. Tortoises maintained on substrates that they cannot burrow into are at risk from dehydration from respiratory moisture losses. This is especially so in the case of hatchlings and juveniles.

A further major advantage offered by substrates that permit natural microclimate behavior is body temperature regulation. Take the example of a 50 g (1.6 oz) juvenile maintained on a newspaper substrate in a glass vivarium. This tortoise is thermally isolated to a high degree from its surroundings. Its body core temperature will respond extremely rapidly to local changes in air temperature, or to directional point sources of radiant heat, such as basking lamps. These swings and fluctuations in core temperature can be very severe, and occur far more rapidly than the tortoise would normally experience in its natural environment. This has possible serious consequences for health, for example, the incidence of respiratory disease and kidney disease is far higher in tortoises kept under these conditions than in those maintained under more natural conditions.

By contrast, if the same 50 g (1.6 oz) juvenile is maintained on a 3" (75 mm) depth of substrate, in a large, open table-top terrarium, the sheer mass of the substrate acts as a thermal buffer - stabilizing temperatures significantly. The tortoise burrows into this substrate, and in effect, *becomes part of its overall mass*. As a result, its core temperature no longer fluctuates wildly but instead changes at the same rate as that of the surrounding mass, i.e., very much more gradually and slowly. A tortoise in this type of environment is much better able to thermo regulate naturally than a tortoise that is thermally isolated from its immediate surroundings.

For Mediterranean tortoises we have found that an ideal substrate for indoor accommodation can be made from a 50/50 mixture of loam (soil) compost and soft (play) sand. A top layer of dried grasses, bark pieces and medium-sized stones completes the substrate and permits near-natural microclimate utilization and excellent basking possibilities. The provision of surface materials under which the tortoise can dig, such as bark pieces, plants and 'scrub', plus a variety of angled surfaces, such as logs or stones, also helps to prevent tortoises from inverting themselves, and being unable to turn over again. **Should this occur in the vicinity of a heat lamp, fatalities can occur in a few minutes.** By providing a suitably 'rough' and varied surface, the risk of this type of accident occurring can be reduced dramatically.

Lighting

Ultraviolet light is believed to be important for all tortoises, as it plays a role in the production of vitamin-D3 which is important for the correct formation of bony tissue. Unfiltered sunlight (i.e., not through glass) is the best sources of ultraviolet light and therefore tortoises should be allowed access to natural sunlight whenever possible. Tortoises synthesize their D3 through the action of UV-B radiation upon their skin (not their shells), and as much surface area as possible is exposed during basking.

There are several full spectrum fluorescent lamps on the market that aim to provide a good approximation of natural sunlight. Where tortoises are maintained indoors for extended periods, use of such tubes is highly recommended. Not only will they assist in the provision of UV-B and UV-A, but it is believed that they also provide some 'psychological' value and enhance normal patterns of behavior. Alternative sources of 'full spectrum' lighting such as mercury vapor and metal halide should be considered for large indoor terrariums. It should be noted that intense, daylight frequency (5,500 °K) lighting is highly recommended for all Mediterranean tortoises. Lighting should always be switched off at night in indoor enclosures. Timers may be used to insure that a proper day/night cycle is maintained. For tortoises maintained indoors, a 12-14 hour period of artificial illumination should be given daily.

Feeding and drinking

The diet of Mediterranean tortoises in the wild consists almost entirely of herbaceous and succulent vegetation, including grasses, flowers, twigs and very occasionally fallen fruit. During episodes of rainfall the tortoise will drink from the puddles which form, and it may also approach streams or ponds. It will frequently also pass urine at this time as well, and will simultaneously dispose of the chalky white uric acid residues which form in the bladder. **It is categorically not true that wild tortoises rarely drink.** I have seen both *Testudo ibera* in Turkey, and *Testudo graeca graeca* in Morocco approach streams and ponds and drink copiously, in addition to regular observations of drinking following rain. During the dry season, and in the more arid parts of their range, tortoises rely mainly upon the water content of their food in order to supply their moisture requirements. In captivity, we suggest soaking the tortoise for 10 minutes twice each week in fresh, shallow water to ensure an adequate state of hydration.

