

Christoph Fritz & Beate Pfau

Care and Breeding of the Afghan or Steppe tortoise, *Testudo horsfieldii*

Steppe tortoises were already imported in huge numbers into the former German Democratic Republic around 1965 and, after the general import ban on Mediterranean tortoise species, also into the Federal Republic of Germany. These animals generally did not survive long. In the beginning there were only very few successful care and captive breeding results. KIRSCH summarised the knowledge on the species and gave his own experience in a very detailed series of articles with a lot of nice photographs, in the journal “Aquarien Terrarien” already in 1971. These articles focussed our interest on this species and we are sure that they did so with a lot of other hobbyists too.

Introduction

Steppe tortoises are regarded as less threatened in their countries of origin than the Mediterranean species are, which leads to a lower protection category with respect to the EU. In 2001, Kazakhstan had an export quota of 40,000 and Uzbekistan 30,000 specimens. These figures are alarming, especially considering the impact which such a large-scale collection must have on a species with a relatively low reproduction rate (see e.g. MICHEL & STÖCK 1996). Besides a few captive-bred specimens, there are regular offers of wild-caught animals (which sometimes are claimed to be from ranching projects) and regrettably there is also a black market for smuggled steppe tortoises. The combined effects of these mass legal and illegal imports lead not only to the fact that steppe tortoises are sold at clearly lower prices than other tortoises, but unfortunately there are also sick specimens offered for sale and these can be bought unknowingly by members of the public.

It is needless to say that the natural demands have to be fulfilled as much as possible in order to keep steppe tortoises healthy. The amount of money and effort necessary for of this can - like for most turtle species – be considerable; the purchase price of the animal is often the lowest in a long list of costs!

In this paper we want to summarise which parameters should be observed and how much fun there is when one decides to acquire steppe tortoises despite their special demands.

Recognition

Steppe tortoises normally have a significantly flatter carapace than the more frequently kept *Testudo* species from the Mediterranean region. There are even specimens with a half-circled or still flatter carapace profile, which resemble pancake tortoises in this respect. The curvature of the carapace depends on origin and gender, males are generally flatter than females (BONNET et al. 2001). The shape of the carapace – seen from above – is almost circular, especially in young specimens or males, but adult females are mostly longer than wide. The colouration of the carapace varies widely too, as could be expected for a species with such a large geographic range. There are specimens with bright yellow, brown or olive basic colour. The dark patterns at the carapace can vary from almost absent to extending over practically the whole shell. Clear, regular patterns are lacking, instead the patterns on the steppe tortoise carapace look frayed. The plastron is predominantly black. This leads to the conclusion that the animals in their natural habitat need to emit heat to the ground (see notes below), as supposed for dark-plastroned *Testudo hermanni* by WILLEMSSEN & HAILEY (1999). The male plastron is flat and does not have the plastral concavity typically seen in other tortoises. Males definitely have longer tails than females. The maximum size recorded is 28 cm, but the females of our most frequently kept variety are rarely longer than 20 cm and the males mostly remain below 16 cm carapace straight length. The maximum attainable size will depend on the animal's origin, but more detailed specifications in literature are difficult to find and to interpret.

Steppe tortoises have powerful forelegs with only four toes (the other *Testudo* species have five) for burrowing; for this reason, one of their vernacular names in German and some other languages is “Four-toed tortoise”. They can be clearly distinguished from the other *Testudo* species by appearance and so in a Polish research paper (KHOZATSKY & MLYNARSKI 1966) they were placed in a special genus, *Agrionemys*. But meanwhile, there appeared so many hybrids of the steppe tortoise with other *Testudo* species (e.g. KIRSCH 1984, KABISCH 2001) that this division does not seem valid any longer. Therefore in this article the species is again referred to as *Testudo horsfieldii*.

Natural history observations

Much useful information about the requirements of a certain species which is relevant for its care in captivity can be derived from observations in the biotope. Unfortunately, we could not yet visit the Asian steppes ourselves. Instead we will summarize what we found in literature about the ecology and the habits of *Testudo horsfieldii*. This information is mainly taken from the studies of ATAEV (1985) and KUZMIN (2002) and from the book and a lecture by OBST (1985, 1988).

