Husbandry Guidelines
For
Indian Star Tortoise
Geochelone elegans
(Reptilia:Emydidae)

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DISCLAIMER

OCCUPATIONAL HEALTH AND SAFETY RISKS

One of the biggest OHS risks associated with keeping Indian Star Tortoises in captivity is the possible link between tortoises and the Salmonella Bacteria. Almost all chelonians carry salmonella bacteria within their intestinal tracts, and will usually never suffer any health problems during their life; however Salmonella can be a problem for humans. This is where practicing proper tortoise hygiene and acknowledging common-sense precautions to prevent the spread of Salmonella infection should come into your animal husbandry.

What is Salmonella?: Salmonella is a microscopic, living bacterium, which is most commonly heard about in uncooked poultry but is also commonly found in tortoise faeces and any thing contaminated by your tortoise's faeces such as the water-dish. Salmonellosis is the infection cause by the salmonella bacteria, which can affect humans, sometimes fatally.[111]

What are the symptoms of Salmonellosis?: The average person with a healthy immune system may experience fever, diarrhoea, abdominal cramps, headache, chills, and nausea if they have contracted Salmonellosis. These symptoms can appear within 8 to 72 hours after getting infected, and go away after about 4 to 7 days – often with no medical treatment.

How does Salmonellosis infection in humans from tortoises occur?

Contracting a Salmonellosis infection from a tortoise may occur in three ways:

1. First, the tortoise may roam around in its captive environment, but outside of its enclosure, and leave a trail of salmonella behind.
2. Second, tortoise equipment (terrariums, vivariums, water-dishes, food bowls) might come in contact with human food preparation areas or human eating dishes during cleaning.
3. Third and most common, when you touch a tortoise or some salmonella-contaminated material, i.e. faeces, dirty water-dishes, enclosure substrate, and then transfer the bacteria on your hand to your mouth, eyes, or open wound (scratches, cuts etc.) on your body.

What precautions can be taken to prevent Salmonellosis infection?

1. Personal hygiene should be of a high standard at all times.
2. Wear disposable gloves during animal handling or enclosure cleaning, or ensure that all exposed parts of the body are thoroughly washed with an anti-bacterial soap and hot water for at least 20 seconds.
3. Keep all cuts, abrasions, etc. clean and dry and covered by a suitable waterproof dressing.
4. If possible change clothing before and after work and ensure that clothing is thoroughly cleaned after use.
5. Any sick tortoises should be segregated or isolated and treated with caution.
6. Protective clothing should be worn, especially when handling sick or infected animals. Waterproof aprons and boots should be thoroughly washed and disinfected after use.
7. Keep a set of dishes and cleaning materials, such as sponges, that only get used for tortoise use. Never store them with dishes and sponges used for human use.
8. Have a separate area for all tortoise washing tasks, cleaning of dishes, furniture, equipment, tortoise food preparation and human food preparation and cleaning to prevent any cross contamination.
    - Even though separate areas are used, make sure any sinks, surface that have come in contact with possibly contaminated liquids, substrates or equipment, are

sterilised with hot water and a bleach solution or Animal House Veterinary Disinfectant.

9. Ensure arrangements are in place for disposal of any possibly infected materials safely.
10. Never ignore and always suspect any symptoms or lesions such as: - 'Flu-like' (fevers); chills, sweats, fatigue & depressions; unexplained weight losses; gastrointestinal upsets e.g. Diarrhoea, nausea, sickness; muscle aches and stiffness; muscle spasms; hydrophobia; jaundice; conjunctivitis, fits; septic lesions; skin rashes, etc.; and any respiratory problems.[16,46,49,58,60]

TABLE OF CONTENTS

1 INTRODUCTION 8

2 TAXONOMY 10

2.1 NOMENCLATURE 10
2.2 SUBSPECIES 10
2.3 RECENT SYNONYMS 10
2.4 OTHER COMMON NAMES 11

3 NATURAL HISTORY 11

3.1 MORPHOMETRICS 12
3.1.1 Mass And Basic Body Measurements 12
3.1.2 Sexual Dimorphism 13
3.1.3 Distinguishing Features 13
3.2 DISTRIBUTION AND HABITAT 16
3.3 CONSERVATION STATUS ..... **ERROR! BOOKMARK NOT DEFINED.**
3.4 LONGEVITY 17
3.4.1 In the Wild 17
3.4.2 In Captivity 17
3.4.3 Techniques Used to Determine Age in Adults 17

4 HOUSING REQUIREMENTS 19

4.1 EXHIBIT/ENCLOSURE DESIGN 19
4.2 HOLDING AREA DESIGN 21
4.3 SPATIAL REQUIREMENTS 29
4.4 POSITION OF ENCLOSURES 30
4.5 WEATHER PROTECTION 30
4.6 TEMPERATURE REQUIREMENTS 32
4.7 SUBSTRATE 34
4.8 NESTBOXES AND/OR BEDDING MATERIAL 41
4.9 ENCLOSURE FURNISHINGS 44

5 GENERAL HUSBANDRY 45

5.1 HYGIENE AND CLEANING 45
5.2 RECORD KEEPING 50
5.3 METHODS OF IDENTIFICATION 51
5.4 ROUTINE DATA COLLECTION 52

6 FEEDING REQUIREMENTS 54

6.1 DIET IN THE WILD 55
6.2 CAPTIVE DIET 55
6.3 SUPPLEMENTS 61
6.4 PRESENTATION OF FOOD 62

7 HANDLING AND TRANSPORT 64

7.1 TIMING OF CAPTURE AND HANDLING 64
7.2 CATCHING BAGS 64
7.3 CAPTURE AND RESTRAINT TECHNIQUES 64
7.4 WEIGHING AND EXAMINATION 65
7.5 RELEASE 66
7.6 TRANSPORT REQUIREMENTS 66
7.6.1 Box Design 67
7.6.2 Furnishings 69
7.6.3 Water and Food 69

7.6.4 Animals per Box ... *69*
7.6.5 Timing of Transportation ... *69*
7.6.6 Release from Box ... *70*

8 HEALTH REQUIREMENTS ... 71

8.1 DAILY HEALTH CHECKS ... 71
8.2 DETAILED PHYSICAL EXAMINATION ... 71
8.2.1 Chemical Restraint ... *71*
8.2.2 Physical Examination ... *73*
8.3 ROUTINE TREATMENTS ... 75
8.4 KNOWN HEALTH PROBLEMS ... 76
8.5 QUARANTINE REQUIREMENTS ... 86

9 BEHAVIOUR ... 88

9.1 HABITS ... 88
9.2 REPRODUCTIVE BEHAVIOUR ... 88
9.2.1 Mating Behaviour ... 89
9.2.2 Gravid Behaviour ... 89
9.2.3 Laying Behaviour ... 89
9.3 BATHING ... 89
9.4 LOCOMOTION ... 90
9.5 BEHAVIOURAL PROBLEMS ... 90
9.5.1 Signs of stress ... 90
9.6 BEHAVIOURAL ENRICHMENT ... 91
9.7 INTRODUCTIONS AND REMOVALS ... 91
9.8 INTRASPECIFIC COMPATIBILITY ... 92
9.9 INTERSPECIFIC COMPATIBILITY ... 92

10 BREEDING ... 93

10.1 MATING SYSTEM ... 93
10.2 EASE OF BREEDING ... 93
10.3 REPRODUCTIVE CONDITION ... 93
10.4 TECHNIQUES USED TO CONTROL BREEDING ... 93
10.5 OCCURRENCE OF HYBRIDS ... 93
10.6 TIMING OF BREEDING ... 94
10.7 AGE AT FIRST BREEDING AND LAST BREEDING ... 94
10.8 ABILITY TO BREED EVERY YEAR ... 95
10.9 ABILITY TO BREED MORE THAN ONCE PER YEAR ... 95
10.10 NESTING, HOLLOW OR OTHER REQUIREMENTS ... 95
10.11 BREEDING DIET ... 96
10.12 INCUBATION PERIOD ... 96
10.13 CLUTCH SIZE ... 97
10.14 AGE AT WEANING ... 97
10.15 AGE OF REMOVAL FROM PARENTS ... 97
10.16 GROWTH AND DEVELOPMENT ... 96

11 ARTIFICIAL REARING ... 99

11.1 INCUBATOR TYPE ... 99
11.2 INCUBATION TEMPERATURE AND HUMIDITY ... 100
11.3 DESIRED % EGG MASS LOSS ... 101
11.4 HATCHING TEMPERATURE AND HUMIDITY ... 101
11.5 NORMAL PIP TO HATCH INTERVAL ... 101
11.6 DIET AND FEEDING ROUTINE ... 101
11.7 SPECIFIC REQUIREMENTS ... 102
11.8 DATA RECORDING ... 103
11.9 IDENTIFICATION METHODS ... 104

11.10 HYGIENE 104
11.11 BEHAVIOURAL CONSIDERATIONS 105
12 ACKNOWLEDGEMENTS 106
13 REFERENCES & PHOTO CREDITS 107
14 BIBLIOGRAPHY 115
15 GLOSSARY 116
16 APPENDICES 121

1 Introduction

The Star tortoise belongs to a group of tortoises that bear a unique radiating star pattern on their carapaces. Variations of this pattern are quite common and are - despite the eye-catching appearance in unnatural surroundings - a very efficient means of camouflage. The Indian Star Tortoise has been since the early days of herpetoculture much sought after among tortoise enthusiasts and commercial trade, legal as well as illegal has together with the ever-present habitat destruction led to all these species becoming locally or regionally threatened. The Indian Star Tortoise has traditionally been the most common species kept in captivity, much due to an historical extensive trade in wild caught specimens mainly from Sri Lanka.

The Indian Star Tortoise has been identified as a regional flagship taxon for the Asian Turtle Crisis. Wild populations are being heavily impacted by the collection of the species for the international pet trade, and to a lesser degree food. As such, it has become part of the Asian Turtle Crisis and should be a good species to highlight this issue through proper interpretation and education (ASMP 2009).

Importance to humans

In captivity

1.1 ASMP Category

ASMP Reptile and Amphibian TAG – Management Level 3 – No Regional Program

TAG Notes: Identified as a regional flagship taxon for the Asian Turtle Crisis. Wild populations are heavily impacted by collection for the international pet trade, and, to a lesser degree, food. As such, it has become part of the Asian Turtle Crisis and is, therefore, a good species to highlight this issue through appropriate interpretation. Need to develop a program outline

1.2 IUCN Category

LR/lc – Least Concern

LOWER RISK (LR) - A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable.
Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.

1.3 EA Category

CITES listing – Appendix II – Needs an export permit only to facilitate its legal crossing of international boundaries and only if “the export will not be detrimental to the survival of the species.”

Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called "look-alike species", i.e. species of which the specimens in trade look like those of species listed for conservation reasons. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. No import permit is necessary for these species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild.

VPC 2 - Limited to statutory zoos or endorsed special collections

Indian Wildlife Protection Act 1972 – List IV – Trade of species illegal, but penalties not as great as with a Schedule I or II animal

1.4 NZ and PNG Categories and Legislation

N/A

1.5 Wild Population Management

Very little is known about the Indian Star Tortoise in its wild habitat and precise information is required on the status of the species in the wild. Studies are currently ongoing in the wild in relation to the affect of the illegal pet trade on the species.

1.6 ARAZPA Species Contact

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1.7 Studbook Holder/AZA Population Manager

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2 Taxonomy

2.1 Nomenclature

Current

- Class: *Sauropsida*
- Order: *Testudines*
- Family: *Emydidae*
- Genus: *Geochelone* - Fitzinger, 1835
- Specific name: *elegans* - SCHOEPFF 1795
- Scientific name: - *Geochelone elegans* SCHOEPFF 1795 (Figure 1)[76]

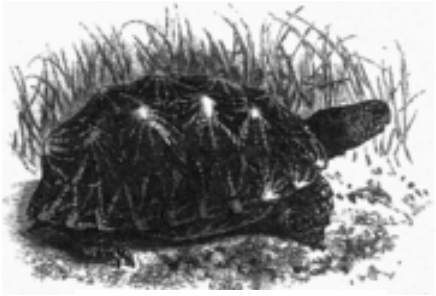


Fig 1 – Geochelone elegans – SCHOEPFF 1795

2.2 Subspecies

No recognised subspecies, but has three geographical variants:

a) Northern India (Gujarat, Rajasthan, Uttar Pradesh) and Pakistan[21]
- Very large in size
- Relatively dark ground colour
- 'Black' field of shell, more often brown than black
- 'Dirty' appearance when compared to Southern Indian Star Tortoises

b) Southern India (Tamil Nadu, Kerala, Karnataka)
- Smaller in size than northern Indian Star Tortoises
- Have more contrasting pattern with crème-yellow ground colour
- Jet black dark fields

c) Sri Lanka
- Look much like Indian Star tortoises from Southern mainland
- Grow nearly as large as Indian Star Tortoises from Northern India and Pakistan
- Sri Lankan Stars can only be distinguished from Indian Stars if their origin is known
- Has more natural pyramiding and more yellow in markings

There is a distinct possibility that the species will be divided into several subspecies, or maybe even separate species in the future.[30]

2.3 Recent Synonyms

1. Original name - *Testudo elegans*
2. *Testudo elegans* Schoepff 1795
3. *Testudo stellata* Schweigger 1812
4. *Testudo actinodes* Bell 1828a
5. *Testudo megalopus* Blyth 1853

In some old literature, *Testudo geometrica* was used; *Testudo geometrica* is really the original name for the Geometric tortoise from Africa, now called *Psammobates geometricus*.[76]

2.4 Other Common Names

- Star Tortoise
- Sri Lankan Star tortoise - Indian Star tortoises native to Sri Lanka
- Indische Sternschildkröte - German
- Indische stralenschildpad - Dutch
- Indisk Stjärnsköldpadda - Swedish
- Intian tähtikilpikonna - Finnish
- Tortuga estrellada de la India - Spanish
- Tortue étoilée d'Inde - French

The Indian Star tortoise has numerous local names in India, here are a few examples:

- hooniam ibba (magic tortoise) - Sinhalese
- katu aamai (forest tortoise) - Tamil
- kattupota aamai (checked tortoise) - Tamil
- meta tabelu (land tortoise) - Telugu
- suraj kachba (sun tortoise) - Gujarati
- tariwala kachua (star tortoise) - Urdu
- vairan ibba (striped tortoise) – Sinhalese[76]

3 Natural History

The Indian Star Tortoise prefers the dry areas of southern India, containing a large variety of herbaceous plants, but it is also found in some green prairies farther to the north and the west of India. During the dry season, the Indian stars are active in the morning and hide during the day. They become very active when the rains occur, during which time they mate and feed extensively. This is an herbivorous species, showing a fondness for fruits and vegetables, as well as succulent plants, while during the dry season it feeds upon dead leaves and spiny vegetation. In Sri Lanka it is known to consume the fruits of the pawpaw tree, although doing so may lead to death through intestinal impaction[30]. It has also been seen feeding on lizards, dead rats, and insects.

In the western part of the range, it spends several weeks each year in hibernation when the temperatures become cool, especially at night. This is due to a geographical variant as the Indian Star Tortoise is not usually a hibernating species of tortoise. Sexual maturity arrives quite early for the Indian Star Tortoise: some individuals have been seen copulating at just five or six years of age. The mating seasons coincides with the monsoon seasons. Courtship efforts from the male are brief and rather gentle, quite the opposite when compared with other tortoise species; they do not injure the females or bite them and they rarely engage in male-male combat. Most nesting occurs from May to June and again in October. The eggs are elliptical or nearly spherical and are rather large for this small species of tortoise, measuring about 40x32 mm. the eggs number three to six, with a maximum of four nestings per season. Incubation lasts for 110 to 130 days. In the course of an entire season, a female may lay up to 24 eggs.[6,29,79]

The Indian Star Tortoise is the most commonly held of all the starred species to be held in captivity, due to the large and extensive historical trade in wild caught specimens mainly from Sri Lanka[30,91]. The present status of the species is unclear, and since there are very few reliable sources describing its historical distribution, it is very hard to determine how the Indian star will manage in the future. It is therefore of the greatest importance that the remaining Indian star populations all over the species range are studied and protected, because if the human population in India keeps rising as quickly as it has done in the last 50 years then the Indian Star tortoise will face great problems.

3.1 Morphometrics

Carapace very convex, dorsal shields often forming humps; lateral margins nearly vertical; posterior margin somewhat expanded and strongly serrated; no nuchal; supracaudal undivided, incurved in the male; shields strongly striated concentrically; first vertebral longer than broad, the others broader than long, third at least as broad as the corresponding costal. Plastron large, truncated or openly notched in front, deeply notched, bifid behind; suture between the humerals much longer than that between the femorals; suture between the pectorals very short; axillary and inguinal rather small. Head moderate; forehead swollen, convex, and covered with rather small and irregular shields; beak feebly hooked, bi- or tricuspid; edge of jaws denticulated; alveolar ridge of upper jaw strong. Outer-anterior face of fore limb with numerous unequal-sized, large, imbricate, bony, pointed tubercles; heel with large, more or less spur-like tubercles; a group of large conical or subconical tubercles on the hinder side of the thigh. Carapace black, with yellow areolae from which yellow streaks radiate; these streaks usually narrow and very numerous: plastron likewise with black and yellow radiating streaks (Figure 3).[94]

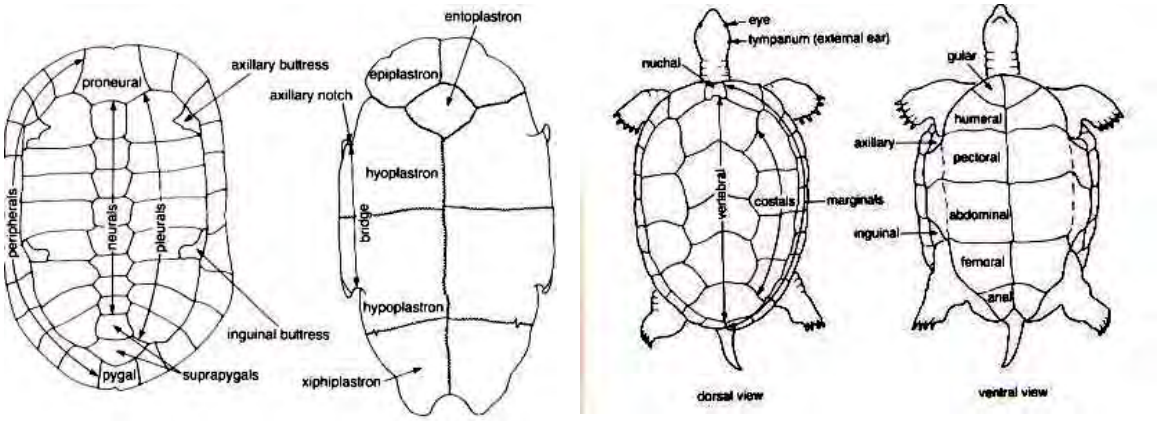


Fig 3 Morphometrics of Indian Star Tortoise

3.1.1 Mass and Basic Body Measurements

Male

- Straight Carapace Length (SCL) = 15-20cm (5-8 inches)

Female

- Straight Carapace Length (SCL) = 30-38cm (12-15 inches)

Weights

- Ranging from 1-7kg (2.2-15lb) – Males generally weigh less that the females[6,11,65, 79]

Interesting Fact
The specimen that so far holds the size record was a female from Northern India, which weighed 7kg and measures a SCL of 380mm[11]. Confirmation of the validity of this statement is yet to be determined.

3.1.2 Sexual Dimorphism

The Indian Star Tortoise is a sexually dimorphic species, which is quite apparent, with females growing too much larger sizes than their male counterparts. A typical male Star tortoise is about 20cm (8 inches) in Straight Carapace Length (SCL) while a female may grow as large as 30cm (12 inches).

Aside from the size variation and as with several other tortoises there are several differences between male and female Indian Star tortoises. The best way to determine sex is by looking at the tail; the males have a much longer tail, while the females have a much shorter tails as well as a much more rounded appearance, placed side-by-side it's obvious which is male and which is female (Figures 3 & 4).
In addition to these characteristics, the males may have a slightly concave plastron while the plastron of a female is typically flat. Males may also have a "V" shaped notch between the anal and supracaudal plates whereas it is larger and typically "U" shaped in the females.[30,78,94,]

Fig 3 & 4 – Left – Male Geochelone elegans, Right – Female Geochelone elegans

3.1.3 Distinguishing Features

Numerous tortoise species in the world, from South Africa and Madagascar to India, may be described as "starred." Although these species may seem to be so similar as to be closely related, the patterns represent convergence of evolution in response to factors of climate and ecosystem, rather than relationship.[10]

To distinguish the Indian Star Tortoise from other starred tortoises, Burmese Star Tortoise *Geochelone platynota* and Radiated Tortoise *Astrochelys radiata* or *Geochelone radiata*, the following characteristics should be used to identify between the different species.

The Indian star does not grown larger than 380mm in length and 7kg in weight; the larger radiating scutes of the carapace often have a concial form (Figure 5), especially in Sri Lankan Indian star females, *A. radiata* has a more evenly rounded carapace (Figure 6), with vertical marginals on the sides, whereas *G. platynota* has flat carapace scutes, with no concial form (Figure 7); the posterior marginals have lightly serrated edges, especially in juveniles; the middle scutes of the carapace are somewhat narrowed; and there is no nuchal scute. *G. platynota* also has no nuchal scute but the nuchal scute is present in *A. radiata*.[10,91]

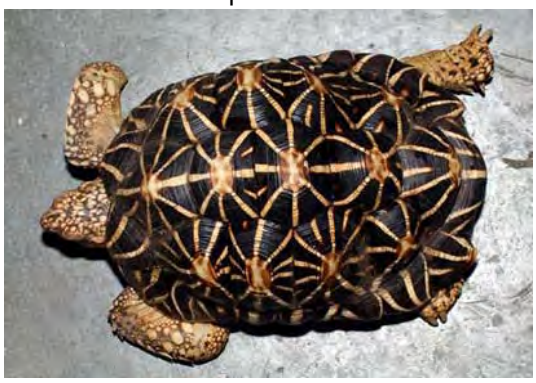


Fig 5 Geochelone elegans cara

Fig 6 Astrochelys radiata carapace

Fig 7 Geochelone platynota carapace

The black rays forming the stars on the scutes extend in all directions (Figure 8), while in *A. radiata* they form a fanlike design on only about one quarter of the scute (Figure 9). In *G. platynota*, the colouration is more subtle, with the dark rays being fewer in number and the background creamy white rather than yellow (Figure 10).