In captivity, a high fiber, low protein and calcium rich diet will ensure good digestive tract function and smooth shell growth. Mediterranean tortoises fed on cat or dog food, or other high protein food items such as peas or beans, frequently die from renal failure or from impacted bladder stones of solidified urates. Peas and beans are also very high in phytic acid, which, like oxalic acid, inhibits calcium uptake. Avoid reliance upon 'supermarket' greens and fruits which typically contain inadequate fiber levels, excessive pesticide residues, and are too rich in sugar. Fruit should be given very sparingly as it frequently leads to diarrhea, intestinal parasite proliferation, and colic.

When planning a diet for captive tortoises, take their natural dietary behavior into account as fully as possible. In

the case of Mediterranean tortoises, try to provide a mixture of edible grasses and clovers, supplemented by mulberry leaves, grape leaves, and hibiscus leaves and flowers. *Opuntia* cactus pads are a great favorite and are rich in both calcium and fiber. A lack of dietary fiber, or roughage, will precipitate digestive tract disturbance, diarrhea and an apparently much increased susceptibility to flagellate and worm problems. Other useful foods include fresh alfalfa leaves, dried alfalfa hays, and grass hays.

Although Mediterranean tortoises will take animal protein if offered (as will most normally herbivorous tortoises), in practice this leads to excessive growth and causes shell deformities, liver disease, and renal stress. It should therefore be avoided entirely.

A balanced diet for Mediterranean tortoises can also include dandelion, naturally occurring non-toxic weeds, white (Dutch) clover, both leaves and flowers, rose leaves and petals, and sow-thistle, romaine or red leaf lettuce (in very limited quantities). Do not use head lettuces such as iceberg, as these contain very little in the way of vitamins or minerals.

Most land tortoises can and do fare best when allowed to graze, offering the other listed items as occasional supplements. Once weekly, a commercial food, such as Pretty Pets[®] Tortoise Food, can be offered as a dietary supplement if inadequate fresh graze is unavailable, for example, when over-wintering animals that are not hibernating. Do not routinely offer cabbage, spinach, chard, bok choy, or any vegetable related to these, as they inhibit calcium absorption and can cause serious health problems. This is particularly critical in the case of juveniles or egg-laying females. The regular use of a cuttlefish bone left in the enclosures allows tortoises to regulate the amount of calcium in the diet. Some tortoises like this very much, while others will refuse to eat it. Allowing Mediterranean tortoises to forage and graze naturally actually helps the tortoise to maintain good digestive-tract health, and greatly assists in the prevention of obesity. If scute pyramiding is noted, this usually indicates that either too much of the 'right' type of food is being consumed, or, more likely, that the overall protein content of the diet is too high. We recommend the use of a good quality phosphorus free calcium and vitamin D3 supplement at least twice per week, more frequently for juveniles and egg-laying females.

Summary

1. Dehydration due to respiratory losses of water vapor and lack of access to appropriate microclimates (e.g., burrows) may be implicated in causing bladder stones and kidney problems;
2. Keeping tortoises on flat surfaces, with no burrowing facility, and high temperatures can easily cause fatal overheating and an increased incidence of respiratory and kidney disease;
3. Vivarium surfaces (e.g. tanks) are particularly bad as they do not offer sufficient differential between ambient (air/radiant) temps and surface temperatures which tortoises employ in thermoregulation and do not allow creation of localized, more humid, microclimates;
4. Arid habitat species are not biologically or metabolically 'geared' to 365-day-a year activity and feeding. In captivity, this is often demanded of them. The net result is usually an increase of over 100% (sometimes 200 or 300%) in the gross food/protein intake over a 12 month period compared to a wild specimen. This results in corresponding increase in urate production (putting increased 'load' on renal capacity) and is also the cause of the unnaturally high growth rates also seen in these species in captive situations.