Steppe tortoises mainly live in steppe-like areas in southern central Asia. The soil of these rather inhospitable areas is loamy with sparse vegetation. In this region, a long, cold winter is followed with hardly any transitional periods by a very hot, dry summer, and the transition from summer to winter also is abrupt. Precipitation falls mainly at the end of winter and autumn rains are rare. MICHEL & STÖCK (1996) report an average annual temperature of 15.2 °C and an annual precipitation of 369 mm in their research area in Uzbekistan, which was 300-600 metres above sea level. For two study areas in Iran, KAMI (1999) gives very different climatic conditions. In the mountain area at an altitude of about 1,200 metres, the average temperature was 12 °C and the average precipitation 217 mm. For his second, lowland, study area no altitude details were given, but the average annual temperature here was 17.7 °C and the precipitation per year was 642 mm. For comparison, Frankfurt/Main (Germany) lies about 100 meters above sea level, with an average annual temperature of about 9.6 °C and about 500 mm precipitation annually.

The highest population density was observed close to river valleys and oasis, where the vegetation was denser and food availability for the tortoises was better. Shallow slopes are preferred habitats in higher locations (400-1,200 m) and steep slopes and stony areas are avoided. The species also occurs in mountain areas, up to about 2,000 m above sea level in the Kopet-Dag region. In Afghanistan several specimens have been found even at an altitude of 2,440 m. The data on population density vary widely due to region and season. In literature, densities of up to 80 specimens per km² are given, but in the detailed study of MICHEL & STÖCK (1996) the densities recorded were between 0.45 (dune area) and 18 (on loamy, sandy soil with woody *Artemisia* species as main vegetation) specimens per hectare. These authors found more females than males and the sex-ratio was 1:1.25 to 1:1.57, depending on the biotope. Juveniles were seldom found, 3 year-old specimens had a weight of about 63 grams, and 5-6 year old specimens between 77 and 180 grams, which indicates that the tortoises grow very slowly in the wild.

Steppe tortoises typically dig burrows. This is reflected in their physique, which shows obvious adaptations to a digging life-style (BONNET et al. 2001). The entrance of the burrow often lies between the roots of a bush, a grass-shrub or beneath a stone/rock. The burrows are long, mostly between 80 cm and 2 m. Other animals also use them for shelter, e.g. lizards or small mammals. The chamber at the end of that burrow generally lies about 30 to 50 cm below the surface. The burrow is not only used for hibernation/aestivation, but also visited regularly in the evenings. It is not defended against other members of the own species and therefore it frequently happens that several tortoises can be found together in one burrow. The tortoises retire from the very high temperatures of the day beneath shrubs or into their burrows at noon. Their dark plastron may be helpful to stand

the heat, because excessive heat can be emitted to the surrounding (see WILLEMSSEN & HAILEY 1999).

The annual activity period of steppe tortoises can be quite short, depending on the geographic location. ATAEV (1985) reports an annual activity period in Turkmenistan of about 100 days. In general, the tortoises emerge from hibernation in February/March and use the short time until the dry period begins for intensive foraging, mating, and for oviposition. After hibernation, the tortoises sometimes deliberately ingest soil that is rich in minerals, as do the American desert tortoises (MARLOW & TOLLESTRUP 1982). Then they feed on almost all available plants, which are young and juicy at first, but become drier and more straw-like later. In most of the distribution area, the onset of aestivation is already in May. Often aestivation directly proceeds into hibernation, and only rarely specimens are seen in autumn. We do not have any data about the temperature in the burrows during the summer months. Temperatures of 5 to 10 °C have been measured in winter, air and body temperatures were the same.

Data on the reproduction in the wild are hard to find, and in most cases these are single observations. KAMI (1999) specifies that mating takes place directly after the hibernation and that egg incubation is between 90 and 105 days.

Requirements of the steppe tortoise in captivity

Steppe tortoises are excellently adapted to the conditions in their natural surroundings. In order to keep them successfully in captivity, several important requirements must be met. These can be deduced from the description of the natural habitat and way of life given above.

Dryness and warmth in summer

The steppe climate should be simulated as closely as possible in the terrarium. This means that dry and hot conditions should be offered immediately after hibernation in spring, which is best realized indoors or in a greenhouse. Steppe tortoises cannot be kept exclusively outdoors in spring, because they cannot stand our typical (northern European) weather conditions in April! But as soon as it becomes warmer in early summer, the tortoises should be moved into a very sunny outdoor enclosure, because the outdoor climatic conditions then correspond more closely to their requirements than any indoor conditions. Because the tortoises are sensitive to high soil humidity, the enclosure should never be situated in a damp surrounding. The tortoises should remain outdoors during summer, but already in August it can be anticipated that they will bury themselves for hibernation. Detailed information about temperature and light requirements can be found in VINKE & VINKE (1997) and WILMS & LÖHR (2000).