Fig 8 Geochelone elegans carapacial scute

Fig 9 Geochelone platynota carapacial scutes

Fig 10 Astrochelys radiata carapacial scutes

The areolae of *G. elegans* are often brown to orangish and form slightly raised platforms. The limbs are rather short and have large round scales, encircled with black. The head is also rather small, with small yellow scales on a black background, while *A. radiata* has a bicoloured head – brown-black on top and yellow below the eye and *G. platynota* has a uniformly brown-cream coloured head. The plastron is yellow with black rays (Figure 11). *G. platynota* has a plastron decorated with a black triangle on each scute, with a light yellow or orange background (Figure 12). The plastron of *A. radiata* is similar in colouration to that of *G. platynota* but is otherwise immobile or unhinged (Figure 13). The females are larger than the males, and the latter have a fairly concave plastron, with thickened xiphiplastra. The young are almost entirely yellow or orange-yellow, with dark markings along the seams.[10,89,91]

Fig 11 Geochelone elegans plastron

Fig 12 Geochelone platynota plastron

Fig 13 Astrochelys radiata carapacial plastron

3.2 Distribution and Habitat

The range of this species has two distinct parts, one in the northwest of India from Gujarat into South-eastern Pakistan, and the other in Southern India from the south of the Ganges Delta to the southern top of the peninsula (except Lower Bengali) and into Sri Lanka (Ceylon)(Figure 14). No comprehensive studies on population density of the Indian Star Tortoise have been completed, but existing data implies that the density varies greatly between the different habitat types. In Central India, a figure of 1 tortoise per sq. km. has been mentioned, whereas the density for central Gujurat has been estimated at 4-12.5 individuals per hectare.[30]

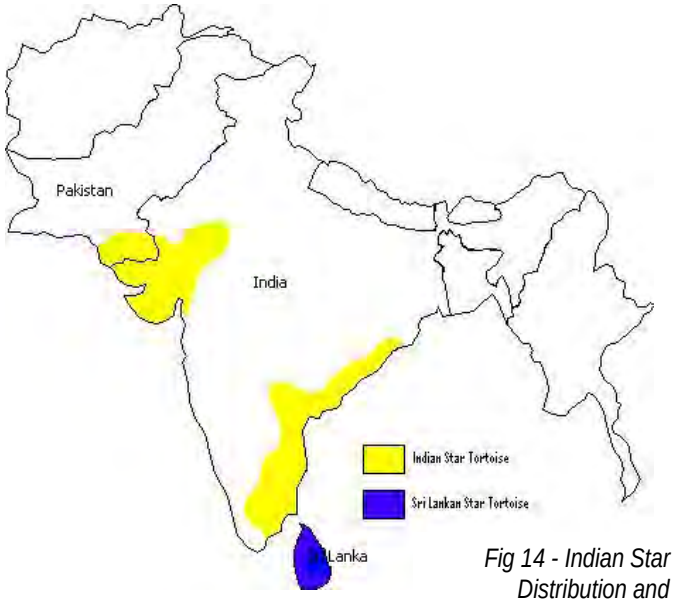


Fig 14 - Indian Star Tortoise – Distribution and Range

In the wild, the Indian Star Tortoise inhabits both semi-arid, thorny lowland forest habitats and semi-deserts (North-western India – Thar area in Rajasthan and Gujarat), as well as the savannah grasslands and the more moist deciduous forest habitats that have monsoonal seasons and very high levels of rain (Southern India and Sri Lanka), followed by an extensive hot and dry period. They can also be found in agricultural areas.[30,94]

3.3 Conservation Status

IUCN RED LIST - LR/lc – Least Concern[94]

While the Indian Star Tortoise is only classified as LR/lc under the IUCN Red List, native habitats are being destroyed and rendered useless for the species, under increasing Indian use of natural resources, which is inadvertently making the taxonomic conservation status uncertain. The eradication of Indian Stars from any large area could, in theory, mean the extinction of any of the geographical variants or even the species in that particular area.

During the past century, the Indian natural environment has been subject to considerable strain with the increased and aggressive use of forests and other natural resources together with the demand for viable agricultural land to satisfy the needs for the rapidly growing population. Large areas of land, that was once suitable habitat for the Indian Star Tortoise, are being destroyed to make way for human urban sprawl. The rapid growth of the Indian population is also affecting the slow growing and slow reproducing species predominantly in areas where the tortoises are used as a part of the diet in traditionally tribal areas. This tradition works just fine when the human population is relatively low, but endangers numbers when it rises dramatically within a short period of time.[30]

Added to the threats of increased habitat loss and human consumption is the often illegal trade of wild caught Indian Star Tortoises, predominantly within the pet trade, and the sale in markets for food. In Southeast Asia (Hong Kong, Singapore) and in the Gulf States (Dubai, Oman, UAE) as well as India, numerous wild caught specimens, largely juveniles, can be found in just about every animal market.

Seized Indian Star Tortoises

A conservative estimate is that the yearly toll on the Indian populations of the Indian Star Tortoise is 10,000-20,000 specimens. The Indian Star Tortoise has since been placed on CITES appendix II, which regulates the legal international trade, and it is also protected under the Indian Wildlife Act from 1972, where it has been placed under Schedule IV, making it illegal both to possess and trade in Star tortoises inside India without a permit. Sadly, the enforcement of this law seems to be lacking, as star tortoises are still openly offered for sale in pet shops, e.g. in Mumbai's Crawford market. There has been no legal large-scale exportation of Star tortoises from India for many years and there is no indication that such exports will again be permitted.[30]

The present status of the Indian Star Tortoise is unclear due to the fact that there are so few readily reliable and available records on their historical distribution, which will in turn make it hard to determine and appreciate how the Indian Star will manage in the future. One thing is certain, that they face great problems in anything but nature and conservation reserves if the human population in India keeps rising at an accelerated rate as it has done in the last 100 years[89].

3.4 Longevity

3.4.1 In the Wild

Average life span - approx 25-35 years
No studies on natural survivorship or lifespan in nature are available. As with other chelonians, presumably the eggs and small hatchlings and juveniles suffer the highest levels of mortality, with increasing survivorship as tortoises reach adulthood. Thus average lifespan might be considerably lower than potential lifespan.[23]

3.4.2 *In Captivity*

Live longer in captivity, with good care, than in the wild – 60-80 years.[79]

3.4.3 Techniques Used to Determine Age in Adults

Unless the date of hatching for the individual is known, accurately determining the age of a wild or captive Indian Star tortoise is almost impossible. This is because the rate of growth depends upon the quality and quantity of food eaten. Counting "growth rings" around the scutes could be useful in determining the age of small tortoises, however there may be some difficulty with using this method.

These rings are formed because the scutes (or shields), a modified form of skin, are continually renewed. The new scute material grows under the old, and being larger shows at the edges of the scute as a "ring". Unlike trees, however, tortoises (especially well nourished captives) don't always get a new "growth ring" every year. Both wild and domesticated tortoises develop none to several growth rings on each plate of the shell per year depending upon the food they have eaten. Some wild tortoises, in bad years, may not show any growth at all. For this reason you cannot tell a tortoises age by counting the rings on the scutes.[18]

Once a tortoise reaches adult size (at 10-20 years) growth continues and its appearance continues to slowly change. The often beautiful scute-sculpturing of the youngster becomes progressively less distinct. The scutes become flattened, take on a dull sheen and eventually become a more uniform gray color. In extreme old age the scutes may appear sunken in, as calcium becomes depleted from the bony shell that lies underneath them.

A tortoise with a smooth shell is “old” but “how old” will be something that they will keep close to their shell, just remembering that some tortoises can live about as long as humans.[18,81]

4 Housing Requirements

4.1 Exhibit/Enclosure Design

In moderate and cold climatic zones Indian Star tortoises need an indoor enclosure and, ideally, have also an outdoor enclosure available. Outdoor housing will provide the best quality of life to a captive tortoise. The closer your location is to the natural habitat of the Indian Star Tortoise, the easier it is to provide high quality outdoor housing. In many cases, a combination of indoor and outdoor housing will be needed. All pens need to be secure against two eventualities: the tortoise inside getting out, and potentially lethal predators getting in.[63]

An outdoor habitat for a Star Tortoise should be around 1.20m by 1.80m. The enclosure can be any size, but bigger is always better.

The outdoor enclosure needs to be surrounded by walls that have very little in the way of surface texture. The lack of texture on the wall will prevent the tortoises from climbing. The outer perimeters of all pens need to be of adequate height, at least twice as high as the largest tortoise is long. The walls need to be buried deep enough into the ground and be built high enough so that the tortoises can not climb and/or burrow out of their enclosure. Burying a wire mesh barrier beneath ground level as part of the perimeter can also aid in preventing any burrowing escapes from occurring. Cement blocks or even wooden timbers can work well as walls around an enclosure because they are heavy and very difficult to move once in place.[43,68]

Outdoor enclosures, while being dry and well drained, should ensure that they contain adequate shelter that will allow the tortoises to hide in case of inclement or cold weather. These tortoises can tolerate light, warm rain; it is even good for them to be stimulated by their changing environment.[3]

However, the Indian Star Tortoise cannot be left outside for long periods of cold, damp, rainy weather, or in the cold falls and winters of northern areas. You can provide an insulated shed with an access ramp for shelter (Figure 15&16)[43].

You should also provide heating in this shed with heat pads and heat lamps for warmth as well as lining the inside of the shelter with a soft substrate, such as hay.

Fig 15 & 16 Insulated shed with access ramp

Hides, similar to those used in indoor enclosures, can also be used for shelter, just as long as they are made of more sturdy materials, such hardwoods including pine and Jarrah (Figure 17).

Fig 17 Jarrah hide

It is best to plant the outdoor enclosure with plenty of low ground natural vegetation for the tortoise to hide in. It can also provide shade if the tortoise needs to cool off and be covered from the elements. Grass can be seeded year round to keep fresh for grazing, but always avoid fertilizers.[68]

Position of Enclosures

- You will want to place your outdoor tortoise enclosure in a sunny location - preferably where there is some sun most of the day, especially morning and early afternoon sun, but also offers some areas of shade as well if they need to cool off. An enclosure with a southern or western exposure is desirable.
- Don't locate it in a heavily shaded location.
- The location that you select should also allow you easy access to your tortoises and provide a location where you can sit and enjoy them.[43]

For the first few years of life, Star Tortoises do better in an indoor enclosure. This eliminates any unpredictable outdoor risks that can occur with these fragile tortoises. These tortoises are from very dry grasslands and need to be stimulated in order to survive.[63]

It is important to keep in mind while designing, constructing and decorating an indoor enclosure that it can be easily and properly cleaned. For this reason, make the maximum depth of the enclosure approximately one arm length. The floor surface and walls should be smooth or properly varnished so that they are cleaned and disinfected easily. They will do well in a 0.60m by 0.90m enclosure. The enclosure should be as tall as the tortoise is long (including the extended length of the legs).[28,64]

To prevent overheating, try not to place the enclosure in direct sunlight and ensure that there is proper and adequate ventilation.

When choosing plants, take note of potentially toxic species (A list of toxic and non toxic plant species can be found in Appendices 2&3). If it is hard to obtain live plants or you are not sure which plants are safe, then artificial plants can be another option, which can also be good especially from a hygienic point of view. For the remainder of the decorations, natural rocks and preserved wood can be very attractive.[13]

Substrate will depend on personal and tortoise preference (Substrate selection can be made in conjunction with Section 4.7 Substrate. They can do very well on a mix of peat and sphagnum moss, sand, and beaked moss.[28,39]

Star Tortoises need a high UVB percentage (10%) and it is recommended to replace the bulb every 10-12 months. They enjoy a basking side of 85-90° with a cool, sheltered side of 70-75°. It is very important to set up a temperature gradient inside of the enclosure so that the tortoise can regulate its own body temperature. A light misting once or twice a week is also recommended. They need weekly soakings and a water source available to soak in at all times.[13,28,39, 64]

Regardless of their age, tortoises enjoy a hiding place. The easiest solution is to provide them with a hiding box that is not too high and has an open front.

Size[74]
Spatial requirements obtained from Standards for Exhibiting Reptile in New South Wales (Exhibited Animals Protection Act).

e) Terrestrial Tortoises

Minimum floor area for up to 2 specimens = 6L x 3L (L = length of shell of largest specimen)

Spatial Requirements Clause 11

1) General

a) Sufficient space must be provided, both horizontally and vertically, to meet the activity needs of the animals and to enable husbandry to protect animals from undue dominance or conflict.

b) The enclosure must be large enough to provide a temperature gradient that allows the reptile(s) to thermoregulate.

c) The minimum floor space allowable for any enclosure must be increased in area by 20% for each additional specimen over one or two specimens for which a minimum floor space formula is established[74].

Terrestrial Tortoises (Including the Indian Star Tortoise)
Allow each tortoise 0.28 metres (3 square feet) of floor space for each 20.3cm (8 inches) of tortoise length.[61]

4.2 Holding Area Design

Holding areas for Indian Star Tortoises can be as complicated or simple as you want them to be. They can be pre-made commercial tanks/terrariums or hand-made wooden tortoise tables utilising a variety of different materials (Safe for tortoises of course). Here are a few simple versions for Indian Star Tortoise holding areas that are easy to establish, clean and move[75]:

- Pre-made acrylic enclosures
- Plastic storage boxes
- Glass tanks
- Tortoise tables: pre-made or hand made
- Open topped tortoise enclosure utilising plastic storage boxes and plastic seed trays

Pre-made acrylic enclosures

This is a large, 4ft x 2 ft acrylic enclosure with 13" high walls. The Acrylic pens are very lightweight and easy to move. Cleaning and disinfecting is simple. You can easily cover the walls if your tortoise does not like seeing through them. As seen, UVB and heat lamps can be easily placed on the edges of the tank and moved when needed. These enclosures are readily available from pet and reptile supply stores in a variety of different sizes and shapes.[75]

Plastic Storage Boxes

These plastic boxes can be used for tortoise enclosures and are very simple to establish. The bottom box is a very sturdy wardrobe shelf box from Ikea (34 x 20 inches), and the top box is a large litre (74 qt) underbed storage container (44 x 18 inches).[75]

This type of plastic tub can be used as a holding pen or an exercise area for younger or smaller Indian Star tortoise. You can cover the base of the tub with the substrate of your choice (seen here is reptile carpeting), simply decorate it with some rocks, feed and water dishes and plastic plants to provide some cover for your tortoises when they are placed in it while their normal enclosure is cleaned. It has no lights or hides because it should only be used for short periods at a time. The holding area below is a good example of a plastic tub set-up complete with lighting and heat which will allow for longer periods of holding.[75]

This plastic holding tub is simply made up with a day lamp for lighting and a ceramic heat emitter for heating. You can use separate UVB and heat lamps or one that combines the two. It can be used for longer periods of holding, i.e. during full substrate changes in the regular enclosure or even quarantine of new animals to the collection.[75]

These types of tubs are easy to use for establishing a holding area. They can be easily relocated to another area, cleaned and disinfected between uses.

Glass Tanks

Like the acrylic enclosures, this long, breeder glass tank (30 x 12 inches) can be brought from pet and reptile suppliers. They are just as easy to set up but maybe a bit harder to move around due to the weight.[75]

Tortoise Tables

Tortoise tables are open top pens with wooden sides that prevent potential escape. They can be brought already-made in a variety of different shapes and sizes, as seen below, from pet and reptile supply stores or online or they can be built fairly cheap and quite easily. They allow for airflow around the tortoises and limit the amount of humidity within the enclosure.[62]

Tortoise Table 1

Tortoise Table 2

Tortoise Table 3

Tortoise Table 4

The Tortoise trust and pettortoise.co.uk has a guide to build your own tortoise table. This can be adapted in size and shape to suit your own tortoise's needs[28,62]:

Assembled in 5 easy steps!

1. Using the brackets already fastened to the front and back position the sides and screw together.

2. Secure the base with the pins provided.

3. Position the basking lamp.

4. Push on the UV starter caps, Position and fasten the UV tube.

5. Finally decorate as you wish, and you're done.

Simple open topped tortoise enclosure

This simple enclosure, developed by Sue Brooks for Tortoise Trust, can be made with minimum technical skills. It is light to move around and easy to keep clean. The technical skills required are limited to the use of an electric drill and a jigsaw; otherwise it is just down to a bit of elbow grease and measuring. No corners were mitered or any other fancy finishing techniques used.[12]

The materials used were:

- 1 pack of laminate flooring (5 pieces)* * Try not to get the ultra thin type as they would be difficult to screw into.** The ones used were 11.3mm thick.
- ½ sheet of twin walled polycarbonate glazing
- MDF off cuts
- Timber batten
- Strong seed trays
- Duct tape

The overall measurement of the enclosure illustrated is 108 cm x 48 cm, but as floorboard sizes may vary and your own requirements will also vary, no precise measurements of the constituent parts will be given. The size of the enclosure can be adjusted to fit in the seed trays.

The most important part is to get your seed trays first and measure them. The ones used here measure 24cm x 38cm but slightly larger or smaller could be used. They will dictate how long and how wide your enclosure needs to be. To this you will need to add the thickness of the side verticals, the thickness of the polycarbonate lining and the timber batten which will hold the main section in place. Don't forget to add a little extra to allow room for fingers when removing trays for cleaning or replacing substrate. When you have your overall base measurements you are ready to begin.

First, clip three of your floorboards together and keep them in place using duct tape or similar before cutting to required size using a jigsaw. With the timber batten make an oblong the same size as the base just made and secure it to the base with screws from below. You now have something resembling a tray, which should be firm and stable, enabling you to remove the duct

tape. The remaining 2 floorboards can now be used in conjunction with the MDF off cuts to make an oblong inner to fit inside the batten edging. This should then be firmly attached using screws through the timber batten at the front and again at the back. The only job then remaining is to construct a lining using the polycarbonate glazing which can easily be cut with jigsaw or sharp knife. This lining was made about 8cm deeper than the inner, to keep the enclosure light and provide extra security. The outer corners were simply secured with duct tape and it was left unattached to facilitate cleaning. A plastic rim was later attached to the edge of this lining to cover the sharp edges.[12]

The trays can be filled with a soil/sand substrate alone, or preferably planted with edible plants to be enjoyed by the tortoises. Having 4 separate trays will enable you to vary the habitat a little. In this particular case one of the trays was filled with cobbles to provide a surface for clambering over and also to keep the water dish away from the substrate, which can otherwise turn into a mud bowl. The 4th tray (not seen) was simply filled with folded towels, which provided a popular burrowing area.

Used with a UV-B Active Heat lamp, this enclosure is ideal for any small tortoises requiring indoor accommodation. For ease of maintenance, additional trays can be planted up, ready to exchange with those in use and trays of cobbles which have become soiled, can be put out in heavy rain or simply hosed down and left in the sun to dry.[12]

The total cost of this enclosure was approx $75 (excluding heat lamps and other electrical items)

4.3 Spatial Requirements

e) Terrestrial Tortoises

Minimum floor area for up to 2 specimens = 6L x 3L (L = length of shell of largest specimen)[74]

Spatial Requirements Clause 11

1) General

a) Sufficient space must be provided, both horizontally and vertically, to meet the activity needs of the animals and to enable husbandry to protect animals from undue dominance or conflict.

b) The enclosure must be large enough to provide a temperature gradient that allows the reptile(s) to thermoregulate.

c) The minimum floor space allowable for any enclosure must be increased in area by 20% for each additional specimen over one or two specimens for which a minimum floor space formula is established.

Terrestrial Tortoises (Including the Indian Star Tortoise)
Allow each tortoise 0.28 metres (3 square feet) of floor space for each 20.3cm (8 inches) of tortoise length.[61]

4.4 Position of Enclosures

- You will want to place your outdoor tortoise enclosure in a sunny location - preferably where there is some sun most of the day, especially morning and early afternoon sun, but also offers some areas of shade as well if they need to cool off. This can provide a natural alarm clock. The sun enters their burrows or enclosures and wakes them up with the light and warmth that the sun provides. The light wakes them up and the warmth is necessary to get their day started.
- Don't locate it in a heavily shaded location.
- The location that you select should also allow you easy access to your tortoises and provide a location where you can sit and enjoy them.[41]

4.5 Weather Protection

Outdoor enclosures, while being dry and well drained, should ensure that they contain adequate shelter that will allow the tortoises to hide in case of inclement or cold weather. These tortoises can tolerate light, warm rain; it is even good for them to be stimulated by their changing environment.

However, the Indian Star Tortoise cannot be left outside for long periods of cold, damp, rainy weather, or in the cold falls and winters of northern areas. You can provide an insulated shed with a access ramp for shelter (Figure 18&19).[41]

You should also provide heating in this shed with heat pads and heat lamps for warmth as well as lining the inside of the shelter with a soft substrate, such as hay.

Fig 18 & 19 Insulated shed with access ramp

Hides, similar to those used in indoor enclosures, can also be used for shelter, just as long as they are made of more sturdy materials, such hardwoods including pine and Jarrah (Figure 20).

Fig 20 Jarrah Hide

Natural vegetation is also a good choice for providing your tortoise with shelter and weather protection as well as providing natural, readily-available food and foraging opportunities (Figure 21).[43]

Fig 21 Natural Vegetation in Outdoor area

4.6 Temperature Requirements

Indian Star Tortoises are considered savannah animals that DO NOT hibernate. The seasonal temperature fluctuations that they experience in their wild habitat stimulate the normal hormonal cycle of breeding populations but not to the extent where they require brumation or hibernation. This means that they must be overwintered indoors or in a heated enclosure that will not drop below 15.6°C (60°F) at night but will still reach at least 21.1°C (70°F) during the day.[39,41]

Optimal Temperatures

Day – 23.9-29.4°C (75-85°F)
Night – 23.3-26.7°C (74-80°F) } Air Temperatures

Basking end of the pen should be about 32.2-37.8°C (90-100°F), while the cooler end should be 23.9-26.7°C (75-80°F).

Indian Stars prefer higher humidity, however they do not tolerate damp or cold (can cause shell rot or other health problems), and they enjoy light "rain" shows which aid in raising humidity levels as well as influence breeding behaviours.

After you decide which type of cage or enclosure you're going to use, you need to decide how you will supply heat. Consider providing more than one source of heat, such as an incandescent light (which provides warmth and a place to bask in the artificial "sunshine") and belly heat — heat underneath your tortoise.

An incandescent light is a good source of heat, and you can position it anywhere you want over the cage to make a hot spot. Test the temperature of this spot by putting a thermometer in the light at a position where your turtle may rest: The temperature should be at least 32.2°C (90°F) degrees for many tortoises. A clamp light fixture with a ceramic socket (Figure 22) is a good idea to hold a standard-sized basking bulb or household light bulb for heat.[28,40,42]

Fig 22 Clamp light with ceramic socket

If you have a glass aquarium, you can use an undercage heater for belly heat (Figure 23). These heaters attach to the bottom of a glass cage, sticking to the glass, and can be positioned at one end of the tank, providing a heat gradient. However, never use one of these heaters on a plastic cage (it will melt or crack the plastic) or a wooden cage (it could start a fire). If you use an undertank heater, it's a good idea to put a reptile carpet on the bottom of the glass tank first to prevent accidental burning. Then put the substrate on top of the mat. Without the mat, your tortoise may dig to the bottom of the substrate and lie directly on the hot glass. The undertank heat pad must be placed on the outside of the tank (bottom or side), never inside.

Fig 23 Undercage heater

If you have a plastic or wooden cage, you may want to use a heat rock for belly heat. Bury the heat rock in the substrate so that it doesn't overheat and burn the turtle's or tortoise's lower shell that covers the belly).