Suggested preventative measures

1. Do not assume that all desert/arid habitat species must constantly be 'baked' at high temperatures. Moderate temperatures are very much safer. In fact, Mediterranean tortoises dramatically reduce their activity as temperatures climb beyond 30°C or 86° F and seek local retreat in burrows, scrapes or in the roots of vegetation (all offering cooler, more humid microclimates where bodily losses are dramatically reduced);
2. Do not keep tortoises on flat vivarium surfaces with shallow substrates which are prone to result in overheating and that induce dehydration;
3. Ensure soaking is carried out at least 2 times per week or that fresh water is always available;
4. In captivity you are almost certainly overfeeding and forcing a continuous, unnatural, activity cycle. Reduce overall intake over a monthly, or annual cycle and give the animal 'rest periods' where no activity is encouraged (these may last for days on end under the right conditions). Provided body weight is maintained, a low growth rate is safe. You must take care, however, to avoid under-feeding and malnutrition. The best guide is to check the tortoises' weight regularly and, as a rule of thumb, pick the animal up and judge how "solid" it feels; a healthy tortoise will have a solid feel to it - an underweight or emaciated tortoise will feel "hollow". See the table below for average weights and lengths of healthy, captive-bred juveniles.

5. Outdoor pens are by far the best; Second best is a 'tortoise table' with adequate depth of substrate; least satisfactory is a glass tank. There is a direct correlation in incidence of urate stones if plotted against these environments! Do not rush tortoises inside every time it rains. This an in important stimulation to drink and evacuate urates. Most arid habitat species drink copiously during episodes of rainfall.
6. On **no account** feed dog or cat food, peas, beans, cheese, eggs, milk products, bread or similar items to tortoises. These will invariably lead to long-term health problems and very probably to death.
7. Ensure that adequate levels of calcium and D3 are provided by means of supplements, and permit as much exposure as possible to natural, unfiltered sunlight.

Hibernation

It is natural for tortoises to gradually reduce their food intake as fall approaches. A tortoise's digestive system is governed to a great extent by temperature, but generally speaking, when the animal's biological processes are slowing down it takes between 2-4 weeks for the food last consumed to pass completely through the gastro-intestinal tract (the exact time taken depends upon the size of the tortoise; small animals require less fasting time, larger animals need a longer period). In other words, do not attempt to hibernate any tortoise if it has eaten recently. Throughout the fasting period, keep the tortoise at moderate room temperatures - above (10°C) 50°F but below (18.3°C) 65°F. Gradually reduce lighting levels simultaneously to prepare the animal for hibernation.

Delay hibernation rather than allow a tortoise to hibernate while the possibility of undigested food matter within the stomach remains. Tortoises which are hibernated with undigested food still remaining inside are unlikely to survive in good health. The food decays, produces large quantities of gas and causes potentially fatal colic. Outdoor or natural hibernation consists of allowing the tortoise to excavate its own burrow instead of hibernating it in a box under controlled conditions. In the wild tortoises usually dig themselves in under large rocks, tree roots, or into the side of earthen ledges. Excavations may be several feet deep.

Outdoor vs. Indoor hibernation

Natural hibernation offers some advantages, and some disadvantages. In its favor, freezing is very unlikely to occur - even under severe weather conditions - as at anything beyond a few inches underground temperatures are very stable indeed. Even in the most severe weather, frosts rarely penetrate more than 2 inches deep. If your tortoise has safely hibernated itself in this way before, then there is no necessity to vary its routine. Natural hibernation is not intrinsically dangerous. Be aware, however, that Mediterranean tortoises are especially susceptible to damp conditions, so any hibernation area must be very well drained or in a naturally dry habitat. The disadvantages of the method, however, include:-

1. Flooding. If this should occur, then the tortoise is at serious risk;
2. Health inspections during hibernation are practically impossible;
3. There is always the danger of attack by foxes, raccoons, rodents or similar predators.

Bearing these possible problem areas in mind, you can do much to minimize the dangers!

1. Do not allow tortoises to burrow in an area where flooding is possible
2. Perform extra-careful health checks throughout the summer and especially during the period immediately prior to hibernation
3. The area above a hibernating tortoise can be protected by covering the ground with wire mesh - but be watchful in warm weather as the tortoise may be trying to emerge! In the majority of cases, we recommend that 'artificial' hibernation in a temperature controlled environment is generally more satisfactory.