Long hibernation

A long hibernation is essential for this species. It is important that the temperature remains constantly low, just like in the well-insulated burrows under natural conditions. Besides of this, the environment should be only mildly humid, since the tortoises are sensitive to dampness. The conditions for successful hibernation have been described repeatedly in different papers by experienced keepers. For further reading we refer the reader to the article by WILMS (2000). Specimens that are kept under constantly warm conditions all year round generally do not live long. Unfortunately, a widespread opinion, even among breeders, is that juveniles should not hibernate at all in their first or second winters. There is no logical reason for this, because the tortoises are neither too small nor too weak, and in the wild, there is nobody to keep them awake and warm! If not allowed to hibernate, the natural biorhythm is disturbed and in most cases, growth problems will appear. Specimens that have been kept awake all year round often grow too fast and normally will not have a stabilised metabolism (for hints about growth in the natural habitat see above). Mostly, they pay for their breeder's ambition with their health or even with their life. The early maturity attained by these speeded-up specimens cannot be used as a favourable argument, because their offspring are sometimes sickly, even when properly and carefully raised. If someone decides to acquire young steppe tortoises, an adequate hibernation facility should be available from the beginning on.

Some steppe tortoises also retire into their burrow and temporarily cease feeding and activity under European outdoor conditions in early July. This corresponds to the natural aestivation period. The tendency for aestivation is very prominent in some specimens imported as adults and mostly diminishes in captivity with passing years.

Furnishing the enclosure

Steppe tortoises living with us also need to feel that they have a burrow. Accordingly, it is important to ensure that the soil in the outdoor enclosure is suitable for the digging of such a shelter. Clay, sandy or loose soils should be mixed into a suitable consistency and especially good tips for this can be found in the article of HENNEN (2000). Some tortoises will even accept artificial hiding places such as roofing tiles. These artificial burrows should be low and flat enough so that the tortoises will reach the "ceiling" with their carapace (which will give them a feeling of security!), or they should be filled with some material that enables the animals to dig in and make their own burrows.

Vegetation

The vegetation should be similar to that in the natural habitat. This means that the enclosure should be sparsely planted and contain many plants with hard and aromatic foliage. Especially good results have been obtained with shrub-like seasoning plants such as lavender (*Lavandula*), true sage (*Salvia*), or santolina (*Santolina*), besides (non-poisonous) small brushes like *Potentilla* or dwarf pines. Herbs will be grazed in most cases. Open areas should be a feature. Burrow digging at the roots of brushes may cause some damage to delicate plants, which should be expected and can be anticipated. The tortoises can sometimes be distracted away from the plant roots by offering them logs or large stones in the enclosure, which can be used to support the burrow entrance. Depending on the orientation of the outdoor-enclosure, a cold frame can be indispensable and will offer a place where the tortoises can find a warm and dry shelter during spells of bad weather. Particular attention should be paid to the surrounding fence, because steppe tortoises are excellent climbers, industrious diggers and therefore notorious escapees. Best results can be achieved with an enclosure of stones or with very stable stockades of about 60 cm height which are embedded 20 cm deep into the soil. Acute angles must be avoided or covered at the top, because the tortoises can use these to gain grip and climb up here very easily. Wire-mesh is absolutely useless, it can be easily scaled (steppe tortoises can climb these fences up to heights of 1.20 metres!), and because it is transparent, it even encourages the will to escape – the grass is always greener on the other side, as everybody knows. In addition, special attention must be taken to ensure that there is enough distance between the shrubs in the enclosure and the terrarium walls, because even their twigs offer possibilities to attempt to climb the fence.

In spring and, depending on the maintenance conditions in autumn too, the tortoises should be housed indoors. Ideal in these periods are moderately heated, well-ventilated greenhouses, but keeping them within the house is also possible. Aquarium tanks or commercial terrariums are hardly suitable. In almost all cases, they are too small and there is insufficient air exchange. The transparent walls may also confuse the tortoises. More suitable are homemade wooden terrariums. Very large containers for hydroculture are quite useful for juveniles. It is important that the walls cannot be climbed but that they also are low enough to allow a good air circulation. In this situation, the indispensable heating lamps can hang from the ceiling or can be fixed to the room sides. What counts is that the tortoises have the possibility to attain an inner body temperature of more than 30 °C to ensure that their digestion will work properly.