During the daylight hours, illuminate and warm one end of the cage. An ambient cage temperature of 24.4 to 27.8°C (76° to 82°F) is fine, but you should also have a hot spot warmed to 35.0 to 37.8°C (95° to 100°F) by a full-spectrum UV-B-heat bulb. Reptisun brand long bulbs are recommended by many tortoise breeders and T-Rex Active UV Heat bulbs provided both UV and heat. Nighttime temperatures can drop by a few degrees and the heat bulb will be turned off. Another choice for heat is a ceramic heat lamp (Figure 24). It emits heat but no light, so it can be used at night.[39,40,41]

Fig 24 Ceramic Heat Lamp

You might also want to consider getting a reptile lamp stand (Figure 25), especially if you are using a large UV/heat combo bulb with a deep dome. These stands are adjustable in height and depth, and come in two sizes. The larger model, LF-20, is better suited for UV heat lamps. The larger foot on the LF-20 makes it more stable to hold such a large and heavy light fixture. The stand allows you to position the light exactly where you want it. Also, some plastic containers have a slippery surface which may cause a clamp light fixture to slide down to one side and create a fire hazard. Using a lamp stand will prevent this.[39]


Fig 25 Reptile Lamp Stand

Most breeders recommend an overhead heat source, not an undertank heater. They feel that bottom heat is unnatural for tortoises, and may even harm them. A overhead heat source can be used in the daytime in display enclosures, but on glass tanks you can use an undertank heat pad for gentle night time heat on cold nights because it is very low wattage. Some people put the undertank heater on the side of the tank instead. A heat pad can also be used in the day time if additional heat is needed on a very cold day. Keep the overhead heat bulb and the undertank heater at the same end of the tank (warm end).[39,40,41]

It's a good idea to use a thermostat (Figure 26) or a rheostat with a ceramic heat emitter to control the temperature. A thermostat turns the heater on and off or regulates the electricity as needed based on the enclosure temperature. A rheostat is a dimmer switch that regulates the flow of electricity on a constant rate based on the user setting. Many people like thermostats better because they are automatic and will adjust the enclosure temperature if the room temperature goes up and down. Enclosure lights and heaters can be plugged into digital power center timers with eight outlets. This way they will go on and off automatically AM and PM. Not a necessary item, but very handy to have.[39,40,41]

Fig 26 Habistat Thermostat

4.7 Substrate

Ideally a cage substrate should attempt to duplicate a natural setting as much as possible; however there is the need for sanitation within an indoor enclosure especially if the cage is small as your tortoise will spend most of its time on it. If it is too moist constantly, they may develop shell rot or other health problems. If it is too drying, your tortoise may become dehydrated and if you have allergies to certain things, it has to be one that doesn't make you sick.

If you choose to use a loose substrate (e.g. recycled paper pellets, gravel, sand etc.) it is suggested by most keepers that you do not feed your animal in the cage with the substrate present. The accidental ingestion of substrate particles has the potential to cause health problems in your animals, ranging from decreased nutrient absorption, to a fatal impaction (intestine blockage)(Figure 27&28). It is strongly suggested that a large feeding bowl is used or the removal of the substrate/animal during feeding.

Fig 27 Bearded Dragon Impaction

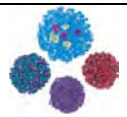
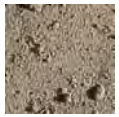
Fig 28 Leopard Gecko Impaction

There are several cage substrates that allow you to reach a balance between sanitation, aesthetics, and still provide the necessary "give" that is necessary for proper bone growth and the prevention of "splayed leg." This is where the tortoise begins to walk on the inner part of their feet when young, eventually leading to the loss of the ability to walk up right[25]. It's best to strive for an uneven, but somewhat soft surface if possible. Some substrates, on the other hand, can be dangerous or even deadly to tortoises; therefore these factors, research comprehensively by Renier Delport, should be taken into account when looking at substrates for Indian Star enclosures[67]:

- Heat transmission
- Ability to remain in place (or the suitability to burrow in)
- Safety with regard to ingestion
- Ease of cleaning
- Suitability for use with feeding insects (or other live prey) – If applicable
- Odour
- Compostability
- Dust accompanying
- Toxicity
- Absorbency
- Appearance
- Weight
- Cost
- Availability

The following table looks at a number of different options for your Indian Star enclosure substrate and the information can be used to aid in selecting the most suitable substrate for your tortoise.

SUBSTRATE	DESCRIPTION	PROS	CONS	RECOMMENDATION
Wood shavings & Sawdust 	Natural by-product of wood processing. Available from most pet shops or in bulk from wood processing factories.	Light, inexpensive, absorbent, compostable and easy to clean manually and to replace	Might cause compaction if ingested. Not natural looking. When fine and dusty, it may cause respiratory problems when used for long periods of times. Makes good hiding for feeder insects. Does not transmit heat well. Can be pushed aside easily.	Shouldn't be used as permanent or semi-permanent substrate. If being used, ensure dust free and no contact with heat sources. Never use Cedar shavings TOXIC! Pine shavings can cause compactions. NOT recommended for with other herptiles but can be used for transporting, brumating or burrowing snakes.
Corn Cob 	Natural, non-toxic by-product of maize processing. Small, roundish, fibrous substrate Is available from some specialised pet shops.	Light. Disposable. Large insects cannot hide under it. Looks clean and neat. More natural looking than wood shavings. Can be cleaned easily by removing droppings manually.	Does not transmit heat well. Pushed aside easily. Will support mould growth when wet. Must be changed regularly. Indigestible to herptiles and can cause compaction when ingested.	NOT recommended as it can cause drying of dermal tissues and can cause intestinal obstruction if swallowed, which may lead to death.
Vermiculite 	Natural, non-toxic, mineral - expands with heat. Available in a coarse and fine grade and can be brought from some specialised pet shops and some large garden nurseries	Light. Semi-natural looking. Large insects cannot hide under it. Can be cleaned easily by removing droppings manually. Good absorber of moisture. Compostable and relatively safe with regard to ingestion.	Relatively expensive there fore less disposable. Can be easily pushed aside. Small insects can hide underneath it. Not a good conductor of heat. Can be difficult to see small droppings among the pieces.	Good for egg laying, egg incubating substrates, transporting or bromating snakes or for burrowing snake species. NOT to be used with lizards. As vermiculite tends to break up into smaller pieces, especially when wet, it is recommended that it is replaced regularly. Although expensive, cheaper when brought in "bulk" quantities from nurseries
Soil 	Soil from the garden or potting soil	Cheap. Natural looking. Easily collected. Droppings can be easily removed by hand. When wet it can raise humidity within the enclosure. Transmits and keeps heat relatively well. Stays in place easily. Difficult for large insects to hide in	Heavy. Has to be disinfected. Has to be changed regularly. Not easy to replace. When wet it can raise humidity within the enclosure. Can become muddy. When dry it can become dusty. May cause impaction when ingested. Can stain the enclosure it is used in. Can be a breeding ground for ants and other pest species.	NOT recommended as a substrate even if sterilised due to the risk of compaction within the herptiles if they do inadvertently ingest it and the possibility of introduction of insects and micro-organisms into the enclosure. Should only be used for display purposes.

Compost 	Brought from garden nurseries to fertilise the soil for plant growing.	Light. Cheap. Natural looking. Easy to remove droppings manually. When wet it can raise humidity within the enclosure. Transmits and hold heat well.	Has to be disinfected when used for herptiles. Has to be changed regularly. When wet it can raise humidity within the enclosure. May be considered smelly. May cause compaction if ingested. Is difficult to replace and clean a container properly after it is removed. Can be a breeding ground for ants and other pest species.	NOT recommended as a substrate for herptiles.
Aquarium Pebbles 	Small round rocks, usually colourful, sold at most pet/aquarium shops. Available in different sizes and colours. Usually used as aquarium substrates	Attractive. Uniform in size. Can be washed, disinfected and re-used. Good transmitter of heat. Natural colours can look quite pleasing visually. Cannot be pushed aside easily.	Can be ingested by larger lizards. Heavy. Expensive. Insects can hide underneath them. Difficult to clean droppings manually.	Can be used with snakes, but NOT larger lizards. Make sure that the pebbles are large enough to minimise accidental ingestion, choking or intestinal blockages by the herptile. Pebbles should be cleaned before use and regularly during enclosure cleaning.
Aquarium Gravel 	Natural small rock substrate. Used as a substrate in aquariums and is available in different shapes and sizes, in small packets or bulk, from most pet/aquarium shops.	Cheaper than aquarium pebbles. Clean. Natural looking. Transmit heat well. Can be washed and re-used. Not pushed aside easily. Easy to clean droppings manually.	Heavy. Can be ingested easily and may cause impaction. More expensive when disposed of regularly. More difficult to clean than pebbles. Small insects can hide underneath them. Moisture and water may pool at the bottom of the substrate.	Can be used with most herptile species, especially ground dwelling insect eaters and those needing higher relative humidities. NOT recommended for lizards, as they are most likely to ingest it with their food. Make sure that the gravel is large enough to prevent accidental ingestion.
Build, Plaster, Play, River Sand & Calcisand™ 	Sifted plaster sand, building sand or play sand can be brought from building suppliers and some toy shops. Calcium carbonate enriched sand, Calcisand™, are also available. Clean river sand can also be brought/collected and used.	Moderately cheap. Easy to clean droppings manually. Natural looking. Clean. Not moved aside easily. Transmits heat relatively well. No hiding areas for small insects.	Heavy. Difficult to replace regularly. Can lead to impactions when ingested with food or when ingested on purpose i.e. mineral deficiency (usually calcium) and fine/dusty sand/plaster sand can cause respiratory problems.	Sand should always be washed to eliminate fine and dusty particles and sterilized before use. Although it is recommended by some herpetologists, any sand should NOT be used for lizards or any animals with high calcium needs. Can be used with Desert reptiles.

Shredded Aspen 		Somewhat natural looking. Over time, forms a dense mat. Safe to use. Easily disposable. Replacing is simple. Very absorbent. Minimises microbial contamination well. Dense mat not easily moved. Transmits heat well.	Priced a bit higher than wood shavings.	Can be used for incubating eggs, but hatchling should be removed once out of the egg. NOT to be used with small lizards
Bark/Reptile Bark & Other Wood Mulches & Nuggets 	Commercially produced and disinfected for herptiles or bark nuggets from plant nurseries. Cypress or other wood/bark mulches are also popular.	Attractive. Natural looking. Cannot be pushed aside easily.	Holds dangers when ingested and should be prevented. Commercial bark very expensive and only available at some large pet shops. Not a good conductor of heat. May cause compaction problems. Makes suitable hiding places for insects. Can cause irritation and injuries to the legs and snouts of digging reptiles.	This substrate is <u>NOT</u> recommended for use with greedy lizards as it has a very high fiber content and is indigestible when accidentally eaten. Can be used with some snake and lizard species. Be sure NOT to use bark/wood chips that contain treated pine (green coloured). This is toxic due to the chemicals used in the treating process, and is not suitable for use as a substrate.
Butchers Paper, Newspaper, Brown Paper & Kitchen Towel 		Cheapest. Disposable. Easy to replace. Ink (if present) usually non-toxic. Clean and safe to use.	Unattractive. Makes good hiding place for snakes, large and small insects. Shouldn't be used when under tank heating is implemented and temperatures are very hot.	Popular to use with juvenile snakes and lizards and as a transport substrate for snakes. Should NOT be used in enclosures that have under tank heating/pads, enclosures with very high temperatures
Astroturf 	Any type of artificial/synthetic turf. It differs from carpet in that it resembles grass.	Transmits heat well, cannot be pushed aside, there's no hiding place for insects, safe and can be re-used.	Tends to rot easily when wetted, should be rotated regularly and serves as hiding place for insects.	Good for tortoises, lizards. Should <u>NOT</u> be used in a moist container with a high humidity. Wash and let it dry in the sun before re-using.
Carpet (Reptile etc.) 	A piece of indoor-outdoor/cricket pitch or reptile carpet. Ready cut reptile carpet can be bought for higher prices at some larger pet shops.	Semi-natural looking. Safe. Can be washed and re-used. Transmits heat well. Easy to clean. Not easily moved. Can be used with higher relative humidities. Cannot be eaten.	Expensive. Labour intensive to clean regularly. Should be replaced and washed regularly. If not cut to the correct size, it can curl up to give hiding places for snakes and insects. May smell permanently if not properly and regularly cleaned.	Good for most herptiles. Because of difficulty to clean quickly, carpet should be used in a rotatory system. The extra piece should be cleaned and sun dried weekly. In case of an emergency, carpets can be removed and vacuumed.

Rabbit or Lucern/ Alfalfa Pellets 	Pellets that you feed rabbits. Can be bought from most pet shops.	Safe to ingest. Not many hiding places for insects. Easy to clean manually and to replace.	Loose. Can be moved aside easily. Crumbles when absorbed water so cannot be used in higher humidities.	Can be used for raising lizards and some other reptiles. NOT to be used in cages with high humidities. Popular substrate for tortoises
Maize Meal (Corn) 	Produced as food product for human consumption and sold at most food stores.	Light. Safe to use. Disposable. Easily replaced. Easy to clean droppings manually. Transmits heat well.	Relatively expensive. Ferments and gets sour easily. Needs to be replaced regularly. Easily pushed aside.	Can be used when transporting or brumating/hibernating snakes or for burrowing snake species and as substrates for small lizards. NOT to be used with Splashing lizards as they splash in their water and cause the maize to get wet and sour. Ensure that substrate is changed immediately if damp to avoid souring.
Moss (Sphagnum or Spanish) 	Commercial sphagnum moss is a dried mixture of natural mosses in the genus Sphagnum. It is also known as Bog or Peat moss. Sphagnum mosses are available from specialised pet shops.	Attractive, natural looking and absorbs and retains water well.	Expensive and only available at some specialized pet shops, may cause compaction problems when ingested, make suitable hiding places for smaller insects and can be a source of fungal infections.	Can be used with Some amphibians and wetland environment reptiles as the main substrate or for humidifying shelters or hide boxes Can also be used as egg-laying medium. NOT to be used with desert reptiles. Sphagnum moss can be prepared by soaking it in water and manual expression of excess water.

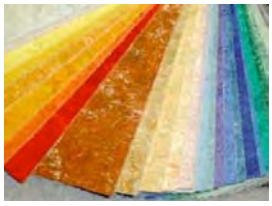
Other Substrates

Other useful substrates can include:

Leaf litter (with soil) - The only concern with this substrate it that it must be kept clean as it easy for the substrate to "go bad" quickly, especially if it gets moist.

Shredded coconut hull/husk - Coconut husk. This material that expands to 7-8 times the packaged size when unpacked. It will also expand in the stomachs of any animal who has eaten it thus causing an impaction and possible death. There have been several deaths in tortoises from this material and it is NOT recommended.

Vinyl/Linoleum - easiest of all to clean and disinfect
Provides excellent footing as long as it is kept dry. Easy to completely sterilise. Needs to be monitored constantly though for waste materials as it has no absorbent properties. Can be used in combination with newspaper (fully cover the enclosure with vinyl and then cover half of it with newspaper) - the newspaper for its absorbency and the vinyl for good footing.



Hay - Grass hay is inexpensive and doesn't cause any problems if it is eaten. It is not very absorbent however and should be changed out frequently.

Terry Cloth Towels
Can be inexpensively obtained from thrift shops. Easily cleaned and disinfected by machine washing in hot water, soap, and bleach. They are especially suited for reptiles in quarantine or with abdominal injuries.

Recycled paper pellets (e.g. Breeders choice)
A step up from paper is to use recycled paper pellets, which are made for use as kitty litter. They are very absorbent, and while they don't look completely natural, they can look quite good in an enclosure (kind of like a grey gravel), and are extremely easy and fast to change. Because of this, these pellets are another substrate commonly used by keepers with large collections.

It is important to note that not all the pellets will need to be changed on every occasion - soiled pellets become obviously discoloured, and swell to around twice their initial size. The soiled pellets can easily be removed and replaced with new ones - a full substrate change is not required. However, it is still suggested that a full substrate change (and enclosure clean) is conducted every one or two weeks. These pellets will break down over time, so it's important to remember that simply "spot cleaning" will not do. Silverfish are also attracted to these paper pellets, so if you don't clean your enclosure for a while you might end up with a healthy colony of these insects.
These pellets can be quite dusty, so it's a good idea to shake out the dust (perhaps by putting them into a large garden sieve) before using them in an enclosure.

These pellets come very dry, and because of this they are very absorbent. When you first add them to an enclosure, they tend to lower the enclosure's humidity for the first few days, by absorbing all the water from the air. This can be a problem if your animal is coming up for a shed. One way to avoid this problem is to leave the required amount in an open tray for a couple of days - the pellets will absorb water from the air in the room, and as such will not dry out the air in your enclosure as much when you add them.

They can also easily stick to anything wet, including food items. It's recommended that you don't feed your animals on this substrate, as invariably some pellets will get ingested. Whilst there have been no reported side effect of accidental ingestion, it is best that the risk is avoided. If dry pellets are ingested, it's conceivable that they'd swell up in the animal's stomach, which (needless to say) could be a problem. It has been suggested that these pellets will just break down in a fluid medium, but nevertheless, recycled paper isn't a 'normal' food item for any Australian reptile!

Water - Water can be used as partial or main substrate for some herptile species such as frogs, toads and some snakes. Some of the important aspects of water as a substrate includes: the pH (brackish or salt), the chloride content and bacteria. Chloride can and usually should be removed from water either reverse osmosis or filtration. Bacteria are used as biological water filters to remove molecules such as ammonium, nitrates and nitrites.
There is also the option of not having any bedding at all within an enclosure.

Dangerous substrates include crushed walnut and should be avoided

Many years ago, bird keepers became aware of the problem associated with using walnut shell litter for their birds: shortly after being wetted with water or feces and urates, a colony of bacteria started growing, often underneath the surface of the litter. So, what happened when the walnut shell recyclers found they'd lost a significant share of the bird market? Repackaged their crushed shells for reptiles, of course! One went one step farther and touted theirs as safer than sand.

Why is walnut shell (and corn cob, for that matter) not suitable for reptiles?
Aside from promoting bacterial and fungal growth (yes, even when they have been "heat treated" at the factory), they can stick to the hemipenes/cloacal tissue when it is everted during defecation and are thus retracted up into the body, causing irritations and inflammation. They also cause irritation, inflammation or injury to the digestive tract if ingested intentionally or accidentally - and no matter how closely you watch your reptile, you aren't watching it 24/7. If that reptile is an arboreal lizard that spends a great deal of time investigating new things with its tongue, ingestion is guaranteed.

Indian Star Tortoise Substrates – Recommendations

Selection of substrate is a personal choice, influenced by availability and pricing, however the following sections are recommendations from associations and people who have had extensive experience with keeping tortoises…

Tortoise Trust recommends a substrate mixture of loam or topsoil and play sand. For very a arid habitat species the formula is 30% loam and 70% play sand, and for a more humid habitat use 60% loam and 40% sand. The substrate should be changed every few weeks. Some people mix the play sand with coconut coir instead as a 50/50 mix. With sand, you must provide a sand-free eating area to avoid intestinal impaction which can be deadly.[42]

Ian Recchio of LA Zoo recommends newspaper, terrarium carpet, rabbit pellets, wood bark chips other than redwood and cedar, and organic garden soil with no fertiliser. His advice is to avoid sand, coarse bark, and gravel.[67]

There is on going debate between herpetologists, tortoise owners and breeders and zoos on the advantages and disadvantage of using rabbit pellets, or something similar, as a substrate within Indian Star Tortoise enclosures. Some tortoise owners like to use the pellets, especially for small tortoises, as they do not hurt the tortoises if they are eaten and they are also easy to replace. However, there are also tortoise keepers that will no longer recommend the pellets due to the following factors:

- They are very drying to the tortoise
- They mould quickly
- They are known to cause infections
- May induce walking problems due to unstable surface
- Don't allow for periodic misting
  They tend to foul water bowls quickly

The use of pellets as a substrate is really down to personal choice and trial and error, while ensuring the health and safety of any tortoises. If they are used, it is best to keep them dry most of the time, and removing tortoises to an outside pen or plastic trough for showering and shell washing will minimise dampness.

Whatever substrate you use within your Indian Stars' enclosure, it should be something that doesn't harm your Chelonian if it is accidentally or even purposely eaten; impaction can be fatal!!

It should always be non-toxic and be able to be passed or digested if it were to be consumed

4.8 Nestboxes and/or Bedding Material

Tortoises do not use bedding in the same way as mammals do. Mammals will use their bedding to keep warm while sleeping or resting whereas tortoises will use the substrate in their enclosure and bury down into it to cool down. The substrate section recommends a number of different mixtures that can be used as "bedding" for tortoises within their enclosure. Some include:

- Mixture of 30% loam and 70% play sand (Arid habitat species)
- Mixture of 60% loam and 40% sand (More humid habitat Species)
- 50/50 mix of play sand and coconut coir
- Recycled paper pellets or Rabbit pellets
- Wood bark chips (Other than redwood and cedar)
- Organic garden soil (With no fertiliser)
- Newspaper
- Terrarium Carpet

Indian Star Tortoises can be very picky when it comes to hide/nest boxes within their enclosure. However there are numerous options available which can tried and tested until something is found that the tortoises are happy with.

The amount of commercially made hide/nest boxes is huge. They range from: big ones, small ones, light ones, dark ones, moist ones (New research suggests that humid hide boxes are important for baby tortoises and juveniles to prevent excessive pyramiding), dry ones, warm ones, cool ones, open-back ones, closed-back ones, cardboard ones, plastic ones, with a floor, without a floor, single occupancy, and double occupancy ones, with many different styles and textures including plastic, bark look, coconut shells etc. Many companies, including Zilla, Exo-Terra and Zoo Med, make them and can be easily picked up from pet stores and reptile equipment suppliers as well as the many pet/reptile suppliers online. A dark hide is better than see-through. The hide box should be big enough for the tortoise to turn around, however what is use will depend on tortoise and personal preference.[75]

Commercially made hide/nest boxes can be used as a start but you can also easily make your own that can be adjusted to suit the tortoises in your collection. Startortoises.net offers a number of different ways to make up home-made hides. Hides/nest boxes can be made from any box that is available as long as it is easily cleaned (probably not a good idea to use washing/soap powder boxes).

The easiest hide to make, is made from a disposable, plastic food storage box (Figure 29). It has a wet sponge attached to the ceiling (to slightly raise the humidity), and the sides are coloured black and green on the outside with non-toxic markers. Some light comes through the gaps in the colouring, which gives the tortoises the feeling that they are hiding under plants. The plastic is also thinner than regular food containers, so it's easy to cut with scissors and finish the cut edges by smoothing them with a nail file.[75]

Fig 29 Home-made hide

Another version of a simple, humid hide.[75,76]

Supplies - disposable food storage box, sponge, non-toxic permanent markers, and bag ties

Cut the doorway, color the outside of the box black and green, and attach the sponge to the ceiling

This is what it looks like to the tortoises inside; dark, green, and shady with some light coming through

You can leave the lid on as the floor, or if your tortoises don't like it, just remove it and use the top sponge

Other hide/nest boxes can be made from:

Small, individual hide boxes with wet sponges, made from disposable food containers

A baby wipe container is a good size box for two small tortoises or one a bit bigger baby

In addition, tortoise hiding boxes can be made from Kleenex boxes, juice cartons, milk jugs, and other cardboard and plastic containers. Plastic ones are better because they can be used as humid hides and disinfected.

Hide/nest boxes should be placed in a warm area of the enclosure but not directly under a heat light, or the tortoise may overheat during rest or sleep.