Some tortoises can prove difficult to 'settle' in hibernation, and may scrape the bottom out of cardboard boxes. A plywood box is recommended. Recently imported tortoises **SHOULD NOT BE HIBERNATED** unless they are in excellent condition. Suspect animals should be over-wintered in a warm, dry and well ventilated terrarium. The most critical factor in hibernation is temperature stability. Maintaining the temperature within close parameters is absolutely critical to a successful and healthy hibernation. Insulation merely slows down the rate of heat exchange, it does not prevent it altogether. Therefore, no matter how well you insulate, if you subject your tortoise's hibernation box to sub-zero temperatures for an extended period, it will still get too cold and will die. Similarly, if you allow your tortoise's hibernation box to get too warm for too long, it will begin to use up valuable fat and energy reserves and may

even wake up too early. Generally, we recommend a maximum of 4 months hibernation period - less for small specimens. The absolute critical minimum and maximum temperatures for a safe hibernation are:

MAXIMUM = 50°F or 10°C
MINIMUM = 35°F or 2°C

Under no circumstances whatsoever, should a hibernating tortoise be subjected to prolonged exposure to temperatures higher or lower than these. Failure to appreciate the importance of this invariably leads to death and injury in hibernation. Blindness due to the eyes quite literally freezing solid is a particularly tragic consequence of allowing temperatures to fall too low.

The easiest way to check temperatures is to obtain a maximum-minimum reading greenhouse thermometer from any garden or hardware store. Check it at regular intervals, hourly if necessary in very cold spells. If sustained low or high temperatures are noted, temporarily move the tortoises into a more suitable place until temperatures stabilize to a satisfactory level again. Today, some excellent electronic thermometers are available with built-in alarms if the temperature goes outside pre-set points. These are truly excellent, and can make a major contribution to hibernation safety.

An ideal temperature for hibernation is 5°C, or 40°F. At this temperature tortoises remain safely asleep, but are in no danger of freezing. In some areas, hibernation using a temperature controlled refrigerator (not freezer) is recommended as a safe and reliable method of hibernating Mediterranean tortoises. However, if this method is used, an adequate air exchange is essential. Opening the door briefly once every 48 hours has proved successful. Each tortoise should be placed within the refrigerator in its own cardboard box. This box should be slightly larger than the tortoise, and should be partly filled with shredded paper. Once they are in the refrigerator at a starting temperature of 12°C (54°F), slowly reduce the temperature over the 1st week until it reaches a stable 5°C (40°F).

It should be noted that very small juveniles can be hibernated with perfect safety. They do so in the wild, and can also do so in captivity. However, temperature control and stability is critically important. We strongly recommend that the refrigerator method be used with tortoises under 75 mm (3") long. Greater temperature stability and safety can be assured by allowing the juveniles to bury into a tray containing a minimum 3" depth of loose substrate comprised of fibrous potting compost, sand, and medium gravel. By surrounding themselves with this substrate, their effective mass is increased dramatically, improving thermal stability, and a more natural microclimate is also achieved, reducing the dangers of dehydration.

If hibernating tortoises in a box in an attic, shed or similar location, be sure to monitor temperatures carefully, and protect hibernation boxes from possible attack by rodents which are a serious hazard to hibernating tortoises. A 'frost protection' heater may be required to ensure temperatures never approach freezing point in some locations. Please consult the Tortoise Trust's free guide "Safer Hibernation & Your Tortoise" for complete information on how to ensure hibernation success.