Even when kept indoors, the tortoises need a hiding place in any case. Because digging deep burrows is usually impossible indoors, a substitute should be offered, which gives the tortoises at least the feeling of a shelter. For smaller specimens,

this can be easily achieved by using half-round roof tiles or heavy flowerpot fragments. For larger specimens, small dog-kennels or cat toilets have proven useful. The refuges should be filled with an adequate substrate to dig in and hide. Hay or long fibroid straw can be used for this purpose, for example. Because the home range of the steppe tortoises must be very large in their inhospitable native situation, their movement activity is high. For this reason, they need very large, well structured enclosures that invite them to explore, to climb, to dig and to use all the available space for exercise.

Feeding

Steppe tortoises find almost exclusively green and, later in summer, dried plant material for food within their natural habitat. Flowers and fruits as well as animal protein like carrion and excrements are only found exceptionally. Their nutrition generally corresponds to that of other European species and especially to that of tortoises from steppe-like areas. Therefore the feeding recommendations for these species (see e.g. DENNERT 2001) are applicable for steppe tortoises, too. In brief, the tortoises need a diet which is low in proteins and rich in fibres, and which has a well balanced calcium-phosphorus ratio. Particular attention should be paid to the fact that steppe tortoises have a relatively short activity period. Vegetation is available only for a few weeks, therefore the tortoises eat enormous amounts of juicy food on emerging from hibernation and soon appear to be really fat. This is normal and the amounts of food should not be reduced at that time! Dandelion (with flowers!) and other wild herbs should be available at all times after the hibernation, when these are short in supply they can be supplemented by market vegetables and salads (see below). Besides a great quantity of food the tortoises will need a lot of minerals, especially directly after hibernation. After this intensive foraging period, about at the time when the animals can be moved into the outdoor enclosure, the amounts of food can decrease and the efforts for finding it can increase. Now, juicy plants should not be fed every day, but instead, the tortoises should search for food on their own. Sometimes wild herbs like plantain, wild chicory or yarrow can be offered. Additionally, fibrous hay like as is used for horses should always be available. Fine hay for cattle is relatively low in fibres and therefore not as suitable.

Social behaviour

Steppe tortoises are sociable animals – with some reservations! Several females normally get on without any problems and juveniles of about 5 cm carapace length can be kept together with the adults (at this size, they are sufficiently resistant to trampling by the adults). Corresponding to the low population density in the natural range, the males constantly try to expel their rivals and to keep all available

females for themselves. In a terrarium, at best this will lead to a distinct dominance order among the males. In most cases however, it is necessary to separate the males from each other. Only in rare cases it will be possible to keep males and females together all year round, because the persistent courtship attempts of the males, who are capable of inflicting severe injuries to them, will stress the females. In all probability, some separated outdoor enclosures will be necessary when several steppe tortoises are to be kept. A remarkable improvement in the physical condition of the females will be noted if they are kept mainly separated from the males, and the fertilization rate will be equal or even higher than that of the females within a group that is kept together all year round. This corresponds to the experiences with the captive care of several other turtle species (see e.g. MEIER 1997, JOST & JOST 1997, BAUR 1997).

Like many other turtle species, steppe tortoises are stress-sensitive and therefore they should be picked up as little as possible. In the wild, being lifted up means to the turtle that it has been caught by a predator. Presumably it will be very afraid each time it is handled. This should be considered and explained especially to children from the family and neighbourhood. The disposition of steppe tortoise individuals is rather variable. There are specimens that will recognize their keeper and come close if they perceive him, and others which always will prefer to be left alone and do not show any desire for contact with humans. One helpful remark about the perceptive faculties of steppe tortoises: they see very well (in turtles, the colour vision is highly developed), but they do not hear the regular sounds that humans can hear. So it makes no sense to give them names and to call them – they cannot really respond or recognise voices. The reason that some tortoises apparently like music (especially piano music) is based on the vibrations of the ground, which they can feel very well through their plastron.

In general, a combination of steppe tortoises with other species is not recommended. It is possible to keep the females together with those of other European tortoise species, but in this case, all the males should be kept separately. The reason for this is based in the different behaviour patterns (in some species, the males butt and ram the females, in others they bite, which can evoke extreme stress and sometimes severe injuries in tortoises of the other species). Separation also prevents crossbreeding, which has already been described in the steppe tortoise see KABISCH (2001, with *Testudo graeca*) or KIRSCH (1984, with *Testudo hermanni*). A mixed housing of both sexes of different species might be possible in rare cases, but one should be aware of the risks involved. Careful supervision is essential and if the necessity arises, the animals must be separated! It is not possible to keep tortoises in a combined enclosure together with aquatic turtles because of their different requirements and the danger of type-specific parasite transmission. It is also inadvisable to house tortoises together with rodents or other small pet animals.