4.9 Enclosure Furnishings

Your tortoise enclosure may be decorated, but should remain uncluttered so that the tortoises may move around freely. A few shelters or hides are required, one at each end of the enclosure, they can be custom built as in 4.8 Hide boxes section, or commercially available hides, logs and shelters. Other enclosure furnishings can include:

- Rocks/stones of various sizes
- Live and artificial foliage including potted arid land plants, cacti and grasses
- Rock ledges and caves
- Individual basking rocks
- Half and full logs including drift wood
- Corkbark hiding areas
- Coconut shell huts
- Shallow water baths
- Cholla cactus skeletons

Be absolutely certain that any hides or planters have sufficient integrity to withstand the rigors of time and the efforts of the inhabitants to dislodge them. Periodically check the integrity of the ledges and caves and reaffix them as necessary.

5 General Husbandry

5.1 Hygiene and Cleaning

Tortoises require special care to maintain cleanliness. Routine cage maintenance is necessary to keep it a safe and healthy home for your tortoise and an enjoyable, odor-free, and attractive showplace for your enjoyment as well.

Because tortoises are susceptible to skin and bacterial infections, cages and housing must be kept scrupulously clean. And because their fecal matter may carry bacteria, like Salmonella, that can cause disease in humans, your tortoise's cage, furnishings, and the cleaning equipment itself needs to be regularly cleaned and periodically disinfected.

Which disinfectant should you use?

This will depend on many factors such as your budget, chemical sensitivities and personal choice. Diluted household bleach (sodium hypochlorite) is often used. A 3% solution is adequate in most cases. Avisafe® is used quite often in Veterinary clinics. The active ingredients are a class of disinfectants called halogenated tertiary amines. All you need to know is that it is extremely effective in eliminating bacteria, fungi & viruses, non-toxic (used as directed) & very economical. Avisafe® is available from your local veterinarian. Regardless of which chemical disinfectant you select ensure you follow the instructions carefully. Do not be tempted to make up a 'stronger' solution than recommended - you might in fact make the solution less effective by making an incorrect dilution.

Although there are many commercially available disinfectants, household bleach is one of the most inexpensive and readily available disinfectants. You can make a disinfecting bleach solution by mixing 1 part bleach to 16 parts water (or 1 cup of bleach to 1 gallon, approx. 3 litres, of water). Apply this bleach solution to the cleaned cage, decorations, and accessories for 5-10 minutes, then rinse thoroughly with clean water.[56]

Melissa Kaplan, recommends the use of Nolvasan (chlorhexidine diacetate) as a cage, accessories and surface disinfectant for reptiles because[46,95]:

- When used in the dilute form stipulated on the product container (4-6 tablespoons of Nolvasan per gallon, approx. 3 litres, of water), it is a safe and effective bactericide and virucide
- When used diluted to 1% strength, it is safe and effective for wound irrigation
- It has no toxic fumes if residues are left in the enclosure or when in use by the reptile keeper

A Bleach solution (1/2 cup household bleach per gallon of water) is recommended and is also frequently used in veterinary offices. It is cheap, and it is one of the few disinfectants effective against the highly infectious canine parvovirus (which reptiles do not get). She does however highlight the fact that it is also dangerous when used in closed spaces due to the toxic fumes. When mixed with ammonia, it creates a new, also highly toxic, substance.

Kaplan also raises the point to owners of tortoises, and Herp owners alike, that they should be aware of the fact that their household dishwashing soaps and other cleaners contain ammonia - the ingredient may or may not appear in the fine print on the back of the product container. If you

use such a product, and fail to rinse the enclosure surfaces thoroughly, or even forget to thoroughly rinse the residues out of the sink and bathtub before rinsing off items that have been sprayed or soaking in a bleach solution, you could make yourself or your animals quite ill as the bleach in the disinfectant solution you made comes into contact with the ammonia product in your sink or tub or any such residues left in the enclosure, on water bowls, etc. when you apply the bleach disinfectant solution.[46,95]

Remember that any product, even used in correctly, is potentially dangerous. Applied full strength to the eyes or respiratory tract, Nolvasan is toxic. However, the only time you should be handling it full strength is when measuring out enough Nolvasan to mix a new gallon of dilute solution.

Don't forget that steam and heat can be an excellent way of cleaning out tortoise terrariums and cages, which is a method regularly used by Margaret Wissman[96]. There are a number of commercially made units available that release steam that can be used to clean, remove debris and disinfect surfaces. Of course, be very careful to not burn or melt plastics, and never steam clean with the herps in the enclosures, as severe burns can occur. They can also be used routinely to clean cage equipment.[96]

Start with clean cage accessories

Make sure any natural items, such as rocks and branches, which you introduce into the environment, are sterile. Rocks should be cleaned, and then boiled in water for 30 minutes. Sand can be rinsed with large amounts of water to remove any particulate debris, and then heated in the oven at 93.33-121.11°C (200-250°F) for 30 minutes. Branches should also be cleaned, and then heated in the oven at 93.33-121.11°C (200-250°F) for 30 minutes.

Cleaning tools

Assemble a cleaning kit expressly for cleaning the cage. Store these items separately from your other household cleaning supplies. To prevent cross-contamination, never use sinks or tubs that are used for human bathing or food preparation.

- Back-up cage - a clean environment for the minutes, hours, or even days your tortoise must be relocated.
- Brushes - small and medium sizes depending on your cage. A toothbrush is good for corners and crevices in decorations.
- Buckets
- Glass or metal bowls or buckets for hot soapy water and for the rinse water
- Herp-safe terrarium cleaner - dissolves matter hardened on surfaces.
- Paper towels, sterilized cloth towels or rags, or disinfected sponges
- Q-tips, toothpicks, putty knives, scrapers and razor blades - needed to reach into the smallest of spaces, and remove hardened material.
- Rubber gloves and goggles
- Sand-sifter - removes feces and other debris from sand and other fine-particulate substrates.
- Soap or dishwashing detergent - do not use any products that contain phenol or pine scent.
- Sponges - 1 set for cleaning, one for rinsing, and one for disinfecting.
- Disposable rubbish receptacles such as a paper or plastic bags.

The disinfecting and sterilization equipment and supplies required include:

- Disposable gloves
- A spray bottle or bucket of prepared disinfectant solution
- A metal or glass or bucket of fresh rinse water and two for disinfectants.
- Large receptacle for soaking and disinfecting furnishings (bowls, rocks, caves).

Utensils such as scrapers, rags, sponges, snake tongs or hooks, and reusable rubber gloves should be washed in soapy water, then soaked in one disinfectant (such as a chlorine solution) for at least five minutes. The utensils are then rinsed thoroughly before being used again. The second container of solution (such as Nolvasan) is used to disinfect the enclosures.[25,26]

This should be set up somewhere away from food preparation areas where the articles can stay until you are ready to thoroughly rinse and dry them before placement back into the enclosures.

Clean and disinfect the utensils before starting to work on the quarantined animals last. (The idea of having separate sets of utensils and spare rags and sponges begins to not sound so crazy, after all...) Clean and sterilize the utensils, sponges and rags after you are finished.

Recipe for Glass and Window Cleaners

Finding a window and glass cleaner that will clean the surfaces thoroughly without leaving streaks and smears often means using one with ammonia (which, by the way, is not good for Plexiglass). It has become harder to find products such as Windex™ made with vinegar.

Make your own window cleaner that can be used on glass (windows and enclosures), mirrors and poured into your car's windshield wiper's cleaning fluid container.

Into a clean, empty 3 Litre bottle, pour:

- 4 Cups (1 U.S. Quart) Rubbing Alcohol
- ¼ Cup Vinegar
- Just a few drops of Liquid Alcohol

Fill up the rest of the bottle with clean water; distilled water is preferred but not essential. Shake well. The mixed cleaner can be poured into spray bottles, or directly (using a funnel will avoid spillage and additional mess) into your windshield wiper cleaning fluid container. Just spray it on and wipe as usual. For stubborn spots, spray some on the spots, let sit for a minute or so while you work elsewhere, then rub it out.[26]

Cleaning schedule

The timing and amount of routine cage cleaning depends on the size and habits of your tortoise. Of course, you will also learn from close personal observation. In general, you will need to perform:

- A daily cleaning to remove spills, uneaten food, shed skin, urates, or feces; also clean and disinfect food and water dishes.
- A weekly cleaning and disinfecting the cage, substrate, and decorations.

During cleaning procedures, it is recommended to use rubber or latex gloves and protective goggles. After every contact with your tortoise, and every cleaning procedure - no matter how large or small - wash your hands thoroughly; you may also wish to use a hand sanitiser.

Daily cleaning

As you clean, it is important to look for any signs that your tortoise may be ill. Also, watch for hazardous conditions in the cage, and remove or correct them. Observe:

- Has the normal amount of food been eaten?
- Is the temperature of the cage within the proper limits?
- Are the feces and urates normal in appearance and quantity?
- Has there been any shedding? Does it appear normal?
- Is there any evidence of parasites?
- Mites appear as small brown, red, or black spots around your tortoise's eyes, between its scales, or moving over the animal's skin.
- Ticks are slightly larger, appearing brown, black, or gray in color.
- Internal parasitic infestations are most often signaled by emaciation or changes in the feces.
- Do any of the accessories appear frayed or need to be replaced?
- Is the cage in good repair?

Daily, remove feces and uneaten food, and wipe up water spills and urates. If you are using a sand substrate, you can use a Sand Sifter to clean and extend its life.

If you deem it necessary to clean the inside the cage with a cleaning solution, relocate your tortoise to another clean cage until the cage is dry and free of fumes.

Food and water dishes should be washed in hot, soapy water, and dried thoroughly. To provide more cleaning power, use a disinfectant. Always rinse well to be sure no trace of soap or disinfectant remains on the dishes. A good alternative is to have two or more sets of dishes, so while one set is being cleaned, the other set can be used in the cage.[23,25,26]

Routine weekly cleaning

Once a week, or as often as needed, relocate your tortoise to a clean cage or holding tub, then…

- Remove all decorations in the cage.
- Clean, rinse, and disinfect water bowls and food bowls, as above.
- Bag and discard disposable substrate.
- Clean all cage surfaces with soap and hot water, and rinse well.
- Loosen tough spots with a commercial herp-safe terrarium cleaner, a toothbrush, or putty knife.
- Wash all decorations and nondisposable substrate, such as indoor/outdoor carpet, with hot, soapy water. Scrub with brushes to remove wastes and dried liquids. Rinse well.
- After washing and rinsing the cage and accessories, use a disinfectant. Be sure to rinse the cage and accessories with hot water until all residues are removed.
    - Apply the disinfectant liberally to the cage and accessories. Allow the disinfectant to have contact with the material for 10 minutes; if an item is porous, a longer time may be needed. Rinse the items, especially any wooden items, thoroughly with clean water to remove all the disinfectant. For your safety and comfort, use the bleach solution in an area that is adequately ventilated. Rubber gloves and safety goggles are also recommended.

- Allow the cage and accessories to dry thoroughly before reassembling to reduce the possibility of mold.
- Re-install decorations. Replace any decoration, especially wood, which will not easily dry.
- Be sure to thoroughly clean and disinfect all equipment, sponges, buckets, gloves, and sinks.
- Lastly, wash your hands with hot, soapy water.
- Replace your tortoise back to their freshly cleaned home

Acclimation

If bathing is recommended for your herp, it is a good idea to bathe your herp before introducing it into its newly cleaned, dry, odor-free cage.

A rule of thumb, if the cage smells dirty then clean it. Every once in a while, clean the entire cage and replace the substrate completely. How often depends on the type of cage or enclosure, how many tortoises are in it, and how big they are.[23,25,26]

A list of chemical agents associated with cleaning as well as the main groups of disinfectants that can be used with reptiles can be found in Appendix 4.
MSDS for Avisafe, Nolvasan, Bleach and Dishwashing Detergent can be found in Appendix 5.

5.2 Record Keeping

Start a journal for the keeping of records of Tortoise activities and growth. Use it for this one purpose and nothing else. There should be a minimum of two sections, one for General Observations and one for Periodic Measurements.

General Observations

If you have more than one tortoise, make a section for each individual. At the top of the first page for that tortoise, record the common name and sex (if known), the scientific name, and your name for the tortoise i.e. “Gonzo” & “Shelly”. On the first page, say where the tortoise came from, when and note down any relevant identification numbers for the individual.

Suggested kinds of observations to record

- Behaviour during the first few days after you receive the tortoise
- Eating habits: choice of growing food through the season, date acceptation of major changes in diet
- Reproductive behaviour: Juvenile (male) first starts to head-bob at and court a female. Head-bobbing by adult male as a sign of courting (not followed by attempts to flip). Response of female. Duration of parts of the event. Egg laying, duration of parts of the event, number of eggs if possible. You can watch without disturbing. Nest site. If in a damp place, date moved by you. How and where? First sight of hatchling, number hatched.
- Other behaviour: Date, time, tortoise (s) involved, duration of event. Behaviour of hatchling. Head bobbing preceding aggressive/defensive behaviour. Describe the behaviour of each tortoise. Drinking, when and where, duration. Use of burrows and other places for cover. Sharing of burrows.

Other Observations or Occurrences

- Change in appearance. New growth visible on the shell, size of chin glands.
- Disease or Injury. Injury site and cause, if known. Signs of disease. Eating or not. If and when taken to the vet for treatment (Preferably biannually). Describe treatment and results. Stool specimen taken to vet for analysis for parasites. Results.
- Questions and Unusual Observations. Make a separate section at back of journal. Write in date and short reference to a question or special observation recorded under General Observations.[27,71]

PERIODIC MEASUREMENTS

Start a separate sheet for each tortoise regardless of how you organise the General Observations. Weigh and measure at least twice a year. If the tortoise is growing very slowly, a given measurement may be slightly smaller than the last measurement.

The following is an example of how you might head journal pages and record measurements (Figure 30)[80].

PERIODIC MEASUREMENTS

Indian Star Tortoise (*Geochelone elegans*), "Gonzo", Adult male

Implanted microchip ID No. 010-579-258, External ID, "5126" on carapace scute V5 and "Tortoise Group NSW, AUST." in on RC4.

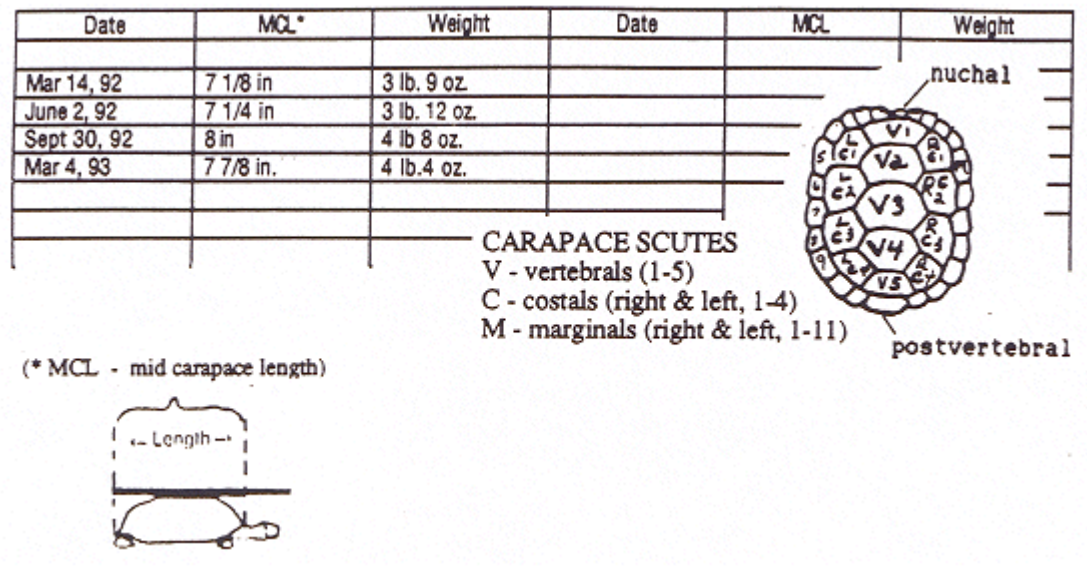


Fig 30 – Example journal pages and recorded measurements

5.3 Methods of Identification

- Microchip or passive integrated transponders (PIT Tagging) - Small, implantable devices that allow the permanent identification of individuals, and are a technique often suggested as a preferred alternative to toe clipping by animal ethics committees *Best Option*
- Temporary marks (paints, dyes, fluorescent powders, adhesive tapes, etc.) Temporary identification can be accomplished with adhesive tape strips or polish placed on the shell
- Documentation (photo identification, drawings, descriptions, passports) - An advantage of photo documentation over microchip transponders is that the animal can often be compared to the photo identification, drawing or description without the need to catch it Photo identification of young animals is more problematic as their characteristics may change substantially between birth and adulthood, which means that documentation, must be repeated to ensure continuous tracking of the changes in characteristics.
- Notches on the carapace and plastron, grinding or filing the carapace, toe clip (young specimens) and aluminum tags with permanently embossed numbers – Notches, grinding and filing should not be performed due to the risk of infection
- Radiotelemetry - Radiotransmitters can allow both the relocation and individual identification of individuals, and remote recording of additional variables, such as temperature. This method requires specialised transmitters and equipment to detect the signal. Transmitters can be fitted either externally or internally (implanted or ingested)[96]

5.4 Routine Data Collection

- Weight (before feeding)
- Dimension of animal – length, width and/or circumference (Midline carapace length – Dorsal Length, Straight Carapace Length, Midline plastron Length – Ventral Length, Scute Length)
- Appearance or condition – any changes in its skin, feet, tail, mouth, eyes, shell, breathing etc and the presence of any parasites
- Feeding – noting the feed times and food type, how it was presented, the amount of food given and then eaten, as well as the addition of any vitamin and/or mineral supplements, use of nutritional supplements (vitamins, minerals, gut loading) - type, brand name, and dose
- Environment – quantity and quality of useable space, temperature readings in the cool and hot end of the enclosure (temperature gradients), location of thermometers, a note of where the UV lamp bulb is (if required) and when it was last replaced, when the vivarium was last cleaned (spot and full) and any information on special features – such as the preferred location on any basking spot; if and how often the tortoise leaves the cage; if the tortoise goes outside
- Preferences – activities (such as digging or climbing), foods, substrate, lighting, temperature and location of refuges
- Description of the tortoises faeces and urates - colour, amount, and consistency
- Use of medications - type, brand name, and dose
- Exposure to other herps (at shows, boarding, traveling)
- Exposure to potential toxins (cleaning supplies, heavy metals, pesticides)
- Reproductive history
- Any behavioral changes
- Any medical problems noted (color changes, history of ingesting foreign objects, injuries, etc.)[27,71]

MEASURING TORTOISE SIZE – SCL (Straight Carapace Length)

Equipment: a stiff ruler (12 inches or more) with legible, 1/8 inch divisions, a pen, and a notebook.

The length of the upper part tortoise shell (carapace) is the commonly used dimension when referring to tortoise size. The measurement is a straight line, not over the curve.

The following describes how to measure for approximate length if calipers are not available: Place the rear end of the tortoise against a wall without molding as shown in Figure 31. Lay the ruler along the length of the shell, in the mid-line, making sure that both the back of the carapace and the "low" end of the ruler are touching the wall squarely. Look directly down at the middle of the front edge of the small scute (scale) that is in the center of the front edge of the shell. Sight straight down (at right angles to) where the appropriate marking on the ruler is over that place on the scute (Figure 32). As you grasp the ruler at the free end, place your thumb nail on the measurement and hold it there while you lift the ruler to read the length.[81]

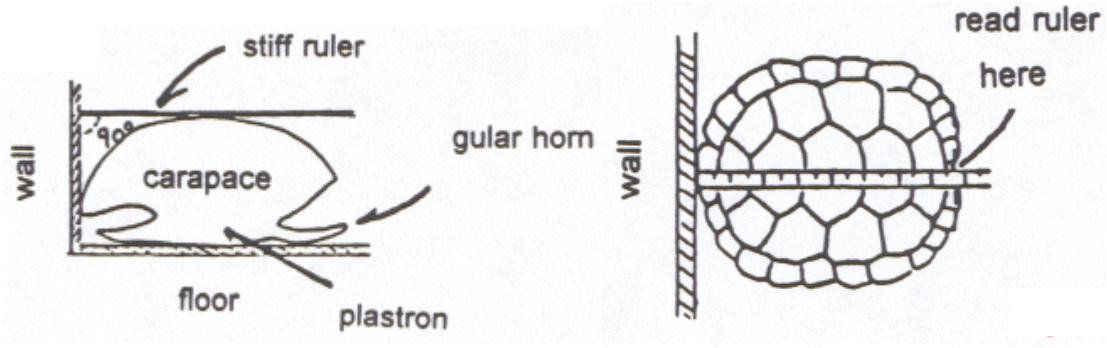


Fig 31 & 32 – How to measure the carapace length of a tortoise without calipers

6. Feeding Requirements

Tortoises are almost always exclusively herbivores, with the Indian Star Tortoise being no exception with a 100% herbivorous diet. Herbivores eat plants and plant products, such as grasses, leaves, vegetables, some fruits and grains; in their native habitat, they will eat the plants found in their particular geographical region. Herbivores, however, are nothing if not adaptable. The same Indian Star Tortoise that readily eats and thrives on grasses, weeds and some flowers found in their native habitat, will thrive on a captive diet as long as it is balanced, varied and supplemented regularly, at least twice a week, with vitamins and minerals.

While some feeding programs call for the addition of some animal protein in the daily diet of tortoises associations such as the Tortoise Trust believe that this is not necessary if a good balanced plant diet is fed. While they do acknowledge carrion consumption in the wild, they highlight the fact that Indian Star Tortoises particularly, fed solely on cat and dog foods containing high levels of protein frequently die from severe renal failure and impacted bladder stones of solidified urates. There are numerous books and websites on the internet that recommend feeding tortoises cheese, moneky chow, boiled eggs and meat along with numerous other unsuitable food stuffs; Where?!?!... in the wild would the animals obtain these types of food?[6,11,12]

Tortoise Trust has one simple rule, which I will now follow since learning it (And is pretty common sense when you think about it):

"If a Tortoise does not eat the same item, or something very similar, in the wild, there is no reason to offer it in captivity."

I personally, after reading all of the literature and seeing the sad photos of affected tortoises, believe that commercially made products should be avoided when it comes to feeding Indian Star Tortoises, because their exclusive (if somewhat misguided) use can be extremely unsafe to the tortoises they are being fed to and influential to the development of severe deformities or eventual death due to malnutrition. I also feel that in no way (contrary to the marketing talk of the production companies) do these types of products emulate any type of wild and natural diet with all of the essential nutritional requirements that Indian Stars need to develop at a healthy rate, and will steer clear of them at all costs.[24,72,88]

6.1 Diet in the Wild

In the wild, Indian Star tortoises tend to be browsers. They wander over quite a wide area and in the process take small quantities of a very wide variety of seasonally available food. They can consume up to 200 different kinds of plants during the year. The exact combination of plants, and their status, young, fresh and succulent or old and dry, varies seasonally. In the case of Savannah and semi-arid habitat species, such as the Indian Star Tortoise, food availability often peaks during early spring, but drops dramatically during the very hot summers that are experienced in the areas.