Health care of tortoises

- **CHECK BOTH EYES** for signs of swelling, inflammation or discharge. If there is a problem, consult a veterinary surgeon with extensive experience of treating reptile patients.
- **CHECK THE NOSE** for signs of discharge; a persistently runny nose requires urgent veterinary investigation. Tortoises with this symptom must also be isolated from contact with others, as some types of RNS ('Runny Nose Syndrome') are highly infectious. The presence of excess mucus also encourages bacterial growth, and hence places the tortoise in additional danger from diseases such as necrotic stomatitis ('mouth rot' or 'mouth canker').
- **CHECK THE TAIL** for inflammation or internal infection; tortoises with cloacitis 'leak' from the tail and smell strongly. Any signs of abnormality should be investigated by a veterinary surgeon. It will help if you take a fresh sample of cloacal excretion for microscopic examination..
- **FEEL** along the legs for any unusual lumps or swellings; abscesses are common in reptiles and if left untreated can result in loss of limbs or even death. Report any unusual findings to a specialist veterinary surgeon who may want to X-ray the affected part.
- **BOTH EARS** should be either flat or slightly concave; ear abscesses are very common and can have fatal consequences if treatment is not obtained. The ears of a tortoise are the two large 'scales' just behind the jaw-bone.
- **CHECK INSIDE THE MOUTH** for any sign of abnormality; necrotic stomatitis, or 'mouth-rot', is a highly contagious (and unfortunately all too common) disease of captive reptiles. It is characterized by the appearance of a yellow 'cheesy' substance in the mouth, or by a deep red-purple tinge, or by the appearance of small blood-spots. Sometimes all three symptoms are present. Expert veterinary treatment is called for as a matter of urgency if the animal is to be saved.
- **WATCH FOR** any sign of breathing via the mouth, gasping or gaping. Listen carefully for 'squeaking' or wheezing sounds. These symptoms often indicate pneumonia. Urgent veterinary attention is required.

Antibiotics by injection are usually essential in the treatment of this life-threatening condition.

A high proportion of pet trade tortoises suffer from a variety of traumatic injuries and contagious diseases. The shipping conditions frequently leave much to be desired, and most animals are subject to fecal contamination and extreme temperature variations in transit. Of particular note is *Hexamita parva*, a highly damaging parasite of the renal and urinary system. This organism has been identified frequently in Mediterranean tortoises and if left untreated leads to rapid weight loss, dehydration and terminal renal failure. In such cases, where treatment is not provided, death may result quickly. *Hexamita* usually responds to oral dosing with metronidazole (Flagyl). Other symptoms include thick or slimy urine which often smells strongly of ammonia. It is imperative that hydration is maintained in affected animals and that precautions are taken to prevent contagion of adjacent stock, as *Hexamita* can be extremely contagious. Routine urine tests should be carried out on all suspect animals. It should also be noted that Mediterranean tortoises have proved susceptible to epidemics of viral disease and should be regarded as potential carriers of Herpes-type viral organisms. Tortoises are particularly prone to two types of intestinal 'worms' - long, grayish-looking creatures called Ascarids, and a smaller, very thin whitish type called Oxyurids. Both respond to treatment with a fenbendazole-type wormer called 'PANACUR', which is administered in the form of a liquid suspension. A paste formulation of this same treatment can also be applied to food. We recommend worming tortoises twice each year to keep internal 'worms' at a low level. Dosing information should be obtained from your veterinarian. **NEVER** use Ivermectin-based worming preparations with tortoises. **This substance is fatally toxic to ALL tortoises and turtles.**

Traumatic Injuries

The most important point to remember when confronting an injury is not to panic. It may not be as bad as it looks. At the Tortoise Trust's hospital we regularly see some very nasty wounds - in 95% of cases the tortoise makes a complete recovery. Even major shell damage (from crushing or even from being hit by cars) can often be survivable. Legs, faces and tails can get chewed and bitten by rodents or dogs. Don't panic. Try to prevent serious bleeding by placing a clean dressing over the wound site. Get the animal to a vet as quickly as possible. Keep all wounds and injuries clean. Minor wounds may only require routine cleaning with very dilute povidone-iodine or chlorhexidine. If the injury has been caused by bites be especially careful to clean thoroughly. Antibiotics may also be required. Consult your vet. Beware of fly strike and maggots in open wounds. Keep animals with open wounds behind anti-insect netting. Tortoises can suffer broken legs. These can be diagnosed by X-ray. Treatment is the same as for other animals, but healing can take a lot longer. Keep tortoises well away from poisons and garden chemicals. If ingested note the substance carefully and seek immediate emergency veterinary advice. Tortoises can also drown. Keep well away from ponds. If they do fall in and become unconscious then empty all water from the lungs by inverting the animal vigorously, keep very warm and stimulate as much as possible. Seek expert advice immediately.