Some keepers will know from their own experience that dogs like to use tortoises to chew on!

Maintenance of our tortoises

Outdoor pens

The 7 adults and the larger juveniles that are kept by Beate Pfau (BP) have the use of a 20 m² south-facing pen. The two males mate with the females only directly after hibernation. Therefore, with good supervision, it was possible to keep the group together. An additional enclosure for the males is available, just in case. This terrarium is now used for the smaller juveniles. For protection against predators, it is covered with wire. All enclosures are surrounded by walls and planted with several dwarf bushes, butterfly bushes and berry brush for visual protection from the road. Between these bushes grow herbs and grass that are picked from time to time so that they will keep growing and can be used for feeding to the animals. An unplanted section at the sunniest part of the enclosure, next to the wall of the neighbouring house, is kept clear and used for oviposition. Some leftover pieces of a cut down fruit tree are used for digging burrows beneath. Each terrarium has a shallow water basin. To prevent bacteria growth these basins are not filled all the time. At regular intervals, about once a week, they are exposed for a day to the sun for disinfecting. In both enclosures, the ground is relatively dry and has good drainage. This is because the subsoil is of rubble with a 40 cm top layer of garden soil. Artificial burrows or cold frames are not available any more, because these accommodations were not accepted in the past. In cases of very bad weather, the tortoises are brought into the indoor terraria.

Christoph Fritz (CF) has a 50 m² enclosure for his female tortoises where the steppe tortoises live within a small group of mixed *Testudo* species. This is not a problem, because the females are not aggressive to each other. The steppe tortoise males are kept separated from other species because of their aggressive behaviour. Even the 30 cm large males of the marginated tortoise (*Testudo marginata*) get stressed out by their attacks. Both the female and the male enclosure have a cold frame (2 by 1 metres) made of 16 mm doubled glazed windows. A sandy landscape with hills and rocks satisfies the climbing and digging needs of the animals. Some low growing bushes and herbs are present and can be used as hiding places. In the colder months the tortoises retreat at night into the cold frame, where they hide under the straw or soil. In warmer periods they spend the night outside hidden under bushes or half-covered in sand. The meadow adjacent to the terrarium offers fresh greens and can be used during the day by some of the tortoises which are taken out of the terrarium to enjoy this special treat. Fresh drinking water is offered three times a week during summer, but neither CF nor BP have ever seen the steppe tortoises actually drinking while in the outdoor enclosure.

Indoor pens

The larger animals of BP are housed in a wooden terrarium of about 6 m² in the basement, which is lit and heated by a halogen lamp and an infrared emitter. At night the temperature sinks significantly, the air temperature is about 25 °C by day and 15 °C by night. The lamps are fixed at one end of the enclosure creating areas with different soil temperatures. This enables the animals to choose their favourite temperature at any time. The ground is a mixture of wood shavings, cut straw, hay and garden soil. A cat litter box filled with hay offers the possibility to dig in and hide. Rocks and logs serve for climbing and as visual barriers. The smaller juveniles are kept in a wooden terrarium of about 0.8 m² with similar features. For the adults that are kept inside for a longer period an ultra-vitalux-lamp is used twice a week for approximately an hour each time. In comparison, the juveniles get ultra-violet radiation from a UV emitting tube light or a special bulb for the whole day.

CF keeps his animals after hibernation also in an indoor terrarium. A mixture of soil and sand is used as a substrate for the younger animals. For the adults, rough pine bark is mixed with beech wood chips. It is very important to offer a separate feeding surface to prevent the intake of wooden pieces. Hiding places and a root to climb on are present in all the terraria. The lighting consists of fluorescent tubes and spot lamps. An ultra-vitalux-lamp is used twice a week for about 20 to 30 minutes per time.