By wandering over a wide area, and by consuming such a variety of foods, the tortoises ensure that their overall intake is well-balanced and can supply the essential mineral trace elements that they require for reproduction and healthy bone development. Even the best captive diets tend to be very restricted when compared to these natural feeding patterns.[6,76]

Fig 33 Prickly Pear Cactus (Opuntia spp.)

Not surprisingly, given its propensity for living in grassland habitats, the Indian Star Tortoise grazes extensively upon mixed grasses. It also favours the fruit and pads of the Prickly Pear cactus (Opuntia spp.)(Figure 33), succulents and thistles.

6.2 Captive Diet

Indian Star Tortoises generally need feeding on a daily basis as they are browsers, eating throughout the day and then resting before feeding again. When it comes to feeding out, young tortoises can be fed *ad libitum,* adult males should be fed as needed to maintain a lean, active condition since decreased sexual interest has been noted in obese male tortoises. Females can also be fed as needed, with reproductively active specimens requiring adequate nutrition for egg development and oviposition.[2,61]

Information I have received from Marcus Langford, a reputable Indian Star Tortoise breeder in the UK, states that it is very hard to specify a daily amount of food for Indian Star Tortoises because every individual tortoise will be slightly different in daily food requirement due to size, age (including rate of growth), level of activity, food available and the time of the year. Langford feeds his tortoises enough so they can eat everything they want to and there is a little left over, which can be left overnight and removed the next day if not eaten. He did state if a weighed amount was needed generally a 2kg adult tortoise could eat 50-100g of food a day but it could also lose this amount of weight in urine and faeces (i.e. lose this weight and therefore still be the same weight at the end of each day) so you would also need to know how much they have had to drink as well, therefore determining a more specific weight to food ratio is somewhat difficult (Personal Communication 22nd May 2009).

Indian Star Tortoises have dietary requirements that fall mid-way between that of the Mediterranean tortoise *(Testudo* species) and the Leopard tortoise (*Geochelone pardalis*). In captivity it is a common error to feed too much “wet” food such as iceberg lettuce to Indian Star

Tortoises. Thousands of baby Indian Stars are sold each year in some parts of the world as pets: the vast majority die within 12 months because basic feeding advice is ignored. They are primarily a grazing species with a preference for various high fibre grasses in the wild; every effort should be made to duplicate this diet in captivity. They need a diet which is very high in fibre, low in sugar and easily digestible carbohydrates, which should be primarily based around coarse green leaf vegetables, mixed grasses, and flowers. It is important not to change the diets of Indian Star Tortoises suddenly. This is because tortoises are very dependent on beneficial bacteria and other microbes in their digestive system to digest their food, and any sudden dramatic change can lead to fatal diarrhoea and the loss of these important bacteria. Introduce any new foods to your tortoise very gradually over a couple of months.[32,72]

Sample Diet – General Herbivorous Tortoise Diet (Mix dependent of availability of food)[35]

Fruits and Vegetables (<10%) – Fruit should be given very sparingly because overconsumption can lead to high levels of sugar in the gut (intestine) and result in colic.	**Mixed Green Leaf Vegetable Base (90+%)**
• Cantaloupe • Winter squash • Mango (no pits) • Peas • Parsnips • Apple (no seeds) • Grapes • Red and green sweet peppers • Sweet potatoes • Green Beans	• Coarse mixed grasses and hays • Dandelion, mustard, and collard greens • Cabbage* • Clover • Kale* • Endive • Parsley* • Carrot toppings • Flower heads and other natural fodder plants

***These contain high amounts of oxalates and should only be fed in limited quantities.**

Outdoors during warm weather, you should try to grow plants within outdoor enclosures such as:

- Dandelion
- Bindweed
- Opunita cactus (Prickly Pear)
- Sedum
- Plantain (the weed, not the banana-like fruit known as plantain)
- Coreopsis
- Hibiscus
- Pansy
- Petunia
- Grape vines (feed the leaves, not the fruit)
- Mulberry (the leaves, not the fruit)
- California Poppy
- Mallow
- Some Vetches
- Some Clovers
- Bermuda Grass

It is also possible to grow many wildflowers and weeds indoors and in greenhouses so that your tortoise does not have to rely on grocery store greens, especially in winter. Anything the tortoise might graze on must be pesticide free. Star tortoises will graze happily on lawn grass if presented with the opportunity and this seems to prevent most such problems at source.[82,83]

Try to avoid a diet based upon 'supermarket salad/greens', which typically contain vastly inadequate fibre levels, excessive pesticide residues, and are too rich in sugar content as they are designed for human consumption. If feeding grocery store produce, it should be mixed into a salad with other more nutritional plants, including:

- Endive
- Escarole
- Dandelion greens
- Watercress
- Frisee
- Red-leaf lettuce
- Radicchio
- Shredded carrot (small amounts)
- Turnip greens (small amounts)
- Collards (small amounts)
- Opuntia
- Romaine (small amounts)
- Occasional pumpkin and butternut squash

The mixed salad diet, itself, is low in fiber. One way to increase the fiber content is to grind hay (Bermuda, Timothy, and Orchard) into a powder (a coffee grinder works well) and mix that into the greens at every feeding. Dust the food with calcium daily, and if the tortoise isn't kept outdoors in natural sunlight, also use a combination calcium-D3 product a couple of times a week. It is also helpful to keep a cuttlebone (Figure 34)(with the back removed) in the enclosure so your tortoise can nibble on it if she or he feels the need for more calcium.[82,83]

Fig 34 Cuttlefish Bones

While carrion may be eagerly consumed if encountered in the wild, the Indian Star Tortoise should NOT be fed any meat-based protein, nor should high protein vegetables such as beans feature regularly in the diet. Indian Star Tortoises fed on high protein diets including cat and dog foods frequently die from renal failure or impacted bladder stones of solidified urates due to dangerously high blood-urea levels or suffer from excessive growth and poor bone formation.

Indian Star Tortoises should not be given large or excessive quantities of fruit or “soft” food on a routine basis. Excessive feeding of these types of food frequently leads to repeated flagellate and other gut problems such as colic and other digestive tract disorders, probably as a result of increased gut motility influenced by the high level of sugars within the fruit. Fruits and soft food should only be fed as part of a treat.

Indian Star Tortoises eating Mango (Personal Photograph)

A nutrient analysis of possible tortoise foods can be found in Appendix 6 and a table showing Calcium: Phosphorus ratios of tortoise foods can be found in Appendix 7.

Some vegetables fall into a category called anti-nutrients. Oxalic acid and phytic acid bind with minerals, including calcium, preventing the availability of a significant percentage of calcium to the body. This means, if too much of these foods are fed out, it may increase the risk of calcium deficiency in the tortoise.[82,83]

Oxalic Acid – Foods to Avoid

- Spinach
- Rhubarb (which is toxic anyway so should never be fed)
- Beets
- Beet greens
- Celery Stalks
- Swiss Chard

Some vegetables in the *Brassica* genus (cabbage like vegetables) contain Goitrogens, which can affect the absorption of iodine. T hey should not be fed out in excess as they may also cause thyroid problems. Some of these include:

Goitrogenic Vegetables – Foods to Avoid

- Cabbage
- Kale
- Bok-Choy
- Broccoli
- Turnips
- Rutabaga
- Cauliflower
- Brussel Sprouts

Tannins, in high amounts, bind with protein and interfere with digestion by inhibiting key enzymes involved, and can render iron and vitamin B12 unavailable. Tannin can cause liver problems if fed in excess. A little of these foods are fine, just not as a staple food. These include foods such as:

Tannins – Foods to Avoid

- Spinach
- Carrots
- Bananas
- Grapes
- Lettuce
- Rhubarb (which is toxic so should never be fed)
- Onions

Other foods falling into one or more of these categories include:

- Beans
- Collard greens
- Corn
- Mustard Greens
- Peas
- Tofu (and other soy products)
- Turnip Greens

Some of these foods, such as collards, mustard greens, and turnip greens can be part of a varied diet, but keep the amounts relatively low.[6,15,65,88]

Australian Reptile Park (ARP) Base Tortoise mix developed for the Indian Star Tortoises daily

Ingredients Include:

- 1 ½ cups Endive (packed) - chopped
- 1 cup Lucerne Hay (lightly packed) – chaff or chopped up hay
- 1 cup Basil (lightly packed) - chopped
- 1 cup Parsley (Continental and Curly) (lightly packed) - chopped
- 1 cup Water Cress (lightly packed) chopped

This recipe is for one feed; however it is quite often made in larger quantities (double or triple quantities) to cover a few days and stored in the cool room.

Additional Tortoise mixes

These mixes can be added to the base tortoise mix, with foods substituted and changed due to availability. The mixes can be rotated on a weekly cycle to provide variety.

Mix 1

- 2½ cups Endive – chopped
- 2½ cups Water cress – chopped
- 1 cup Carrot – grated
- 1½ cups Green Beans – chopped
- 1½ cups Zucchini – grated

Mix 2

- 2 cups Squash – grated
- 2 cups Snow Peas – chopped
- ½ cup Basil - chopped
- ½ cup Oregano – chopped
- 1 cup Corn (Kernels)
- 2 cups Bok Choy – chopped
- 3 cups Endive – chopped (can be substituted with more herbs if there is a lot of Endive in base mix)

Mix 3

- 1 cup Squash – grated
- 1 cup Endive (packed) – chopped
- 2 cups Water Cress (med packed) - chopped
- 1½ cups Parsnip (light) – grated
- 1½ cups Zucchini – grated
- ½ cup Lucerne hay - chaff or chopped up hay

Summer Mix (Sept-May)

- ¼ cup Oregano – chopped
- ½ cup Basil – chopped
- 2½ cups Water Cress – chopped
- 2 cups Snow Peas - chopped
- ½ cup Apple – cut 0.5cm^3 chunks
- 1 cup Squash - cut 0.5cm^3 chunks
- 1½ cups Endive – chopped
- 1 cup Parsnip – grated
- ½ cup Lucerne Hay - chaff or chopped up hay
- 1½ cups Green Beans - chopped

Winter Mix (June-August)

- ¼ cup Oregano – chopped
- ½ cup Basil – chopped
- 1 cup Water Cress – chopped
- 1 cups Snow Peas - chopped
- ½ cup Apple – cut 0.5cm^3 chunks
- 1 cup Squash - cut 0.5cm^3 chunks
- 1½ cups Endive – chopped
- 1 cup Parsnip – grated
- ½ cup Lucerne Hay - chaff or chopped up hay
- 1½ cups Green Beans - chopped

Newly Introduced Ingredients into Indian Star Tortoise diet

- Hibiscus Flowers
- Prickly Pear Pads and fruit
- Dandelion leaves
- Lucern hay
- Spinach
- Silverbeet

Indian Star Tortoises eating (Personal Photograph)

Before these foods were introduced into the Indian Star Tortoise diet, the tortoises were observed frequently engaging in the act of Coprophagy, the consumption of the faeces to extract remaining nutrients. After a discussion with Julie Mendezona at the Australian Reptile Park, we determined that some more nutritionally beneficial foods were needed to bulk out the diet. We included the above foods into the diet, and the level of Coprophagy has decreased dramatically and the tortoises are a lot more active (Personal Communication 20th April 2009).

The following and above photo/s display in Australian Reptile Park Indian Star Tortoises consuming their new and improved tortoise mix complete with prickly pear pads, hibiscus flowers and dandelion leaves (Personal Photographs 2009)

Indian Star Tortoises eating (Personal Photograph)

6.3 Supplements

In the wild, Indian Star Tortoises tend to be found in regions where the soils are relatively rich in calcium and other trace elements. They also have free access to sunlight for basking, which contains UV-A and UV-B radiation which is required to synthesis vitamin-D3. In captivity, there are numerous different nutrients that one should pay attention to when it comes to the health of your Indian Star Tortoise compared to those obtained in the wild; however the primary nutrients of calcium, phosphorus and vitamin-D3 need to be supplemented within the diet.[35,57]

The demand for calcium in the diet is high, especially with juveniles and gravid females for use in bone building and undergoing growth as well as egg producing. Not only are the total amounts of calcium and phosphorus important but the ratio of calcium to phosphorus is critical. According to Highfield (1990) calcium-phosphorus ratio should be at least 2:1 for growing tortoises and 1.25:1 for fully-grown adults. It is also discussed that higher calcium-phosphorus ratios (such as 4:1 or even 6:1) may be even better. Tortoises tend to actively seek out extra calcium to meet their needs and this should be provided by the owner, or they can rapidly suffer deficiencies.[35]

In order to ensure that your tortoise does not become deficient in calcium it is necessary to provide extra calcium in the form of supplements. Many manufacturers provide some sort of calcium carbonate dust which can be added to your tortoise's food every feed or every other feed depending on your preference. One of the best ways to get the calcium onto leaves and flowers is to first make sure that the leaves and flowers are reasonably dry (or the calcium just clumps up and clings to wetter areas) and then to put the leaves and flowers into a plastic bag along with the calcium powder. Blow the bag up and twit to seal it and then shake it vigorously. The result should be that your leaves and flowers are given a thin even coating of calcium powder.

Fig 35 Sprinkling tortoise food with powdered supplement

In order to ensure that vital trace elements and other vitamins and minerals are not omitted from your tortoises diet (usually due to lack of variety in available foodstuffs), it is advisable to dust your tortoises food at least once or twice a week with a good quality vitamin and mineral supplement designed specifically for reptiles (Figure 35). There are several different manufacturers making suitable supplements in powder form and these can be added to the food in the same way as the calcium powder (described above).[33,88]

When it comes to the ability to synthesise the calcium, an adequate level of Vitamin-D3 is required. Basically, all reptiles need vitamin D3 in their diet in order to effectively absorb dietary calcium. This means that a reptile completely deprived of vitamin D3 could theoretically be overfed calcium, and be unable to utilise little, if any of it.

In captive reptiles, including tortoises, vitamin D3 is going to come from one of two sources, or preferably, a combination of both. The first source, and the one most utilized by wild herps, is exposure to ultraviolet (UV) lighting. When a particular wavelength of ultraviolet light (UVB) hits reptilian skin, a series of biochemical reactions occur which ultimately lead to the animal synthesis of vitamin D3. Everyday household light bulbs WILL NOT produce light in the necessary spectrum. In captivity, the only way your pets will receive vitamin D3 is if they are exposed to unfiltered

sunlight, exposed to a reptile bulb (specifically designed to emit UVB) (Figure), or through dietary supplements.[2,33,61]

Generally, tortoises kept in captivity are provided with the aforementioned UV bulbs. In some cases, this may be adequate for efficient vitamin D3 synthesis. However, more than likely, dietary vitamin D is needed to insure adequate levels to allow for calcium absorption. Most modern calcium supplements for reptiles include preformed vitamin D3. These supplements, coupled with a UV bulb, a cuttlefish bone to be gnawed upon and occasional exposure to sunlight will result in a very healthy tortoise.

Some supplements are being manufactured without vitamin D3 for use in animals maintained outdoors in unfiltered sunlight, all the time. These animals are generally able to produce enough vitamin D to get by. Although vitamin D toxicity is quite rare, it is possible, so it recommended that if you do have a 100% outdoor pet you make sure that it is not getting any extra vitamin D3 (or very rarely).

As for animals that spend most of the time indoors under a UV bulb, but make it outside once or twice a week, or during the summer, I still recommend providing dietary D3. The amount of vitamin D that they produce while exposed to a bulb coupled with occasional sunlight should still be small enough to warrant the use of a vitamin D containing supplement.[35,61]

There are a number of different supplementary products available within the herptile industry. T-rex has recently released a new line of species specific supplements with a powder for every situation! Miner-All is available in an indoor formula (with vitamin D3) and an outdoor formula (without D3 added). It is a calcium based supplement with additional trace minerals and vitamins added for complete nutrition in a single product.

Rep Cal offers an ultra-fine calcium supplement with and without vitamin D3. However, they also manufacture Herptivite, a separate product that contains only vitamins and minerals, no calcium. These products can be useful in providing a flexible regimen for growing or ovulating females in which you may want to provide calcium multiple times a day, but without the risk of vitamin overdosing.

A list of commercially available supplements and suppliers can be found in Appendix 8.

Aim for a high calcium - low phosphorous balance in Indian Star tortoise diets

6.4 Presentation of Food

Always provide the food for tortoises on a low-sided trays, such as those used a plant stands, to prevent it being dragged around the vivarium and contaminated on the substrate. It will also be easier to remove uneaten food before it can start to turn mouldy.

The Exo Terra's granite rock feeding dishes (not the higher water dish) are good for food presentation because they are low, heavy, very stable, and don't tip over when tortoises walk all over them. Plus little ones can climb in and out of them. Eating on a hard surface is beneficial for beaks, too. These dishes are made of hard, food-grade resin.[33,88]

Another low reptile dish is the Zoo Med's reptile rock food dish (water dish is higher). It's made of softer material though. To provide a hard eating surface, you can also feed your tortoise on a large tile or a big, flat rock.

A heavyweight bowl of drinking water should be accessible in the enclosure at all times, but ensure that the design of the bowl is such that the tortoise cannot fall in and drown.

Behavioural enrichment feeding

Monthly enrichment Calendar – Indian Star Tortoise – Australian Reptile Park (ARP) - Highlighting enrichment feeding

1. Scatter Spices
2. Scatter basil, Take for graze on grass
3. Scatter feed, Hanging Endive (low enough for them to reach)
4. Flowers
5. Eucalyptus mulch from mammal yard
6. Scatter feed, substrate from possum box
7. Blood scent
8. Scatter feed, Water tray
9. Scatter feed, Browse, Take for graze on grass
10. Used wombat mulch/branches (hide)
11. Fresh Basil, Scatter feed
12. Scatter feed
13. Fresh Rosemary, Scatter feed
14. Earth worms, Scatter feed, Bird calls
15. Fresh Flowers
16. Browse, Mammal used eucalyptus leaves (hide)
17. Graze on grass
18. Water tray
19. Snake shed
20. Mirror
21. Flowers- hibiscus
22. Frog calls, Frog substrate (hidden around enclosure)
23. Scatter feed
24. Graze on grass
25. Scatter feed
26. Scatter feed
27. Fresh Basil
28. Flowers
29. Scatter feed
30. Graze on grass
31. Browse, Fresh mint

Other behavioural enrichment feeding methods:

- Broccoli/Herb trees (fresh packet herbs propped up in enclosure to resemble trees, broccoli propped up in small tubes/containers, or placed in gaps of enclosure log)
- Prickly pear pads (end placed underneath heavy rock to allow tortoises to pull at pad and tear pieces off but to stop it coming out completely)
- Water soaked tortoise mix (extra water added to feed dish to allow drinking)

7. Handling and Transport

7.1 Timing of Capture and Handling

Ideally tortoises should be captured during a time of minimal movement, i.e. just after feeding while warming under a heat lamp or during warming. I have found that the tortoises are quite often very slow in their movements and easy to catch. If the capture is due to transportation, then the above option will be eliminated, due to the recommendation that feeding does not take place 24hrs before transportation occurs. Therefore capture so occur before heat lamps are turned on and the tortoises are given a chance to warm up and start moving around. This can also minimise a lot of movement within transport bags/boxes/containers and potential injury to the tortoise (Personal Observation and Handling 2009).

7.2 Catching Bags

Chelonians need not necessarily be placed in bags during transport, but adequate bedding must be provided in the container to ensure the animals are not injured or traumatised during the general movements of transportation. Shredded paper or similar material can be used as bedding.

If bags have been elected for use, strong cloth bags of a material that allows the passage of air must be utilised. Bags must be of robust construction, using double-stitching with special attention to corners, in a manner that avoids loose threads at internal seams that could entangle teeth or claws. The animal must have sufficient space within the bag to achieve some movement, including righting itself if upturned, extension of head and limbs at the same time.[8]

Bags containing animals must be sealed/tied and secured within the container. The bags/animals must be packed so that they are neither stacked nor overcrowded within the container/compartment. They must be laid flat and fastened to the crate. Shredded paper or similar material should be packed around the bags to reduce bag movement, to prevent specimens from sliding around, and to act as insulation and an absorber or excess moisture.

More than one bag containing specimen(s) may be packed in a single container/compartment. More than one specimen may be packed in a single bag, provided all are compatible and of similar size. Different species must not be mixed in a single bag, but may be transported in separate bags in the same container. Each bag must be clearly labelled with the species name and the number of specimens enclosed.[8,17]

Bags can be used during weighing and for short-term movements or transport.

7.3 Capture and Restraint Techniques

Important - <u>Keep Handling at a Minimum</u>[9]

Physically restrain and lift tortoises only when absolutely necessary.

A baby tortoise can be merely encircled with the fingers and thumb, and physically lifted. The creature will probably feel more secure if laid in the open palm of your other hand. But always

restrain him. Don't allow him to scramble off your hand. A fall or drop could break your turtle's or tortoise's shell, break a limb, or even cause death.

A larger tortoise should be grasped in both of your hands, one on each side of the shell, between the forelimbs and the hind limbs. Tortoises are easily carried in this way, however some can still try to kick out and they may kick strongly. If they are large, they may cause minor scratches. These scratches should be sterilized and dressed.[9,21]

It is important that when handling your turtle of tortoise, you do so in a manner that will minimize the possibility of injury to either you or the animal. The shell is not impervious to feeling but is a living growing entity that can break or be otherwise injured. Your tortoise will feel, and usually respond to, your slightest touch.

Never drop your turtle or tortoise. Always take the necessary precautions to prevent your turtle or tortoise from falling. If any injury does occur, consult a reptile-oriented veterinarian immediately.[48]

Chemical restraint of tortoises, during transportation, is NOT recommended as per the Convention on International Trade in Endangered Species of Wild Fauna and Flora Packer's Guidelines (CITES): Rp/3 – Tortoises and land turtles, snakes and lizards – Point 1.3 which states:

"Reptiles should not be sedated."

7.4 Weighing and Examination

Weighing tortoises – If the situation allows, you should weigh all tortoises being shipped before they are transported. The best time to weigh a tortoise is immediately after it is removed from its enclosure. This way you have a true weight should the tortoise empty its bladder, and can weigh it afterwards. One reason for weighing a tortoise is to determine if it is underweight, which may be one sign that it has Upper respiratory tract disease or another disease.[9,21,87]

Tortoises can be weighed by one of two ways:

- Using spring scales
- Using regular weighing scales (Electronic/digital or Dial/Analogue)[21]

Using Spring Scales - If you are using a spring scale, a cotton bag and cotton string may be used to suspend the tortoise from the scale. If you use string as a sling, be sure that the material is strong enough to support the tortoise. The tape may be doubled for use with very heavy tortoises.

Smaller tortoises may be placed inside the cotton bag and weighed. Larger tortoises can be weighed by making a sling with one loop of the bag placed posterior to its forelimbs and the other loop placed anterior to its hindlimbs.[21]

When weighing a tortoise, hold the ring at the top of the scale to ensure that the scale is suspended vertically and the correct weight is being taken.

Never suspend a tortoise far from the ground; suspend the tortoise over sand rather than large rocks; keep weighing time to a minimum; and take every precaution to prevent the tortoise from falling.