Shell care

A tortoise's shell is living tissue and is very sensitive. The old practice of drilling holes for tethering was truly horrific. Not only did it cause agonizing pain, but it was also a frequent cause of shell infections and septicemia (blood poisoning). The shell does not require much in the way of maintenance but it does require keeping clean. We do not recommend the use of oils for polishing, just gentle wiping with a good quality anti-bacterial agent occasionally - we use and recommend very dilute chlorhexidine solution for this purpose. This will enable you to easily inspect the surface of the shell in fine detail and will reveal any wounds or areas of infection otherwise concealed by mud or dust. Very minor shell wounds will usually respond to a daily application of dilute povidone-iodine without further treatment. If the area of damage is large, or if it is becoming larger, seek veterinary advice. If caught early on, most shell infections respond very well to a combination of a daily wash with povidone iodine solution, and in severe cases, to topical applications of antibiotics under veterinary direction. One area of shell to inspect carefully is just above the tail, especially if you have more than one tortoise. This area is usually the first to get battered during fights between males or during mating behavior. If it becomes loose or flaky, keep it very clean and separate the animals for a while.

Refusal to feed

In all probability, if a tortoise persistently refuses to eat, or is particularly lethargic, despite being provided with a suitable habitat and the correct temperatures, it is seriously ill. You need expert help - without delay. The diagnosis and treatment of a sick tortoise or turtle requires a good deal of logical detective work on the part of both the owner and veterinary surgeon; these animals often do not display very obvious indications of what is wrong, and some familiarity with them is essential if the cause of the problem is to be correctly identified. An initial examination will normally include an investigation of the background to the problem. The answers to routine questions can be extremely useful in this respect:

Has the tortoise only recently been acquired?

*Was it purchased from a pet store?
Were the conditions there overcrowded
or unhygienic?
Has it recently been mixed with other animals??
What does its usual diet consist of?
Is the environment correct for this species?
Did the symptoms coincide with any other event?*

Incorrect feeding and errors of husbandry account for more than three quarters of all sickness reported in captive tortoises and turtles. A careful analysis of the background to the case can very often result in a provisional diagnosis which can then be followed up by clinical investigation. This also follows a logical pattern:

*The animal is picked up - is it reacting normally?
Is there a good response to visual stimuli?
Is limb retraction good?
Is the head being held at an unusual angle?
Is its weight normal?*

The patient is then examined visually and in close detail. This can often be very revealing, especially when carried out by an expert familiar with the species in question: Are there any unusual swellings or local signs of abnormality? Are there any signs of discharge from the nose or tail? The eyes, ears and limbs are subjected to special scrutiny, the latter are probed along their length in an effort to detect fractures or swollen joints. The shell is then examined carefully all over.

*Is it soft?
Is it lumpy?*

Are there any evident wounds or other signs of damage or injury? The plastron is also examined for signs of subcutaneous hemorrhage or bruising and the skin condition is carefully noted. If the external examination results in an 'all clear', the examination progresses internally.

The head is extended and the mouth carefully opened. The condition of the mucous membranes is noted - are they a nice, clean healthy pink? If any suspect material is present, a swab is taken for laboratory analysis. By this point, in perhaps 80% of cases, a few preliminary conclusions will have been reached. Frequently, a satisfactory diagnosis will have been arrived at. In the remaining cases, the full resources of a veterinary testing laboratory may be required. Urine and feces samples can be examined for parasites, or urea levels analyzed. Blood samples can be similarly checked for parasites, elevated white cell counts (which could indicate an infection) and for renal or liver function. If the tortoise or turtle is female, X-rays might be taken to discover if there is an egg problem. Bacterial swabs might be taken from the mucous or from any other suspect discharge for laboratory culture and antibiotic sensitivity testing.

If the correct diagnostic procedures are implemented, sooner or later an answer will normally be forthcoming. Although guess-work may be justified in emergencies, where time is of the essence and every second may count, for the most part a systematic and logical approach to tortoise diagnosis consistently produces the best results.