Feeding

The animals are fed with wild herbs and vegetables from our own gardens as much as possible. After hibernation, which is the time of the most intense feeding, this is not easy. During this period, an adult steppe tortoise consumes half a head of endive or an equivalent amount of other foods per day. At first, from February to April, we are only able to collect enough wild feed for the juveniles. At that time the preferred plants are dandelion, chickweed or dead-nettle which are offered with roots if possible. The adults get store-bought vegetables in addition to the wild feed available. We buy preferably romaine salad but also cultivated dandelion, endive, corn lettuce, radish leaves and varied cabbage sorts for them. Soaked hay pellets for horses are offered to adult and juvenile tortoises. Hay is available at all times. From the middle of April on, it is possible to find enough wild herbs even for the adults and the amounts of store-bought food can be reduced. Depending on weather conditions the animals are moved into the outdoor enclosures about middle of May. CF can move his adults to the outdoor enclosures earlier, because of the well insulated cold frames there. Outside the animals can graze as they wish. When the animals are outdoors, BP feeds supplemental food about three times a

week, at first mostly dandelion, then during summer harder and more fibrous herbs and also e.g. foliage of (unsprayed!) fruit trees and willows. For CF's animals the enclosures and the adjacent meadow offer enough food. In addition both groups of tortoises get seasonal fruits, like strawberries, black currants or apricots. This happens only under close supervision and for control to see if all animals are in good condition and really show up to greedily eat the rarely offered treats. Food of animal origin is deliberately not offered and the tortoises disregard snails and earthworms in the outdoor pen. For the steppe tortoises it is very important to get a sufficient provision of minerals. Therefore BP adds a nutritional supplement for humans made from loess loam ("Heilerde", from the health-food store) to imitate the increased mineral intake that has been observed in the natural habitat after hibernation (see above). Additionally garden soil is available and the wild herbs are offered with their roots. Calcium is provided in the form of cuttlefish bone. The calcium intake is left to the animals themselves and, depending on their individual needs, they can take in as much as they want. Females bite off chunks and even the juveniles like to chew on them. The tortoises of BP do not accept ground eggshells, even though they like to nibble on empty snails' shells outdoors. CF's animals like to eat eggshells outdoors, but only after they have been weathered for a while.

Hibernation

About middle of August, our steppe tortoises start to prepare themselves for hibernation. They feed less, move less and dig deeper burrows. About middle of September they will disappear totally below ground. We think that the onset of hibernation is triggered by daylength and not by weather conditions. This thesis is supported by the experiences of a tortoise keeper on the Côte d'Azur. His steppe tortoises begin to hibernate about at the same time, even though it is still summer there.

BP's animals spend their hibernation in the refrigerator (see also ADAM 1993). As soon as the animals start to dig in, which often happens already in August, they are brought indoors. In the outdoor pen of BP it is practically impossible to find buried animals and outdoor hibernation in our wet climate is too risky. They hardly feed any more and BP chooses not to bathe them, but water is still at their disposal. After some days or a few weeks the animals hide themselves permanently. Then they are put into perforated bowls filled with a moss-leaf mixture which are then placed in the refrigerator. The temperature is fixed at a constant 5-6 °C and once a week the door is opened to exchange air and to control humidity – even steppe tortoises should not be allowed to dry out totally during hibernation! The humidity is controlled by feeling the substrate, which must not be so wet that water can be squeezed out. When the uppermost leaves are getting really dry, water is sprayed on the substrate until the desired humidity is reached. With this hibernation method

few losses occur. Before this method was used, the steppe tortoises were treated like other European tortoises and hibernated in a cool basement. This was less successful, because cases of colds and pneumonia occurred. Steppe tortoises probably do better at a relatively constant low hibernation temperature and the variable temperatures in that basement may have been too extreme. About at the end of February the animals are taken out from the refrigerator and put into an unheated pen in the cellar. Within a 2-week period, the duration of lighting and temperature are increased step by step till they reach normal levels. As soon as the heating enables the animals to raise their body temperature to at least 30 °C, they are bathed in regular intervals. This is done to simulate the spring rains in their natural environment. Soon after this food is offered and the animals will start feeding.

Also around the middle of August to mid-September, CF's animals stop feeding and bury themselves. His animals remain outside until they disappear. Because of the high ground humidity the tortoises are dug out in the late fall and moved to a cool but frost-proof room. The juveniles are hibernated in a refrigerator. At the end of February, when the temperatures rise, the animals awake and are moved into an indoor terrarium in the greenhouse with much the same regime as with BP. Since CF's outdoor enclosures are equipped with well insulated cold frames, the adults can be brought there in April or in some years already in March, depending on weather conditions. The juveniles remain indoors until May.