Using Electronic/Dial/Analogue Scales – The tortoise can be placed directly on to the weighing platform.
You can put them on their plastron or their back (only use if weighing very quickly as your tortoise may try to flip back over); whatever is easier for you and your tortoise/s.
Placing them on their plastron is a very easy way to quickly weigh them, as if they are a bit larger than the weighing platform then the legs "hang down" a bit over the scales, limiting any movement during the weighing process (Figure 36). You may find this occurs more often with raised dial/analogue scales rather than electronic scales.[21,87]

If you find that your tortoise is pushing itself up and walking away (it can happen if the tortoise is a bit smaller than the scale platform and has the ability to use its legs or with electronic scales that have a large weighing platform) or there is a fair amount of movement that maybe affecting the weighing process, you can place a can or bucket (slightly smaller than your tortoises plastron) onto the weighing scales and then carefully balance your tortoise on top so that the legs "hang down", your tortoise can't run away and you can get your weight reading. Just make sure that you zero or tare the weighing scales before you weight and that you watch your tortoise does not fall off, if he/she decides to try and move anyway.[21,87]

Fig 36 Weighing a tortoise on Dial/Analogue Scales

Using the can or bucket method may also aid in facilitating observations and measurements, while preventing your tortoise from "running away" during its examination. The can should be large enough to support the tortoise and small enough to prevent any waving appendages from touching the can. Freedom to move its appendages may encourage a tortoise to extend its head, which allows you to observe the eyes, chin glands, and beak. The can must be cleaned before using it with another tortoise, or you may place waterproof plastic, such as a plastic bag, on top of the can, the tortoise on top of the plastic, and discard the plastic afterwards.[21,87]

7.5 Release into the enclosure

Release should not occur during extreme temperatures, i.e. extremely hot weather (e.g. over 33°C) or cold conditions (under 18°C). Release should be postponed until more favourable conditions are present but the tortoise must be kept warm, between 18-24°C, during that time. Tortoises should be released close to a shelter or cover, which offers the chance to hide, and be allowed to explore their new enclosure at their own pace.[8,17]

7.6 Transport Requirements

The following transport requirements have been obtained from the Live Animal Regulations as required by the International Air Transport Association (IATA) as well as the General Container Requirements for Reptiles and Amphibians under the Herptofauna Transport Standards (HTS) (Developed by Chris Banks for ARAZPA).

7.6.1 Box Design

CONSTRUCTION - CONTAINER TYPE A
(Replaces 41, 43 & 44)
Applicable to most species contained in the following groups:

- Sauria (lizards, except those covered by Container Type B)
- Serpentes (snakes)
- Rhynchocephalia (tuataras)
- Chelonia (tortoises and turtles)[8]

In addition to the general requirements for reptiles and amphibians, specific guidelines relate to the design and construction of *Container Type A*.

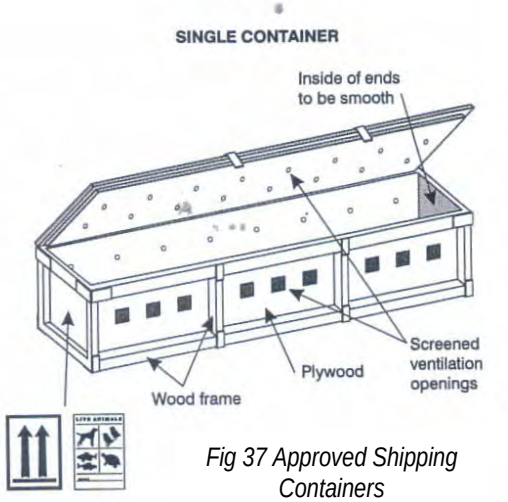


Fig 37 Approved Shipping Containers

Shipping containers may be constructed using timber and timber products, fibreboard, rigid plastic, metal, fibreglass or other structurally rigid materials. Timber and timber products treated with insecticides and preservatives must be avoided. There must be no direct contact between animals contained and any metal surfaces (Examples of approved shipping containers can be seen in Figures 37&38).

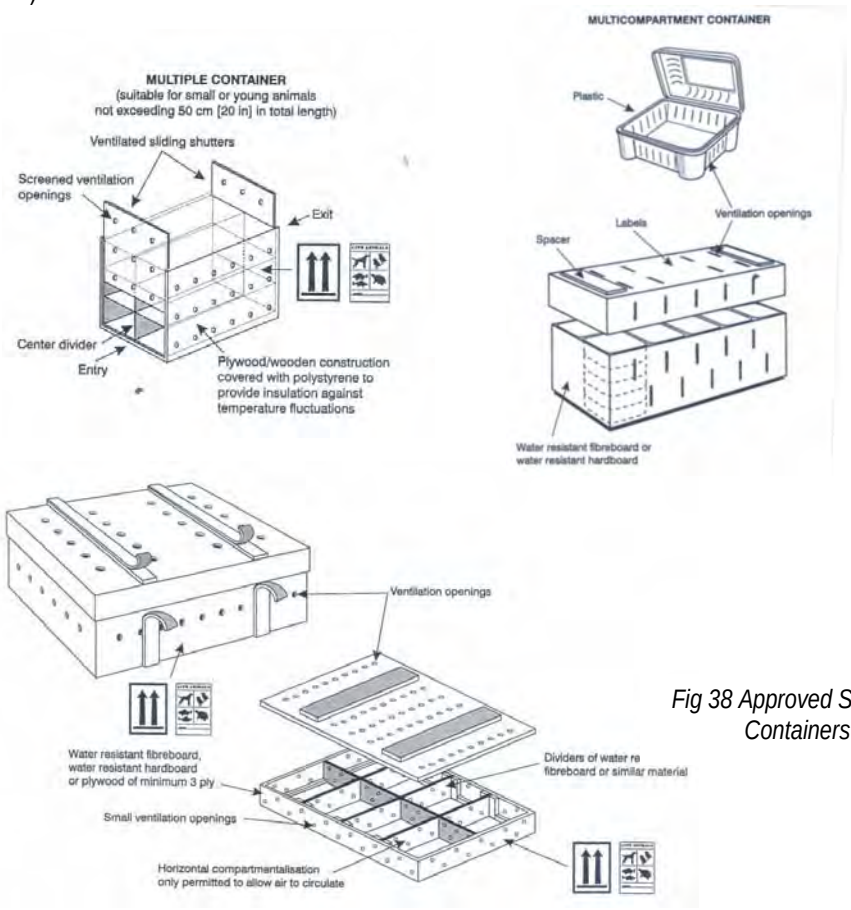


Fig 38 Approved Shipping Containers

Cardboard boxes with Styrofoam box inserts (used commonly in the fish trade) may be acceptable by some carriers for small reptiles and amphibians, but these are likely to require additional structural support to prevent breakage during transport. If the inner container is divided into compartments, the walls must be firmly fixed to the floor and/or sides in such a manner that they do not collapse when the container is tilted or turned upside down when loaded.[8,17,44]

The floor of the main container must be solid and leak-proof. Container lids/doors must be securely fastened, but in such a manner that they can be opened for the purpose of inspection at any time during transport. Viewing/access ports, allowing observation of occupants with risk of them escaping, can be used for specimens of special concern. It is recommended that security seals (available at airports) are placed on latches to dissuade curious transport staff from examining the animals without authorisation, particularly for aggressive and/or venomous species. Nobody except an authorised inspector should tamper with such a seal.

The container must be marked "LIVE ANIMAL" and have "This Way Up" labels affixed to all four sides. "Reptile" or "Amphibian", as appropriate, must be noted on the "Live Animal" label. The container must also be labelled with "Keep Cool", "Keep Out of Sun", "Keep Away From Heat", "Avoid Temperature Extremes", or similar as appropriate.[8,44]

Dimensions

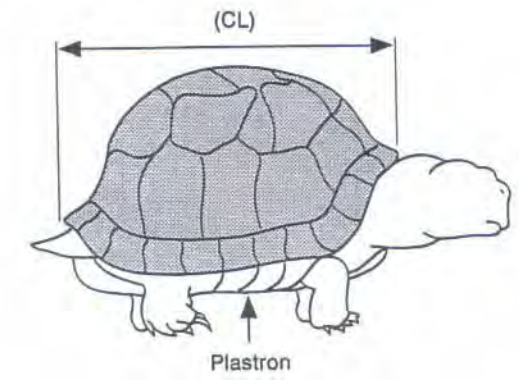


Figure 39 Box measuring done over Straight-line carapace

The dimensions will depend on the size of the consignment and the species/animals being shipped. To aid in determining the size of the box for shipping required, tortoises should be measured by the straight-line carapace (CL)(Figure 39).

The inner container or compartment must be large enough, in general, to allow the tortoise to lie in a natural position, while allowing them to extend their head and limbs at the same time, with enough space to ensure that stacking does not occur.[44]

Ventilation

- Ventilation must be provided as outlined in the general requirements.
- The container, and all animal holding compartments within must be adequately ventilated on at least three sides.
- Generally, the ventilation openings must be small enough to prevent the animal escaping and to minimise the risk of occupants exposing parts of their body (e.g. tail and legs) outside the container and, hence, being injured during transport.[8,17]
- Where ventilation holes have a diameter greater than 5mm, the use of an open weave mesh (e.g. flyscreen) is required to ensure security. The mesh must be of very strong construction and properly fixed in a manner that precludes the possibility of escape, including being placed on the inside of the container to prevent the mesh being easily pushed out from the inside by an animal.

- Where inner and outer containers are used, openings must be configured in such a fashion that precludes blockage of any of the openings due to misalignment of the multiple layers of the container. A strip of material must be fixed to each ventilated side of the container in such a manner as to ensure that if the container is pressed against a smooth surface (e.g. another container), ventilation will not be retarded.[8,17,44]

Insulation

Insulation needs must be considered as set out in the general requirements.

- Shredded paper or similar material can be packed around the catching bags to act as insulation as well as the cardboard boxes with the Styrofoam inserts as long as ventilation is not compromised.[8,84]

7.6.2 Furnishings

There should be no furnishing within the transport box, but substrate, including shredded paper, needs to be provided to absorb excess moisture and prevent sliding of specimens (if not within a bag).

7.6.3 Water and Food

- Animals should not be fed for at least 48 hours prior to shipment.
- Food must not be provided for any species (except tadpoles) in the shipping container
- All animals must be well hydrated prior to transportation. Ideally, animals should be relatively cool at the onset of shipment, i.e. room temperature (20-24ºC) to reduce the initial level of activity.[17,44]

7.6.4 Animals per Box

Carapace Length (CL)	Maximum no. of animals per enclosure
≥ 45 cm (18 in)	1
≥ 30 < 45 cm (12 < 18 in)	2
≥ 25 < 30 cm (10 < 12 in)	3
≥ 17.5 < 25 cm (7 < 10 in)	5
≥ 10 < < 17.5 cm (4 < 7 in)	7
< 10cm (4 in)	10

Tortoises less than 10cm (4 in) carapace length may be packed in rigid plastic containers. Hatchlings are defined as young tortoises which are approximately the size when they were hatched.[44]

7.6.5 Timing of Transportation

All possible precautions should be taken in advance to ensure that animals are not subjected to extremes of temperature. This would necessitate planning their movement with due regard to the climatic conditions natural to them, and to the conditions prevailing at their final destination, and also those that will be encountered during transport. Particular attention should be paid to the facilities at any intermediate stops at airports, etc.

Temperature during transportation should be maintained between 18-24C° for the majority of species. The use of insulation can be helpful in reducing the influence of changes in surrounding temperatures during shipping and transport.

If extremely hot weather (e.g. over 33C°) is encountered, the shipment should be postponed until more favourable conditions are present, or special arrangements made to ensure that shippers protect containers from temperature extremes. Or specific arrangements can be made with the transport company to ensure that appropriate temperatures are maintained. As described above, the appropriate use of insulation and/or ice packs can assist in maintaining relatively cool conditions.[17,44,84]

Containers must never be placed in direct sunlight, near heat sources nor in excessively draughty positions, such as near air-conditioning outlets. The same philosophy applies for cold climates.

7.6.6 Release from Box

As per section 7.5 Release into the enclosure.

8 Health Requirements

8.1 Daily Health Checks

- Has the normal amount of food been eaten?
- Is the temperature of the cage within the proper limits?
- Are the faeces and urates normal in appearance and quantity?
- Has there been any shedding? Does it appear normal?
- Is there any evidence of parasites?
    - Mites appear as small brown, red, or black spots around your tortoise's eyes, between its scales, or moving over the animal's skin.
    - Ticks are slightly larger, appearing brown, black, or gray in color.
    - Internal parasitic infestations are most often signaled by emaciation or changes in the feces.
- Are there any edges or sharp corners that can injure your pet?
- Are there any injuries? Look for bites, scratches, discoloration, swelling, sores, or discharge.
- Are the eyes clear?
- Is the overall appearance of your herp healthy? Check eyes, ears, nose, legs, tail, and skin to see if your reptile looks healthy.
- Is the animal bubbling at its nose, or wheezing? Are his eyes running? These three can be indicators of respiratory trouble.
- Feel the shell; is it hard and solid? A soft shell can be a symptom of calcium problems.
- Check the feet. A tortoise's foot should look somewhat like that of an elephant, with short, even nails that are not curling back into the flesh. This would suggest either that the animal had been kept on the wrong sort of substrate (the material lining the floor of it's cage) or that he suffered from some sort of nutritional deficiency.[27,71]

8.2 Detailed Physical Examination

In order to properly examine a patient, physical restraint usually is necessary. Handling technique is important for patient and handler safety and guidelines will vary according to individual needs. Tortoises are generally held by grasping the rear portion of the carapace, however when physical restraint is not feasible, possibly due to a biting tortoise, chemical restraint may become necessary prior to physical examination.[52]

Chemical Restraint

Procedures that may require chemical restraint (particularly for aggressive, over-excited or difficult tortoises)

- Blood taking in large amounts (it is recommended that a sample is taken pre-anaesthetic)
- Mouth swabbing (particularly on aggressive and biting tortoises)
- Radiography (for over-excited tortoises) or any other diagnostic imaging tests
- Stomach tubing and oral dosing

3 Options for anaesthesia

- Total intravenous injectable anaesthesia - The tortoise will be anaesthetised following an intravenous injection. If it starts to wake up you can just inject some more of the drug.

- Injection plus volatile agent - With this option you can also ventilate the animal with a volatile agent and give it oxygen to improve its chances of survival.
- Balanced anaesthesia – Studies still being completed on side effects of balanced anaesthesia.[51,93]

Injectable Anaesthetics[52]

- Alphaxalone/alphadolone (Saffan: Mallinckrodt) - 10mg/kg intravenously (i.v.) to anaesthetize the animal for 20 minutes, Intramuscular (I.M.) 15mg/kg (only use if i.v. injection not successful)
- Propofol (Rapinovet: Mallinckrodt) – 1.0-1.4 ml/kg i.v. (can only be given via i.v.)
- Ketamine HCl – 60-100mg/kg i.m. (Not to be used in tortoises with suspected renal disease, hepatic disease, dehydration or undiagnosed debilitation)
- Succinylcholine chloride – 0.25-1.5 mg/kg (not true anaesthetic, only for use in restraint)

Volatile/Gaseous Anaesthetic[52]

- Halothane – Can be used to maintain anaesthesia at 1-2% with oxygen.
- Isoflurane – Anaesthesia can be maintained at 1-1.5% but this is dependent upon maintaining the animal within its preferred optimum temperature range.
- Nitrous Oxide – This can be used at 2:1 mixture with oxygen and in so doing reduces the amount of volatile anaesthetic by about 25%.
- Methoxyflurane – Used in the same way as halothane but care must be taken with animals suspected of having liver disease or toxaemia.

PLEASE NOTE

Great care should be taken to maintain the anaesthetised tortoise's body temperature suitably, using a heat pad or hot water bottle. The preferred optimum temperature (POT) for the species would be most suitable otherwise 22°C is normally the recommended anaesthesia temperature and 25°C is the recommended recovery temperature.[51,52,53,54]

Physical Examination

As tortoises are encased in a protective shell, it can prove very difficult to give an effective clinical examination. Importance must be placed on weight, length, and the careful visual examination of all available areas. The general demeanour (activity, eating patterns etc.) of the tortoise should be assessed in relation to its stage of yearly activity. A full history including nutrition, environment and contact with other tortoises should be taken. Any previous diagnoses and treatment should also be noted. A suggested history/examination form can be found in Appendix 9.

Examine the tortoise

The veterinarian should review these aspects of your tortoise's husbandry, diet and health during the examination.[22,27,71]

- Where you purchased/obtained the tortoise
- What other animals you have in your institution; if they are cagemates; and what is their health status
- Housing, including cage size and type, bedding, cage furniture, and presence of cage plants; if and how often the herp leaves the cage; if the tortoise goes outside; cage hygiene
- Heat sources, locations of thermometers, and temperature gradients
- Light sources and frequency of bulb changes
- Relative humidity of the cage, and water/humidity sources
- Typical diet including brand names, if applicable; what and how much is offered and what and how much is eaten; feeding frequency
- Description of the tortoises feces and urates - color, amount, and consistency
- Use of medications - type, brand name, and dose
- Use of nutritional supplements (vitamins, minerals, gut loading) - type, brand name, and dose
- Use of pesticides or any other treatments - type, brand name, and dose
- Exposure to other herps (at shows, boarding, traveling)
- Exposure to potential toxins (cleaning supplies, second hand smoke, heavy metals, pesticides)
- Reproductive history
- Any behavioral changes
- Shedding history
- Any medical problems noted (color changes, history of ingesting foreign objects, injuries, etc.)

The following table summarises the common presenting symptoms of many tortoise diseases and can act as a simple check list during a physical examination.[27,52,71]

Symptoms that may be indicative of several illnesses

Region	Possible presenting signs
Eyes	• Swelling • Discharge • Infections • Cataract • Evidence of vitamin A deficiency • Foreign bodies, corneal lesions • Jaundice
Ears	• Swelling and abscess formation • Secondary spread of infection
Mouth	• Erythema • Haemorrhagic foci • Necrosis • Jaundice • Caseation
Nose	• Mucus discharge • Purulent discharge • Beak overgrowth
Skin	• Sloughing • Exudation • Oedema • Abscess formation • Jaundice • Other inflammation • Trauma
Shell	• Trauma or damage • Infection • Discharge (as in ulcerative shell disease) • The red flush associated with septicemia
Cloaca	• Trauma, discharge, infection or prolapse

The veterinarian should also observe the tortoise's posture, movement and attitude.

Laboratory samples and further investigations

- Faeces and urine
  - May be examined for parasites
- Swabs
  - May be cultured from suspected bacterial infections
- Blood
  - May be taken and biochemistry and haematology assessed (complete blood count and chemistry profile depending on the age of the tortoise)
- Radiography
  - If egg retention, calculus formation, pneumonia, limb fracture or another potential problem is suspected[52]

Weigh and Measure the tortoise

Weighing is easy is small electronic kitchen scales are used. An active tortoise can be immobilised by placing it on top of a small empty pill container so that its legs cannot reach the ground. This is usually measured in grams (g).

Measurements of carapace length are made easy by using a clear plastic ruler. The distance from front to back of the carapace is measured by eye whilst standing over the animal. Then length recorded does not include the upward curvature of the shell and is called the straight carapace length (SCL)(Figure 40). This is usually measured in millimeters (mm).[71]

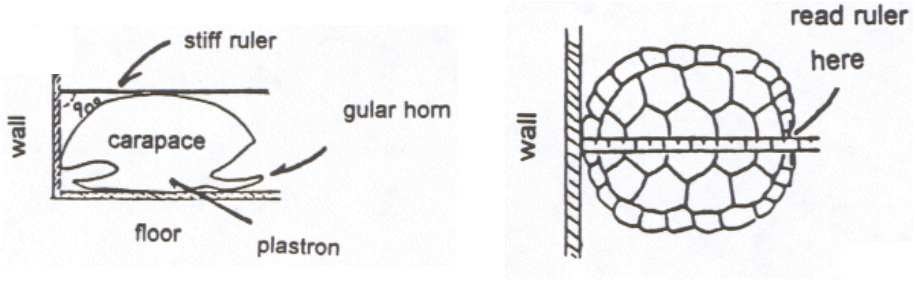


Fig 40 – How to measure the carapace length of a tortoise without calipers

8.3 Routine Treatments

Regular worming

Tortoises can pick up and carry a great number of worms. For this reason, twice-yearly health checks are recommended, with worming to be carried out at each of these. Your vet will also advise checking a faecal sample for the presence of worm eggs if there is any worry over the health of your tortoise at other times as a worm burden can lower your tortoise's immune system.

Treatments

- Oxfendazole – 65mg/kg orally, as a single dose
- Fenbendazole (Panacur) – 50-100 mg/kg orally, repeat in 2 weeks[52,71]

IVOMEC/IVERMECTIN is toxic to tortoises – DO NOT USE!!

8.4 Known Health Problems

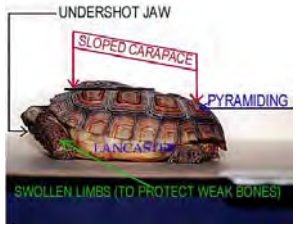
A sick Indian Star Tortoise will show one or more signs. They can be varied, but several common factors should alert the conscientious tortoise owner to seek veterinary attention urgently.

WARNING SIGNS

- Unexplained weight loss: for example, the tortoise which is steadily losing weight during the summer months.
- Loss of appetite.
- Perpetually hiding in the corners of the garden or the terrarium during the middle of the summer.
- Evidence of upper airway disease such as a runny nose, foamy saliva-like material in the mouth, or obvious mouth-breathing (tortoises should breathe through their noses).
- Evidence of diarrhoea. Tortoise faeces should be relatively firm pellet-shapes.
- Tortoises should never be sick; any vomiting is a severe sign of illness and veterinary advice should be immediately sought.
- Any damage to the shell is important as this is living tissue. Trauma to it allows infectious organisms access to the tortoise's body. Open wounds can become rapidly infected by environmental bacteria and develop abscesses.
- Head tilts, walking in perpetual circles or obvious lack of use of one or more legs should be investigated. A lack of response to your touch is another obvious indication of a seriously unwell tortoise.
- Continual straining to pass something through the vent, but with no evidence of any egg or faeces, should alert you to the possibility of retained eggs in a female tortoise. Males may suffer from prolapse of their penis due to chronic wasting diseases or straining associated with gut parasites. This large, fleshy organ can become quickly and seriously damaged if not put back in its proper place.[19,52]

The following table will highlight some common health problems that may occur with tortoises, the cause/s, signs and treatments.