Owners can help their veterinary surgeons considerably if they are made aware in advance of the type of questions a vet is likely to ask, and especially if they understand the reasons why such questions have to be asked. Unfortunately tortoises and turtles cannot tell us by themselves what is wrong - but an intelligent and observant owner, working co-operatively with a good veterinary surgeon, can go a long way towards interpreting what is often only a very subtle sign that all is not well.

One of the main ways in which keepers can help is to ensure that they are thoroughly familiar with the habits and captive care requirements of their own turtles. A veterinary surgeon dealing with dozens, or even hundreds of different species, cannot (unless he or she is a specialist) be expected to know the feeding and temperature preferences or typical breeding behavior of your particular species - but if you do choose to keep such an exotic animal as a pet, there is certainly no excuse for you not to know these things. Books are available, and most tortoise societies or reptile associations will be only too pleased to offer their practical advice. For further information on the management of sick tortoises, consult the relevant Tortoise Trust and Carapace Press publications.

Mixing of animals and quarantine

It is highly inadvisable to mix Mediterranean tortoises with other species. **Not only are there potential health risks in so doing, but the structure and behavior of the various different races also renders them incompatible with each other.** For example, male *T. ibera* are typically highly aggressive and can inflict severe bites, especially around the face and eyes. Tortoises that are bullied, or subject to undue aggression, will fail to eat properly and may develop stress-related illnesses. Females of the North African *graeca* are also poorly protected against the "butting" or "ramming" behavior of *T. ibera* (a behavior pattern not engaged in nearly so aggressively by males of North African origin). Severe traumatic injuries are a frequent consequence of mixing species. Different geographical races may also

carry virus pathogens that are dangerous to each other - we strongly recommend NEVER allowing Turkish and North African races to mix. No safe minimum quarantine period can be recommended even where 'new' Greek tortoises are to be introduced to existing colonies of the same species: 12 months should be adequate to eliminate most cases of *Hexamita* as well as many other ailments, but indefinite quarantine may be necessary to offer complete protection against viral (or mycoplasma) organisms. Routine worming is also recommended before new animals are introduced to existing colonies. To reduce the danger of contamination and cross-infection, it is imperative that adequate hygiene measures are followed in all cases. Feeding equipment and utensils should always be washed thoroughly in an antibacterial cleanser (we recommend a dilute chlorhexidine solution) and hands should be washed before and after handling any tortoise or turtle. Several excellent products for this purpose are available from specialist pet suppliers or from pharmacies.

General safety and security

Garden Ponds

Each year - without fail - we hear of several incidents of tortoises drowning after falling into garden ponds. Please ensure all ponds are completely secure and that there is no way your tortoise can accidentally fall in. Most tortoises, including Greek tortoises, cannot swim.

Escapes

Tortoises are incredibly good escapees. The perimeter fences of pens should be securely dug in. We prefer concrete block perimeters for maximum security. Check all fences and gates are secure and ensure that there are no gaps. Also make sure that there is nothing your tortoise can climb over. Also, note that tortoises will constantly attempt to get through barriers which they can see through; opaque barriers are therefore much better for securing the edges of pens.

Fire

Tortoises, electric wires, and basking lamps don't mix. Each year we have had at least one report of tragedy striking following a lamp being knocked over. NEVER use floor standing lamps and NEVER allow combustible substrate anywhere near a basking lamp. Fit appropriately rated fuses and fit a smoke alarm. Ensure all wiring is of good quality and is correctly maintained. BEWARE of potential fire risks and take precautions to prevent the problem.

Dogs

Some dogs may be perfectly safe with tortoises. Others most definitely are not, and unfortunately, you can never be 100% certain which category a dog falls into. We have encountered numerous horrific incidents where tortoises were killed outright or so severely maimed by pet dogs that they had to be euthanized. It is our considered view that if you allow tortoises and dogs to mix, then there is a definite element of risk. If a dog has proved aggressive to tortoises in the past, there is no way you should keep both. Either the dog or the tortoises should go.

Poisons

Please do not use slug pellets or other garden pesticides anywhere in the vicinity of tortoises. They kill not only tortoises but also birds and many other 'friendly' animals. Some plants are also dangerous to tortoises. A full list is supplied in the Tortoise Trust's 'Feeding Manual'.