Courtship and mating

Directly after the end of hibernation the male Steppe tortoises become very active and start looking for females. At first visual contact with another tortoise, the male starts to bob his head, which is a rather funny sight to the observer. If he assumes that the other tortoise is a female, he bites her front and hind limbs until she stops walking. Then he can attempt to mount her. Normally our females mate only once or twice in the spring. Most other mating attempts are forced and often unsuccessful. The persistent mating attempts by the males may stress the females and result in high injury risks from biting. Therefore it is advisable to keep the sexes separated after the mating season. Our steppe tortoises show no mating activity in the fall as is observed in many other turtle species. For successfully breeding this species it is sufficient to keep the males with the females only for a couple of days after hibernation.

Oviposition, incubation and raising

In the females, imminent oviposition is indicated by increased restlessness, reduced feeding and a permanent state of high activity. The first nesting occurs about 6-8 weeks after the end of hibernation, and the second mostly within 4 weeks

of the first. The exact timing of nesting cannot be predicted as accurately as with the Herman's tortoise, for example. The female steppe tortoise buries the clutch normally 2-5 cm deep in the ground. Because the first oviposition of our tortoises occurs sometimes during the indoor housing period, special nesting sites have to be offered. Under good weather conditions, a gravid female can be moved to the outdoor enclosure in the morning, where the oviposition typically takes place around midday. In the evening, the animal can be brought back inside. In cases of bad weather, one of BP's females also accepted a plastic tub (for mixing cement) filled with wood shavings and hay. In order to offer the right temperatures to the female, the tub was put onto a heating pad, as the nesting site has to appear relatively warm to the tortoise. Her other females insist on a natural nesting in soil and have to be moved at least to the cold frame for nesting if the spring weather is too cold. This is not very good for the vegetables normally grown there and works only as an emergency solution!

At CFs, nesting takes place without exception at end of April / beginning of May, which is mostly shortly after the indoor period for his adults. For nesting, the sun has to shine, but the substrate often is relatively cold. Even under these conditions there have been no problems with egg retention.

Outdoor nests are usually well camouflaged and it is sometimes very difficult to find the second clutch. A method that can be used for Mediterranean tortoises – to mark all possible nesting sites with a coloured substrate which is visibly mixed with the lower soil after nesting – does not work with steppe tortoises because of their strongly developed digging behaviour. Usually they will dig over the place, having nested or not.

The clutch size normally ranges from 1-4 eggs, in case of very big specimens there can be up to five eggs per clutch. CF's biggest and oldest female nests at least once per year and always lays 5 eggs per clutch! Second clutches will be produced especially if the female had been well fed the previous year, and if the weather conditions were favourable. After bad years, a female might not nest at all. During the 2000 breeding season, a female in CF's group laid 3 single eggs at intervals of 2-3 weeks, but it is not known if these were 3 separate single egg clutches or staggered laying of one clutch.

An unusual, pale greenish coloured young female of unknown origin laid 3 clutches of altogether 22 eggs, 18 of which hatched, within her first year after attaining sexual maturity. It is possible that this female belongs to a different subspecies than the commonly kept specimens. This animal is hibernated under similar conditions but remains distinctly longer underground than the other steppe tortoises of her owner. Additionally, it also searches actively for food that is rich in protein, like earthworms and snails. Due to the fact that the geographical origin of this female is unknown and an identification of the subspecies without knowledge

its geographic origin is still almost impossible, a more detailed report about its classification cannot be given here. We just give these observations as an example of the variability within this species that might relate to the animal's origin.

The steppe tortoise eggs are incubated in a dry substrate (Perlite, Vermiculite or bird-sand) at about 80 % relative humidity and 30-35 °C in still air incubators. If the substrate is too moist, the eggshells will burst open and the embryos will die. If the young are completely developed, hatching can be induced by increasing the substrate humidity. The eggs take between 62-77 days at a temperature of 32-35 °C (CF) and 65-82 days at 30-33 °C (BP). Eggs from second clutches and eggs from delayed nestings may have even shorter incubation times. The high incubation temperature used by CF did not cause any negative effects on the hatchlings!

The embryonic tortoise lies laterally in the elongated egg and therefore it is folded when it hatches. Some steppe tortoise hatchlings appear quite distorted at first. They start to stretch slowly, and after a couple of days they attain the regular tortoise shape. For some animals this is the first time they can actually reach the ground with all four legs simultaneously. After hatching, the young remain in the incubator on humid blotting paper until the yolk sac is completely absorbed or until the yolk sac remains have at least withdrawn to leave a tough skin. Then they can be moved to an indoor raising-pen. Sometimes a hatchling gets stuck under the offered shelters (roof-tiles) in such a way that the carapace will be deformed again. In that case, some hours or days later the typical carapace shape restores itself. As soon as the hatchlings feed readily and run around vivaciously, they are moved to a separate outdoor enclosure which is covered with chicken-wire against predators. Here they remain until the end of August. Already in their first year they are hibernated under the same conditions as the adults. In general, hibernation lasts already between 3 and 5 months during the first year, just like in nature. Only exceptionally, after a very bad summer season, the hibernation time is reduced, but even in this case they hibernate for at least 8 weeks.