HEALTH PROBLEM	CAUSE	SIGNS	TREATMENT
Shell Problems – Ulcerations and infections  Carapace shell rot *M. parkeri*  Plastron shell rot *T. scripta elegans*	Shells are frequently affected by a water-influenced bacterial condition known as "shell rot" or Ulcerative Shell Disease (USD). This is occasionally referred to as SCUD. This disease may also have viral or mycoplasma aetiology[19,52,61] Can be caused by: • Bacterial or fungal infections in damaged areas of the shell • Dirty or excessively humid enclosures which increase microorganism levels	• A foul smelling haemorrhagic discharge from between the scutes • Soft or pitted areas • May present as lifting and flaking of the scutes (Dry USD) – infection spreads laterally under the scutes • Blisters or red/raw sores • Fluid, sometimes bloody, 'leaking' from the shell • Reddish tinge to the plates, indication of fluid underneath	• <u>Wet USD is a potential emergency.</u> - It often predisposes to a peracute and fatal septicaemia following the initial infection. It may also spread to involve the skin. – Veterinary treatment should be sought out IMMEDIATELY. • If wet USD, reducing contact with water is beneficial – dry docking. • Remove any affected shell material to allow exposure to air. This infection mainly thrives at low oxygen concentrations. • Swab the affected area for aerobic and anaerobic infections. Undertake culture and sensitivity testing. • Debride the area with a 10% povidone-iodine solution. • After extensive debridement, the affected area can be treated with a topical antibiotic according to the sensitivity result. • Parenteral use of antibiotics according to sensitivity. • Exposure to affected areas to oxygen/air is a beneficial line of treatment. This may well mean that extensive removal of scutes is required.
Skin Ailments – Swelling/Abscesses/Infections  Abscess under the shell	May arise anywhere on the body of your tortoise. Maybe due to: • Maggot infestation • Wound/abscess infection • Solidified pus • Bacterial Infection • Fungi Can also occur from minor bites or injuries	• Hard caseous lumps • Cavities containing pus (can be cheesy yellowish or more fluid-like) • Fluid-filled pockets • Redness or irritation in a particular area • Scratching at the area from the individual	• Take tortoise to your vet at the first sign of any abnormal swelling • Abscesses in tortoises will not respond merely to antibiotic treatment; they must be physically drained and all necrotic material removed surgically and the wound left to drain without stitching. • Good post-operative follow-up is vital.[19,52,71]
Beaks – Over grown  Overgrown beak in an Elongated Tortoise	Over feeding of soft foods or fed off of smooth surfaces • Can also be associated with diets poor in calcium and vitamin D3 Closely associated with metabolic bone disease	• Overgrown upper beak • Upper and lower beaks that do not meet evenly • Difficulty grabbing, chewing and/or swallowing food	• Consultation with a veterinarian is recommended, so that they may determine the best course of action. • An uneven or overgrown beak can be reshaped using a Dremel tool or similar rotary grinding device. The procedure is not painful, and sedation is usually not necessary. • In many cases, an affected tortoise will need to have its beak trimmed regularly to manage its condition unless an underlying problem can be corrected. If the animal can chew properly, crunchy foods can promote normal beak wear.

Metabolic Bone Disease (MBD) Classic and advanced MDB  *Gopherus agassizii*  Fatal deformity in a Leopard Tortoise attributed to MDB – shell deformities, splayed legs	• Direct result of poor husbandry. • Poor diet • Poor or no UVB • Lack of Vitamin D, • Poor calcium to phosphorus ratio.	• Pyramiding of scutes • Stacked scutes on the carapace • Saddle shaped shell – may appeared thickened • Overgrown, duck or parrot like beak • Oddly curved out and upward nails • Splayed/bowed legs • Difficulties walking upright - many are forced to drag their hind legs because of this. • Limping • Legs thin and deformed • Tail no longer seen – due to re-absorption of calcium from bones • Hard lumps along the legs, spinal column or jaw • Softening and unusual flexibility of the lower jaw • Low calcium levels can cause – depression, lethargy, twitches, tremors, hind end weakness, seizures, and even death	• Prevention is better than cure! • Provide nutritional diet with proper calcium and Vitamin D • Give proper UVB lighting (natural sun the best) • Plenty of exercise and humidity • Provision of cuttlebones for added calcium[19,22,52,61]
Deformities/Nutritional Deficiency – Vitamin D_3	• Direct result of poor husbandry. • Poor diet • Lack of Vitamin D	• Abnormal growth of the carapace • "Pyramiding" of scutes • Undersized shell when compared to limbs and head • Softening of the plastron • Leg weakness and deformity	• Correct dietary problems • Correct environmental problems • Vitamin D_3 by injections (take care not to over dose)[52]

Nutritional Deficiency – Vitamin A	Seen after a deficient diet has been fed for some time. Results in: • Metaplasia and degeneration of epithelial surfaces such as conjunctiva, gingival, pancreatic ducts, renal tubes, skin and lung alveoli.	• Swollen eyes/conjunctivitis • Skin sloughing • Runny nose syndrome • Necrotic stomatitis • Respiratory problems • Jaundice/renal failure/death	• Prevention of nutritional disease is better than cure. • *Regular supplementation with a vitamin-mineral additive is highly recommended for all tortoises*. • Examine the normal diet for any possible deficiencies or unsuitable components. • Any secondary condition should be treated suitably • Vitamin A injections[52]
Breathing Problems – Runny Nose Syndrome (RNS)	Upper respiratory tract infection which may have several causes. Contributing factors can include: • Dusty conditions • Foreign bodies lodged in the nostrils • Inappropriate humidity or temperature • Lack of sunlight • Confinement in damp areas • Overcrowding • Malnutrition • Stress	• Can be difficult to spot in early stages • Infected tortoises may not display any symptoms but considered infectious • Nasal discharge	• Isolate affected animals. • Consult Veterinarian • Correct any nutritional or environmental problems (especially humidity). • Check for nasal foreign body. • Take a swab for culture and sensitivity • Apply antibiotics as appropriate • Continued supportive treatment such as good nutrition, hydration, and suitable environmental management. **Please Note** - If antibiotics are deemed to be necessary, it might be useful to be aware that *G. elegans* seems to be allergic to one of the more popular reptile antibiotics -Baytril®. The 'allergy' causes a massive saliva and tear production, and evident pain in at the injection site. The treated animal seems to be in distress during all of the treatment time, and generally refuses to feed during the course of the treatment. Despite this, the drug does achieve results, so if no other antibiotic is suitable or the animals kidney status is too bad to allow the use of a more suitable but nephrotoxic drug, Baytril® can still be used - but with some extra care.[19]
Pneumonia  Painted turtle blowing bubbles – indication of Pneumonia	• Unhygienic and damp conditions • Overcrowding • Inadequate temperatures • Exposure to "carriers" • Poor diet • Parasitism • Lack of Vitamin A	• Acute – gaping of the mouth, neck-stretching and respiratory difficulty, excessive nasal/oral discharge, leg weakness and poor retraction, dehydration, depression, open mouth breathing, hyperactivity (because of respiratory distress), concurrent disease (e.g.	For Acute Pneumonia: Urgent veterinary help is needed if the tortoise is to survive. Even a few hours delay can prove fatal. • Isolate affected animals • Deliver injectable antibiotics (i.v. if possible) • Maintaining a high body temperature may increase antibiotic activity and stimulate immunity (30°C) • Affected animals should be rehydrated using a stomach tube and rehydration preparation For Chronic Pneumonia • An aurophayngeal swab for culture and sensitivity or if possible a swab taken from

		necrotic stomatitis, hepatitis/jaundice). Some tortoises run about blindly. • Chronic - persistent low level discharge from nose, cyanosis (mauve mucous membranes), generalised weakness, poor head and limb retraction, sometimes rocking and recurrent mouth opening are seen, concurrent disease	lung tissue via a drill hole • Enrofloxacin, aminoglycoside or other antibiotics according to sensitivity (e.g. baytril: Bayer at 5 mg/kg daily or gentamicin or Framomycin: C-Vet at 10 mg/kg every 40 hours for about seven doses) • Shell drilling and introduction of local antibiotics through the resulting hole if a poor response to above • Appropriate supportive therapy (e.g. fluid administration)[52]
Digestive Problems - Stomatitis	Associated with the herpes virus as well as bacterial infections, and frequently stops a tortoise from eating. Can subsequently lead to further debilitation and influence the development of certain conditions such as septicemia Can also be caused by: • Improper temperature gradients or humidity levels within an enclosure • Improper diet • Oral injury • Rubbing against enclosure walls/furnishings • Chewing on bedding material	• Anorexia (presumably due to mouth pain) • Excess saliva production • Loss of appetite • Reddened oral tissues • Recurrent mouth opening and facial swelling • White necrotic diptheric membrane formation (particularly on the tongue), haemorrhagic foci or erythema • Drainage from the mouth and nose	• Isolate affected animals, correct any environmental or nutritional problems • Take a swab culture and sensitivity • Debride mouth (possibly with anaesthesia as this is painful) – use a cotton swab • Local disinfection with povidone-iodine solution – use a cotton swab • Continue daily cleaning/oral hygiene • Undertake supportive treatment such as stomach tubing and rehydration. Severe cases may require a pharyngostomy or naso gastric tube – *Stomach tubes should be passed only once the mouth has been packed with a suitable antibacterial preparation, otherwise any infection will spread down the oesophagus*. • Severe cases may require antibiotic therapy Severe infections need urgent veterinary treatment. Regular beak maintenance is important to prevent stomatitis. Some forms are caused by a herpes-group virus. Mixed colonies are much more at risk than small same-species groups maintained in isolation. Treatment is prolonged and often the prognosis is poor. [19,22,52,61]
Impacted Colon	Occasionally encountered, usually through incorrect diet or accidental ingestion of foreign material, and can develop into septicaemia if untreated. Severe worm burdens can also cause gut impaction.	• Distension of the gut • Gut impaction should be suspected if the animal does not pass droppings, is lethargic and having difficulty breathing.	• Soaking the tortoise in a bath of tepid water will encourage defecation. • Severe cases need veterinary treatment immediately. An x-ray and even surgery may prove necessary.

Septicaemia	Septicaemia is often the result of a bacterial infection such as pneumonia, ulcerative shell disease or abscess reaching the blood stream.	• Vomiting • Lethargy • Erythematous flush to plastron and carapace • Secondary jaundice (yellowed mucous membrane) • Polydipsia • Petechial haemorrhages of the mucus membranes (esp. mouth)	• Deliver injectable antibiotics as quickly as possible, e.g. o Enrofloxacin 2.5-5 mg/kg i.m. daily o Framycetin 10 mg/kg i.m. 48-72 hourly o Gentamicin 10 mg/kg i.m. 48-72 hourly o Oxytetracycline 50 mg/kg i.m. daily o Ampicillin 50 mg/kg i.m. daily • Appropriate fluid therapy should be undertaken • Tortoises should be maintained at a temperature appropriate to the antibiotic[52]
Sterile Gut Syndrome	Can be caused by antibiotic therapy (usually Tetracycline or flagyl)	• Intense diarrhoea, often with undigested food being passed.	• Remedies include feeding Benebac with food, live natural yoghurt or screened droppings from a healthy tortoise of the same species. • Consult your vet about treatment if you are unsure about this.
Diarrhoea	Not an uncommon problem in tortoises. Associated with heavy parasitism due to flagellates. Highly infectious and can harm a group of tortoises very quickly. Other causes include parasites known as ciliates, which cause severe large intestine damage - particularly dangerous to hatchlings and can cause severe diarrhoea and potentially fatal dehydration.	• Fluid excrement • Overly odourous excrement • Anorexia • The passing of undigested food • Severe intestinal damage which can be fatal	• Provide fluids to maintain hydration (traditional rehydration solutions). • Maintain nutritional status in the face of poor digestion and decrease gut passage time. • Dietary changes. Increase fibre levels, decrease fructose-sugar levels. This will increase gut passage time, provide faecal bulk and decrease the likelihood of fungal superinfection. • Probiotics to recolonise the gut. • Prophylactic ketoconazole if fungal superinfection is anticipated. • Specific treatment related to underlying infections. • Use drugs only if an infection is present, consult your veterinarian. • Any foul smelling diarrhoea should be reported to your vet without delay. A fecal sample should be checked for evidence of worms or flagellate organisms.[19,52]
Constipation	May occur due to the consumption of foreign bodies, such as stones, sand, soil etc. Commonly seen problem in tortoises that are being fed calcium deficient diets, as they try to obtain more minerals from the surrounding environment to top up their required levels. Also associated with intestinal	• Blockage of the gut and subsequent distention from parasites in large numbers • Intestinal worms can also cause weight loss and anemia, which may result in the tortoise appearing dull and lethargic. • Irregular droppings	• Soak the tortoise in a bath of tepid water for 30 minutes, with the water level just covering the plastron. If this does not work, consult your veterinarian for advice. • Increase fibre intake substantially. • Laxatives commonly used are liquid parafin and lactulose. Dandelion root added to feed will often work here too.[19,52] • De-worm tortoises on an annual basis after checking the faeces for signs of the microscopic worm eggs.

	parasitism. It can also be a sequel to dehydration from other factors, or less commonly cancer.		
Anorexia	Not so much a disease but a condition commonly associated with some diseases. It therefore can have many possible causes: • Long term fasting • Social factor • Maladaption to captive environment • Room temperature shock • Period of ovulation or ovipostion • Infection (Parasites or bacterial) • Gut impaction	• Sunken eyes • Noticeable and dramatic weight loss • Poor appetite • Lethargy	• Warm the tortoise to the correct body temperature for the species they are • Bathe it regularly to clean its eyes and nose, and to encourage drinking, defecating and urinating • Assist feeding by placing food in the tortoises mouth[52]
Colic	Caused by parasite-based conditions as well as regular indigestion of inappropriate food stuffs or the feeding of dairy products	• Tortoise may appear uncomfortable • May kick at the sides of shell • Display signs of anorexia or bloating	• Requires URGENT veterinary attention as it can prove fatal
Vomiting	Can be caused by: • Gut blockages • Generalised Septicemia • Very severe worm infestation • Overfeeding or incorrect diet • Force-feeding • Overhandling	• Visible displays of vomiting • Vomit/regurgitated food found in enclosure • Witnessed retching • Disomfort	• Requires URGENT veterinary attention who will identify casual factor and treat accordingly
Liver Problems	Excessive feeding of cat and dog foods	May present as a number of conditions including, ranging from: • Neurological signs; to • Anorexia and weight loss	• Requires URGENT veterinary attention

		Correct diagnosis is essential to aid in treatment	
Neurological Indications – Head tilts and circling	Influenced by damage to the brain	• Tortoise unable to orientate itself properly within cage	• Requires URGENT veterinary attention – can also be associated with poisoning, septicemia or liver damage
Leg Paralysis	May occur for a number of reasons, including: Infections or fractures (singular limbs) Spinal cord damage (multiple limbs) Can also be due to pressure on nerves of hind legs from bladders stones or retained eggs	• Inability to move or use one or more limbs • Limbs being dragged along (particularly the hind limbs)	• Requires URGENT veterinary attention to determine contributing factors and appropriate treatments
Lameness Septic arthritis and articular gout	Metabolic Bone Disease Swollen joints Infections Septic arthritis and articular gout Diet too high in protein Elevated blood urea levels	• Swelling of limbs/joints • Stiffness • Pain on locomotion	• Consult a veterinarian immediately as lameness may be due to Septic arthritis and articular gout, which in turn can cause organ damage
Swollen eyes  Box Turtle with swollen eyes	Infections of the eye (quite often secondary of nose and sinuses) Lack of Vitamin A in diet Thickening of gland responsible for tear production leading to eye inflammation	A white opacity can appear in the cornea of the tortoises as they age. It is quite often a deposition of cholesterol and is known as "acrus lipoides corneae". Blindness may occur after infections due to Vitamin A deficiencies and upper airway disease, as well as straightforward severe conjunctivitis.	• Infections usually respond to treatment with either Genoptic (gentamycin) eye drops or terracortril eye suspension. • Mild cases respond to Neomycin or Chloramphenicol eye ointment. Where you see severely swollen eyelids there is usually a primary bacterial infection in which case a course of antibiotics will be essential. • Some eye problems are simply an indication of vitamn A deficiency. Supply vitamin A and use a mild eye ointment, if the condition does not respond fairly quickly get veterinary help.[19,52]
Egg Retention - Dystocia	• Illness • Malnutrition	• Restless • Repeated attempts to find places to dig	• Here prevention is better than cure - provide good nutrition with plenty of calcium, the correct laying environment for the species, and keep levels of stress to a minimum. • X-rays can be taken to confirm diagnosis and your vet can then determine the best

 X-ray showing example of egg retention in female tortoise	• Lack of a suitable nesting site • Weak muscles from lack of exercise • Misshapen or large eggs • Injuries to the pelvis or other disorders that narrow the passageway for eggs or young • Improper temperature gradients or humidity levels within the terrarium	• Reluctance to walk • Lethargy • General signs of septicaemia • Straining and swollen cloaca • With developing cases – depression, lethargy and cloacal prolapse	treatment. • Laying can be induced using a combination of injected calcium and oxytocin.
Renal Dysfunction	Often seen following long term anorexia, dehydration and bacterial infection.	• Oedema (water retention) • Pale mucous membranes • Lethargy • Reluctance/inability to urinate • Weight increase due to fluid retention	• Get veterinary help immediately. • In early stages, regular warm baths and physiotherapy of back legs can help release any blockage. • Prevention: Always ensure that your tortoise has access to clean, fresh
Diabetes – Diabetes Mellitus Affects the adrenal glands, causing them to secrete less insulin or rendering the insulin inactive in the blood.	Captivity, a change in environment or a change in dietary habits can all bring on this hormonal disorder.	• Increased appetite • Increased thirst • Increased urinary output • Water retention, which is visible in its appearance • Lethargy • In some cases – Anorexia and weakness	• A veterinarian can do a blood test to ascertain whether diabetes exists, as well as treating any signs to the condition and prescribe medication to control blood glucose levels. • In addition, dietary regulations or other supportive therapies may be recommended.
Parasites – Ticks, Mites, Fly Larvae	External parasites are primarily a problem for wild-caught reptiles or in reptile collections where new additions are not adequately examined, treated, or quarantined. Some flies lay their eggs in a small wound that they create in the skin, while others take advantage of preexisting wounds	• Mites – Cause skin appear rough, disruption to normal skin shedding – individuals will frequently soak in water or rub against furnishings to ease discomfort. • Ticks – Easily seen with the naked eye. • Fly larvae – Can cause Lethargy, weakness, loss of	• Check with a veterinarian for pesticides and medications that can be used with tortoises (Indian Stars are particularly sensitive to treatments). They can cause serious illness or even death if used incorrectly. • For any external parasites you can dip the tortoise in Alugan or diluted tritix (Amitraz) 1-2ml/litre. • Ticks can be removed manually - coat with alcohol or vaseline, turn on its back to loosen its grip and pull off. Apply a little betadine to the spot where the tick was attached • Maggots must be picked out of or flushed from damaged skin. If there are open wounds, they should be treated with topical antiseptics. Antibiotics in the form of

	and lay their eggs, resulting in a maggot infestation.	appetite and even death if left untreated.	ointments, injections, or oral preparations can also be given under veterinary direction.
Worms – Roundworm, Hookworm, Pinworm If left untreated, infection with worms can cause serious perforation of the intestine or intestinal blockage.	Low-level parasitism, which causes few clinical signs in the reptile, can quickly escalate when a reptile's terrarium is not regularly cleaned. Previously parasite-free individuals often become infected by ingesting faeces containing immature forms of the organism. In some cases, larvae can burrow through the skin.	• Diarrhoea • Anorexia • Sometimes vomiting or regurgitation • Poor appetite • Weight loss • Abnormal appearing stools • Some tortoises splutter small volumes of liquid from the mouth.	• Faecal sampling may occur to determine presence of worm eggs within an individual/s • Avoid overcrowding. • Routine worming should be carried out twice yearly. Never - ever - try to worm tortoises with any preparation containing Ivermectin - this product has proved consistently FATAL in tortoises of all species. • Required dose rates are high compared to mammals: 3 ml of a 2.5% solution per kilogram of the tortoise's bodyweight. • Recommended dose of panacur is 25-50mg/kg, dose again after two weeks and have a fecal done two weeks later to check that you have in fact eliminated the infection. • Infestations of hookworm are better treated at weekly intervals with the lower dosage rate until fecal tests are clear. All companions should be treated at the same time.[1,6] • Worming should be achieved by oral means only - use of a stomach tube is generally recommended. In all cases, where a bodyweight is cited for dosing purposes, this should be understood to include the tortoise's shell - this is also living tissue and must be included in all drug dosage calculations. If you are fortunate enough to be able to obtain Panacur paste then this is ideal for de-worming as the dose is small and can be offered on a titbit of favourite food.
Prolapse – Penial, cloacal, intestinal, urinary bladder  Prolapse in juv. Burmese Star	Can occur due to: • Infection • Forced separation during copulation • Constipation problems • Neurological problems	• Solid, fleshy tissue mass observed protruding from the vent	• Requires URGENT veterinary attention - Any tortoise found with a prolapse should be brought to a specialist vet without delay • The use of table sugar can be an effective method to reduce swelling of a prolapse as a prelude to surgical replacement • Ensure the involved organ is kept moist – do not allow it to dry out at any stage • Protect the prolapse with plastic wrap to keep the area clean and prevent the tortoise from causing any tissue damage with its back claws

FOR ANY HEALTH PROBLEMS ASSOCIATED WITH TORTOISES, PROPER DIAGNOSIS SHOULD BE CARRIED OUT BY A QUALIFIED VETERINARIAN, BEFORE TREATMENTS ARE ADMINISTERED. ALL DIRECTIONS AND AMOUNTS SHOULD BE FOLLOWED CORRECTLY

8.5 Quarantine Requirements

The basics of quarantine are as follows:

1. Separate holding area

The animals should be kept in an enclosure/pen separate from the rest of the collection. Ideally this involves utilizing different rooms in the house or separate pens in different areas of the yard. Make sure that the air supply from the quarantine room does not enter rooms where the rest of the reptiles are housed.

2. Separate utensils

Do not swap brushes/bowls/cage furniture from the quarantine area with the stable collection area. Utilise separate equipment for each.

3. Work with quarantine animals last

Feed, clean, and water the stable collection before taking care of the quarantine collection. This will help minimize cross contamination. You may wish to have a separate pair of shoes and clothes or smock to use in the quarantine room. Clean and disinfect food and water dishes for all new animal acquisitions in a separate area.

4. Visit a reptile veterinarian

This is especially important for wild caught animals, but I would recommend it for all new animals coming into a collection. Basic information that needs to be gathered includes a thorough physical examination, direct and float fecal examination, urine examination, and an accurate weight. Since not all parasites show up in all faecals, a second and third fecal should be run as well. Depending on the species and the condition of the animal(s), such procedures as cloacal cultures, nasal cultures, bloodwork, and radiographs can also be performed.

5. Time frame

MINIMUM of 90 days with extensions as necessary depending on the condition of the animal(s). Remember, many hard-shell species can live to be over 100 years of age. What are 90 days of proper quarantine compared to a lifetime of enjoyment with your new addition(s)?[78]

REMEMBER : To dispose of any wastes from the quarantine area properly and thoroughly wash your hands after any work with quarantined tortoises.