Captive Breeding

Most females will begin to behave somewhat strangely in the period immediately before they are due to lay. Typical behavior includes aggression displays towards other females, hyper-activity and climbing over obstacles, even attempts to 'mate' other tortoises (male or female) including making the high pitched vocalizations usually only heard from males. Females carrying eggs may also reduce their food intake, and sometimes may stop feeding altogether just prior to laying. Another way to tell is to ask your veterinary surgeon to X-ray a tortoise you suspect may be pregnant - although this is really only justified in "problem" cases.

Some female tortoises can be very selective about what constitutes a suitable nesting site. Others are less discerning. In general however nearly all prefer a site which is on a slope, is well drained and has light but relatively well textured soil which is easy to excavate. Very sandy sites, especially those without plant roots to bind the sand together, are often not favored. The female must be able to dig a bell-shaped excavation without too much difficulty, but at the same time the soil must not be so dry or so loose that the nest collapses in on itself.

Preferred nest sites are also almost always situated in a sunny position. The most common time for laying is from midday to late afternoon. It is vitally important that a suitable nest-site should always be available to a pregnant female as tortoises may chose to voluntarily retain their eggs unless conditions are right - if this continues for too long, there is a real danger of "egg binding" or egg peritonitis. A condition which ultimately proves fatal in a high proportion of cases.

In order to develop properly, tortoise eggs need to be incubated within a specific temperature and humidity range. The incubation temperature is especially critical. If the eggs are incubated at too low a temperature development will be

very slow or the eggs may fail to hatch. Excessively high temperatures can lead to deformity. For best results always use a reliable thermostat and thermometer when incubating eggs.

We suggest that you should avoid sand as an incubation substrate. It does not allow sufficient gaseous exchange to occur, and as a result anoxia is a real danger. It is better to use an artificial, lighter medium such as very slightly moist 'Vermiculite'. Place the probe of a thermometer alongside the eggs to keep a constant check on conditions.

The time of incubation and the eventual sex of the off-spring are both determined by temperature. Higher temperatures produce females in most species, and lower temperatures males. Suggested incubation temperatures range from 29.5°C to 31.5°C (85 to 88.7 °F). Young tortoises are entirely independent and surprisingly alert - some start feeding almost before they have left their eggshell. Occasionally one hatches while still retaining a remnant of its yolk-sac which sustained it through the incubation period. This can be quite large and is attached umbilical fashion to the underside, thus preventing mobility. These are best left quietly in the incubator for 24 hours or so while the yolk-sac is gradually absorbed. For comprehensive data on all aspects of captive breeding, including advanced level guidance on incubation and captive care you are advised to consult our complete book and video list.

Juveniles may be maintained out of doors in protected, secure enclosures whenever the weather permits, or indoors in open-topped pens. Like many tortoises, Mediterranean tortoise juveniles do not respond well to enclosed terrarium housing. An attractively landscaped open-topped enclosure provides both security and a stimulating, well ventilated environment. Their dietary management is as for adults, but with increased sensitivity to calcium deficiencies. The prevention of unnaturally accelerated growth is especially important, as this can result not only in 'lumpy shell' and other deformities, but also in an increased risk of kidney disease and premature sexual maturity.

Additional reading:

The Feeding Manual (Tortoise Trust & Carapace Press)

Tortoise Trust Guide to Tortoises & Turtles by A. C. Highfield (Carapace Press, London and NJ)

Tortoise	Age	SCL	Weight
<i>T. ibera</i>	1 Year	44 mm	18 g
<i>T. ibera</i>	1 Year	52 mm	38 g
<i>T. ibera</i>	3 Years	73 mm	72 g
<i>T. ibera</i>	3 Years	68 mm	74 g
<i>T. ibera</i>	3 Years	60 mm	58 g
<i>T. ibera</i>	8 Years	100 mm	256 g
<i>Moroccan</i>	8 Years	101 mm	258 g
<i>Moroccan</i>	2 Years	75 mm	104 g
<i>Moroccan</i>	2 Years	61 mm	54 g
<i>Libyan</i>	2 Years	83 mm	126 g

Healthy Juvenile Age/Size Table

Note that considerable variation is observed even between siblings reared under identical conditions.