The requirements for raising the juveniles are the same as described for keeping the adults. As much as possible of suitable wild herbs is offered for feeding. Special care is taken not only for sufficient provision in calcium and minerals, but also for UV-radiation as well as for drinking water, which is always available. Animal protein is never offered of course! Under these conditions, the animals grow slowly, but similar to their natural growth rate. At the age of 12 years, a captive bred female from BP had a carapace length of 11 cm and had not yet attained sexual maturity. Juveniles that have been "speeded up" by overfeeding, a protein-rich diet and lack of hibernation can mature within three years, but they usually develop several metabolic problems and are very susceptible for diseases (see below). If someone is intending to obtain steppe tortoises, attention should be paid that the animals have not been grown too fast. Such an animal will bring more

troubles than fun!

Diseases and preventative measures

An amateur can make a lot of mistakes with the dietary management. Some tortoises receive totally unnatural and unsuitable foodstuffs, such as milk soaked rusks, vanilla pudding or the like. But one should realize that the metabolism of steppe tortoises is adapted to the plants available in their sparse habitat. Foods offered should be as close as possible to what they would find under natural conditions. Diseases that are caused through wrong captive maintenance will not be discussed here, instead the book by DENNERT (2001), as well as the reports of VINKE & VINKE (1998) and WIECHERT (2000) are recommended.

A very important aspect in the acquisition of steppe tortoises is to avoid sick animals. Especially during mass transport, the tortoises are often so poorly housed that cross infection is unavoidable. The description of the transport conditions given by SASSENBURG (1993) is something for those with a strong stomach! Even today, cheap tortoises smuggled from Eastern Europe may have had to endure comparable conditions during their transport. Since around 1994, there are reports of infections with herpes-virus, especially among steppe tortoises. The herpes virus appeared meanwhile in various new strains (BLAHAK 1998, KABISCH & FROST 1994, MARSCHANG, GRAVENDYCK & KALETA 1999, WIECHERT 2000). This disease is incurable and the (few) animals that survive an infection may in turn infect a healthy collection, and can cause the death of all or almost all animals. By the way, the virus is not type-specific and can be transmitted to other tortoise species and even to certain aquatic turtles. The only way to avoid an infection is to consistently quarantine newly purchased specimens and have a blood test carried out, even though it is expensive. After 4 and 12 weeks negative tests should be repeated in order to exclude that an infection has occurred shortly before receiving the animals, because the replication of viruses and the immune response leading to antibody formation takes some time. Also a long lasting silent virus infection which could result in a new outbreak due to stress associated with the new environment and the following immune response could need weeks to result in detectable titers of antibodies. This testing procedure is invaluable, but not yet accepted as standard by all tortoise keepers. It is most likely that the herpes virus has already crossed between species. If someone has had specimens with this disease once, this check up will certainly have to be done for the whole livestock, and all new animals from untested stock must be carefully kept isolated and tested before being introduced to others.

Summary

Steppe tortoises are very interesting captives that require species-specific care.

They need a warm and dry accommodation and a lot of fresh, leafy plant food in spring. A large and well-planned outdoor terrarium is necessary during summer and in addition, the need a long hibernation period in the winter. If these requirements are met, steppe tortoises will not do justice to their reputation as troublesome diggers and notorious escapees, but they will become lovely companions and provide much pleasure by observing and particularly by breeding them.

We tried to provide information on the requirements of these animals which we deducted from their natural history, and we tried to show how these requirements can be met in captivity. We are aware of the fact that our experiences and mentioned opinions may vary from those of others and therefore welcome any input or comments from other keepers.

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Authors

Christoph Fritz

Email: ChristophFritz@web.de

Dr. Beate Pfau

Email: bpfau@terrapro.de

Translated from German by OLIVER MEINHARDT, Mannheim, Germany.

Keeper of the ESF studbook *Testudo horsfieldii*: Ruurd van Donkelaar, Laantje 1,
NL-4251 EL Werkendam, Email: ruurdvandonkelaar@worldmail.nl