Diagnostic tests to be carried out during quarantine[51,97]

- Faecal examination, direct and flotation for protozoan (especially *Cryptosporidia sp.* and *Amobea sp.*) and metazoan parasites. Three or more consecutive tests should be negative.
- Culture faeces for *Salmonella sp*.
- Carry out complete Blood Count and PCV - assesses the number of and characteristics of the red blood cells and the various types of white blood cells in the animal's circulation. This may provide clues regarding immune status, presence/absence of infection, presence/absence of blood parasites, stress levels and degree of dehydration or blood loss.
- Cloacal washes

- Examine blood smears for haemoparasites.
- Biochemistry - assesses the levels of various other compounds (e.g. enzymes) in the circulation. This may provide information regarding the health of the kidneys, liver and muscle as well as assessing possible nutritional deficiencies.
- Swab/nasal wash and examination for *Mycoplasma sp.* and *Mycobacteria sp.*
- Serology for antibodies of *Mycoplasma sp.* and herpes virus (includes Virology, PCR, viral culture)
- Check for tick infestation, especially Amblyomma sp.
- Urinalysis
- Cytology
- Diagnostic imaging
    - Radiography (x-rays) - Radiography is particularly useful for assessing the health of the bony structures of the body (e.g. for diagnosing metabolic bone disease, dislocations or bone infections) and the lung ields (e.g. for diagnosing pneumonia).
    - Ultrasonography - Useful for evaluating the internal organs of the coelomic cavity including the heart, liver, ovaries, stomach and intestines.
    - Endoscopy - Endoscopes can be used to look inside the coelomic cavity (entering in the pre-femoral fossa, i.e. in front of the back leg) to view the internal organs directly or can be introduced through the mouth to enter the respiratory or upper gastrointestinal tract. Similarly, the endoscope can enter the body via the cloaca to visualise the bladder, colon or reproductive tract.
    - CT (Computed tomography) scans & MRI (magnetic Resonance imaging) scans – Used to obtain 3-D evaluation of tissues and organs.

9 Behaviour

9.1 Habits. eg.

Like all reptiles, tortoises, including the Indian Star Tortoise, are ectothermic, or cold-blooded. Unlike mammals or birds who can maintain a normal average body temperature, tortoises rely on external influences to regulate their body temperatures. Indian Star Tortoises can operate efficiently with a body temperature somewhere between 22-30°C (71-86°F).[1]

Essentially diurnal, the Indian Star Tortoise feeds during early mornings and late afternoons, thereby avoiding the heat of the day. The rest of the day, they shelter under vegetation or other cover. Occasionally they can be seen taking a sun bath, but it tends to avoid prolonged exposure to direct sunlight[9]. During the rainy/monsoonal season, their activity level increases tremendously and they can be observed moving around and being active, with feeding and mating taking place during much of the day.[6,30,31]

In western India and Pakistan, they become less active during the colder winter months, however the Indian Star Tortoise does not hibernate in the wild or in captivity and facilities should be provided for the continued health and well being of the tortoise indoors in cooler and/ or damp conditions. The Indian Star Tortoise is also rather inactive during long periods of drought, and it can go without food for long periods of time.[6,30,31]

Although individual personalities will differ, this is one species in which the males usually are not aggressive towards each other during the breeding season, and they are less aggressive towards females than other tortoise species. These tortoises, other than reproductive behaviour, show relatively little interest in each other socially or even territorially.[76,79]

9.2 Reproductive Behaviour

9.2.1 *Mating Behaviour*

The mating seasons of the species correlates with the monsoon, which in Indian lasts from late June to September. Unlike many other tortoise species, male Indian Star tortoises seldom or never engage in male-male combat, nor do they show butting, biting or ramming behaviour towards females. If males do engage in combat, they will try to shove rival males or flip them onto their backs.[30,38]

Indian Star Tortoises mating

The Male Indian Star Tortoise will usually circle the female several times, sniffing at her cloaca, before attempting to mate with her. In some cases, the female Indian Star Tortoise may appear totally disinterested during copulation and will often continue to eat while the male performs his duty.[7]

For obvious physical reasons the mating postures adopted by various species of land tortoises are all very similar. The actual mating of the Indian Star Tortoise is a pretty quiet affair compared to other tortoise

species. The male assumes a mounted position, the tail probes for and locates the females cloacal opening. The male's engorged penis is then inserted into the cloaca of the female. While mounted and probably before intromission actually takes place, the male Indian star tortoise utters a grunt, possibly to intimidate the female into submission.[30,38]

9.2.2 *Gravid Behaviour*

When the female has complete eggs inside her, her behaviour will make a noticeable change, and should be observed closely.

1. Even when obviously healthy and alert, the female tortoise will eat a significantly reduced amount of food whilst at the same time steadily gaining weight. It is believed that this happens because the eggs are taking up so much abdominal space, she no longer feels hungry.
2. If kept with other tortoises, she may become aggressive and attempt to establish temporary dominance within the enclosure. She may pick the largest female tortoise and start to mount or butt her around the enclosure. This occurs because she needs to be left undisturbed to properly lay her eggs, and if she is aggressive enough the other tortoises will give her the space that she requires. As soon as she has laid her eggs, she will revert back to a passive personality. Females will normally not lay their eggs if there is a dominant male within the enclosure, so it is vital that all males are removed from the area when females are verified as being gravid.
3. The female may increase her exploratory behaviour, possibly in the search of suitable nesting sites, so security should be increased to prevent any potential escapes from occurring.
4. She may exhibit some reflex digging actions with the back legs. It usually only happens when she is very warm and then only occasionally.
5. A number of areas may be dug within the enclosure, to try and determine suitability for nesting.[1,30,38,47]

9.2.3 *Laying Behaviour*

- Females rarely lay in the morning; bright, sunny afternoons between 2pm-5pm are usually the times most favoured
- If eggs are simply dropped on the surface, without going to the effort of digging a nest, they are usually (but not always) infertile
- If a female you suspect is carrying eggs begins to lose the use of her back legs, seek veterinary attention at once – without delay.[30]

9.3 Bathing

A water dish, which will serve as a water/soaking spot, should be provided within the enclosure. A flower pot base, with a flared perimeter, sunk into the ground is a good example of a dish that is large enough for the tortoise to soak in, if it wishes, while being shallow enough to prevent it from drowning and easy to walk in and out of. Ensure that it is checked daily, and clean it as required.

Bathing Indian Star Tortoises

Hatchlings may be soaked once or twice a week in shallow, warm water. They will drink and often defecate or pass urate waste, which has a white pastelike appearance and the water should be change soon after before the next tortoise soaking.[47,79]

9.4 Locomotion

Due to the relatively unconventional body shape governed by the presence of the unwieldy shell, tortoises, especially when moving on land, have had to overcome certain locomotory problems that are not experienced by most other animals.

Land tortoises, like the Indian Star Tortoise, move slowly with, what seems to us an awkward and ungainly gait. The problem is that the limbs are oriented out of the sides of the shell, meaning that they have to support the often heavy body and shell at an angle. This is exhausting to the limb muscles of a tortoise and can be seen by the frequency in which the tortoise lowers its body to the ground to rest.[1]

9.5 Behavioural Problems

9.5.1 Signs of Stress

- Inappetence
- Prolonged habituation of hiding areas
- Predator defence behaviours – head/limbs in shell, tilting shells towards offender
- Expulsion of eggs by female
- Secretions
- Bowel movements
- Weight loss
- Abnormal limb retraction
- Head held at an unusual angle[38]

Excessive handling can contribute to increased stress levels and should be monitored to prevent signs of stress from appearing.

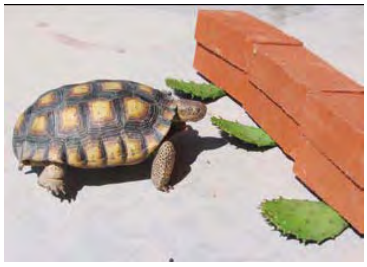
9.6 Behavioural Enrichment

Monthly enrichment Calendar – Indian Star Tortoise – Australian Reptile Park (ARP)

1. Scatter spices
2. Scatter basil, Take for graze on grass
3. Scatter feed, Hanging Endive (low enough for them to reach)
4. Flowers
5. Eucalyptus mulch from mammal yard
6. Scatter feed, substrate from possum box
7. Blood scent
8. Scatter feed, Water tray
9. Scatter feed, Browse, Take for graze on grass
10. Used wombat mulch/branches (hide)
11. Fresh Basil, Scatter feed
12. Scatter feed
13. Fresh Rosemary, Scatter feed
14. Earth worms, Scatter feed, Bird calls
15. Fresh flowers
16. Browse, Mammal used eucalyptus leaves (hide)
17. Graze on grass
18. Water tray, sprinklers
19. Snake shed
20. Mirror
21. Flowers - hibiscus
22. Frog calls, Frog substrate (hidden around enclosure)
23. Scatter feed
24. Graze on grass
25. Scatter feed
26. Scatter feed
27. Fresh Basil
28. Flowers
29. Scatter feed
30. Graze on grass
31. Browse, Fresh mint

Additional behavioural enrichments:

- Broccoli/Herb trees (fresh packet herbs propped up in enclosure to resemble trees, broccoli propped up in small tubes/containers, or placed in gaps of enclosure log)
- Prickly pear pads (end placed underneath heavy rock to allow tortoises to pull at pad and tear pieces off but to stop it coming out completely)
- Water soaked tortoise mix (extra water added to feed dish to allow drinking)
- Small amount of fruit provided with regular tortoise mix
- Adjusting temperatures and day lengths (lighting) within enclosure
- Varying depth of substrates within the enclosure, to allow for digging
- Grassed area within the enclosure
- Rocks placed under heat lamps to allow for behavioural thermoregulation



Indian Star Tortoise with Prickly Pear Cactus

9.7 Introductions and Removals

As the Indian Star Tortoise is a relatively placid species of tortoise, any introductions and removals are a result of long-established potential breeding groups disinterested continually in sexual behaviour. In many cases, interest can be stimulated by temporarily

separating males and females for a few days to several weeks, then reintroducing them. This technique has proved highly effective with the majority of terrestrial species.

Another method is to obtain additional stock and introduce this, on a one-to-one basis, to selected members of the existing established group. Sometimes separating males together will result in competitive behaviour; this may be a precursor to re-establishing reproductive behaviour.

Females and hatchlings can be kept in groups. They will accept shared facilities, each going about their own business and totally ignoring the others. Fighting is only a problem if a stranger is introduced, and even then it normally becomes unacceptable only if the new-comer is sick or weak and the original residents are dominant.[38]

9.8 Intraspecific Compatibility

Indian Star Tortoises are very sensitive to catching disease from other tortoises therefore they are not a very compatible species to have in intraspecific communities. They are extremely susceptible to foreign organisms carried by other species such as Mycoplasma and strict isolation from any contact with them should always be observed.
Indian Star Tortoises should NEVER be mixed with another species.[6,79]

9.9 Interspecific Compatibility

It is possible to keep several Star tortoises together in a large enclosure. Although individual personalities will differ, this is one species in which the males usually are not aggressive towards each other during the breeding season, and they are less aggressive towards females than other tortoise species. Females may become aggressive towards other tortoises, to an extent, while gravid (as stated in Reproductive behaviours) but this change once she has laid her eggs.[6,31]

10 Breeding

10.1 Mating System

The mating system for *G elegans* is polygynous or promiscuous, which means the female pairs with several males, each of which also pairs with several different females during a single breeding season.[11]

10.2 Ease of Breeding

G elegans are not a particularly easy tortoise to induce to breed (or even mate) in captivity although it can be done. The most consistently successful captive breeding results have been achieved within the species natural bioclimatic range in India and Sri Lanka. For unknown reasons Indian Star Tortoises seem to be sensitive to long periods of high humidity and is not always an easy species to maintain.[36,92]

In captivity, where there is no fixed breeding period, interest in mating can sometimes be stimulated by either a natural downpour or by extensive spraying with a hose[38]. If housed together in mixed gender groups, throughout the year the male tortoise may take every opportunity to mate with the female tortoise (especially while she is eating). Keepers should remember that the male's sperm will remain effective in the female for a long period of extended time (It is believed that it can remain effective for up to one year!)[47]

10.3 Reproductive Condition

- Make sure that all tortoises, male and female, are kept in as good a state of health as possible. Ensure that there is enough calcium in the diet for the female and that both genders are not under or over weight.
- Ensure that females are free of any eggs from any previous mating before present day mating occurs. Have the females x-rayed to ensure that they are free of eggs. If eggs are present, have laying induced. Wait another year, x-ray again, and if necessary, induce again. Repeat until the female is clear.[36,38,92]
- It appears from evidence available so far that most Indian Star tortoises become sexually active at a certain size rather than at a certain age. For relevant sizing see section 10.7.

10.4 Techniques Used to Control Breeding

The most effective way to control breeding in this species is to separate the sexes. When first separating the sexes (permanent or temporary) you are not guaranteed a lack of gravid tortoises straight away, as females are able to withhold sperm from males, to produce eggs at a later date in the event of optimum conditions. In this scenario or the case of a mixed sex enclosure, eggs can simply be removed and destroyed (Lana Judd, Pers. Comm. 2009).

As the reproductive cycle of this species is stimulated by environmental cues eliminating these cues should also prevent breeding.

10.5 Occurrence of Hybrids

Currently there are no verified or genuine report/cases of successful Indian Star Tortoise hybrid breeding in captivity.

In the wild, some hybridisation may indeed occur naturally between some geographically adjacent races of Indian Star Tortoises (Northern India, Southern India and Sri Lanka variants), and it may be possible to induce it between normally widely separated races when both held in captivity.

However, for obvious reasons it is undesirable to purposely produce hybrid offspring and in the case of tortoises it is usually extremely difficult. Not only are cross-breeding or hybridisation attempts highly unlikely to produce consistently successful results but it is not good practice from an ethical or conservation viewpoint to cross-bred between animals of different genetic backgrounds.[36,38]

10.6 Timing of Breeding

Although this species habitat is typically dry, stony and thorny for most of the year, it is subject to seasonal rains or monsoons; it appears to be the on-set of this rainy season that initiates interest in mating. During this period (which occurs in India between June and October) the animals become especially active and feed extensively upon the new shoots of vegetation. They can often be seen marching in small groups in some areas, a lone female pursued by several males.[38]

In captivity, Star tortoise has no fixed breeding period. Throughout the year, male tortoise will take every opportunity to mate with the female tortoise (especially while she is eating). Keepers should remember that the male's sperm will remain effective in the female for a long period of extended time (It is believed that it can remain effective for up to one year!)[47]

10.7 Age at First Breeding and Last Breeding

It appears from evidence available so far that most Indian Star tortoises become sexually active at a certain size rather than at a certain age. Size is of course related to age but as captive-bred specimens often grow much faster than equivalent wild specimens, due to normally better availability of food, these often mature sexually and attain breeding capability much earlier than their wild counterparts.[38]

Male Indian Star tortoises will typically reach breeding age when they are approximately 230mm in size (straight carapace length). This may take as little as 3-5 years in captivity. Female Indian Star tortoises typically take longer to reach sexual maturity, approximately at 290mm (straight carapace length) or between the ages of 7-12 years old.[34,36,38]

Whilst the age of males is not that critical, very young and very elderly females should definitely not be used in captive breeding attempts. When eggs have not been produced for many years, severe obstetric difficulties can ensue[36,38]. In captive breeding programs all elderly females should be automatically excluded and maintained separately from the males to avoid undue stress or the danger of egg retention. It is much safer, and considerably more successful, to employ only healthy and sexually mature young females in captive breeding exercises. These very rarely experience any problems and fertility rates are also likely to be much higher.[38]

10.8 Ability to Breed Every Year

G. elegans has the ability to breed annually providing that conditions are adequate within the captive environment.

10.9 Ability to Breed More than Once Per Year

Female Indian Start Tortoises can lay several clutches per year, typically three but sometimes more, can be as many as eight or nine. This may be due to consistent, or persistent, mating from males or use of withheld and effective sperm by the female.[38,92]

10.10 Nesting, Hollow or Other Requirements

It is essential that gravid Indian Star Tortoises are provided with ground soft enough to dig in and moist enough to keep it's shape as they dig for successful egg-laying in captivity. Indian Star Tortoises can be particularly choosy when it comes to finding an acceptable spot to lay in – it must not be too damp or too dry, the soil must be diggable, and it must also show characteristics that it will not become waterlogged, too hot or too dry. If the area is too loose or stony, emerging hatchlings may be trapped and suffocated. If it is too damp the eggs may rot and develop fungal growths, if too dry they may desiccate. If a soil is too hard and dry, the female will actually empty her bladder over the area to moisten the soil and aid in ease of digging.[36]

Once a suitable spot has been selected, the female will dig a flask shaped nest, approximately 15cm deep with her back legs and then proceed to lay her clutch of eggs, which are covered in a viscous mucus, and descended into the excavated nest on a mucous thread. Once laying has been completed, the back legs will then replace the soil and the plastron used to flatten the spot where the eggs were laid. The whole process of digging, laying and covering can take 2-4 hours. Immediately afterward the female will appear exhausted, but soon recovers to become ravenously hungry. There are reports of Indian Star females nesting in leave mounds in captivity, but it is possible that this is a behaviour forced by the lack of suitable nesting places.[30]

Indian Star female laying eggs

Lana Judd at Auckland Zoo (Pers. Comm. 2009), informed me that their Reptile Department, provides all their Indian Star Tortoise females with next boxes in their winter or indoor areas containing a peat and soil mixture at 50/50. To raise humidity and to keep the substrate fairly moist, weekly watering is required.

For outside enclosures, no special digging places are provided. The females prefer to find an area by themselves and seem to favour clay/muddy patches, which allow for ease of digging but also allow hatchlings to emerge easily once out of the egg (Pers. Comm. 2009).

10.11 Breeding Diet

A suspected to be or gravid female should be fed a well-balanced diet, during the gestation period, including increased calories to support the increases energy usage associated with egg development and laying. Additionally, dietary calcium intake should be closely monitored and maintained, as the calcification of the egg surface within the female requires large amounts of calcium. If this additional calcium is not made available in the diet of the female, then it will be pulled from the blood, and in turn from the skeletal tissue of the tortoise. The extra calcium is also essential for the forming eggs. If it is not made available, the growing embryo can suffer from osteodystrophy (soft bones and carapace) and hence be unable to break out of the egg shell.[69]

Indian Star females eating Cuttle fish

Arthur Lim, Indian Star Tortoise breeder, recommends during the breeding season that each female tortoise be fed half a piece of hard-boiled egg (including the shell). There is no reason given for this additional food stuff, possibly to increase calcium levels in the diet of the female so its validity is yet to be verified. He does state however that the male of the species shows no interest in the hard-boiled egg.[47]

10.12 Incubation Period

Incubation periods in the wild demonstrate considerable variability depending upon how late or early in the season laying occurs; data from captive specimens within the bioclimatic range indicates that it can take as little as 47 days or as long as 147 days. Other authors have given incubation lengths of 150-180 days.[14]

Incubation Temperature (°C)	Incubation Period (days)
25°C	120
28°C	100
30°C	70-75
35°C	55

For a Type I container incubator

As incubation temperatures fluctuate in the wild, incubation is usually much more prolonged, lasting years if conditions are inadequate. Hatchlings will wait in the nest for the rain to come so that it loosens the soil, and they are able to dig out easily.[59]

10.13 Clutch Size

For a young or first time female, clutch size is small with 1-2 eggs, however with time & age, a normal clutch size for the Indian Star Tortoise consists of 3-7 eggs (with an average of about 5).[14]

Most eggs measure about 42mm x 31mm, although records indicate a range from 38mm to 50mm in length and from 27mm to 39mm in width. Egg weight is similarly variable from 22g to as much as 38g.[34,38]

Multiple Clutches	3
Clutch Size	3-7
Average Clutch Size	5
Sex Ratio	Dependent on incubator temperatures
Average Egg Dimensions	42mm x 31mm
Average Egg Mass	22g
Sex Determination (*See note*)	Probably ESD
Gestation Period	47-180 days

** Sex Determination**
Environmental Sex Determination (ESD), or Temperature Sex Determination (TSD), occurs in various patterns in tortoises. In one pattern there is a single transition zone below which incubation result in 100% male offspring and above which incubation results in 100% female offspring. In a second patter, males predominate at intermediate temperatures and females result at either extreme. Some species may even utilise a combination of ESD and genetic methods for sex determination of young.[36]

Eggs incubated below 21.1°C degrees normally will not hatch. Eggs incubated between 21.1°C and 29.4°C degrees will hatch all-male offspring. Eggs incubated at about 30.0°C degrees will bear mixed sexes, and eggs incubated between 30.0°C and 32.2°C degrees will bear all females. Eggs incubated over 32.2°C degrees may result in deformed or dead hatchlings.[61]

10.14 Age at Weaning

This is a reptile and a precocial species and it is born completely independent of the parents. There is no post-nesting parental care of the hatchlings. The female does not provide any form of care and as it is a reptile, there is no weaning of the young off any milk.

10.15 Age of Removal from Parents

This is a Precocial species and is born completely independent of the parents. There is no post-nesting parental care of eggs, once they have been covered, or the hatchlings. The female does not provide any form of care and can breed again as soon as conditions are right. Eggs can be left within an enclosure, or can be removed and artificially incubated up to hatching.[47,59]

10.16 Growth and Development

When ready to hatch, the young tortoise will slit open the eggshell with an egg tooth. The egg tooth is a hard, sharp projection situated on the snout that is shed soon after hatching. The hatchling will piece the eggshell using the egg tooth and gradually enlarge the opening by biting small piece from the eggshell and pushing with the front legs.

Immediate and constant observation should occur as soon as the egg begins to hatch. Hatching can take some time; between 2-5 hours. Most tortoises, upon slitting the egg and having access to air, will often stay in the egg for a day or more gradually gaining strength and allowing time for the yolk-sac to be properly absorbed.

Hatching Indian Star Tortoise

During this time, do not be tempted to "help" the hatchling; let nature take its course. Only if a hatchling is in obvious trouble and is clearly weakening then careful assistance can be given. Provided that the hatchling is in full progress giving such aid will not do any harm. If the eggshell appears to be unusually thick and is causing real problems for the hatchling then assistance is recommended.[1,36]

Once hatching is complete and the young tortoises have completely left the shell and are free moving, can they be transferred into a previously prepared hatchling vivarium or nursery unit. The now vacant eggshells can also be removed to the hatchling unit as they are an excellent source of calcium in the critical early days of development and many hatchlings will avidly gnaw at them. Failure to provide the eggshells can result in early stage calcium deficiencies.[36,38]

Newly emerged tortoises may still have the yolk-sac attached to their plastrons. Under no circumstances should this be interfered with or any attempts are made to remove it. The yolk-sac will gradually be absorbed over the next few days. The yolk-sac can represent a risk of infection, so any hatchlings displaying residual yolk-sacs must be kept under strict hygiene measures. To prevent yolk-sac adhesion to the floor of the tank/vivarium, a polythene sheeting can be placed on the floor or a thin smear to 'KY' non-toxic jelly placed on the yolk-sac or floor.[36,38]

Some hatchlings may begin to drink, or feed on solid foods, almost immediately; while others, particularly those who still have a yolk-sac attached may take longer. They should be provided with a variety of finely chopped greenfood, fruit and vegetables along with twice weekly vitamin and mineral supplements. Hatchlings will normally grown rapidly for the first few months, and then settle down to a slower growth rate, usually 3-6 months after the immediate hatchling stage of development.[1,36,38]

Indian Star Tortoise Hatchling

Newly hatched Indian Star Tortoises will lack the typical star pattern of the adults – they are either completely yellow or black in colour with only yellow 'butterfly' pattern upon each carapacial scute.[30]

11 Artificial Rearing

11.1 Incubator Type

Incubators may be anything from the commercial type used for chickens (available at some pet stores, feed stores, or by mail-order) to the homemade variety made from bread boxes, cardboard boxes, styrofoam coolers, small glass aquariums, or even margarine tubs (placed in a warm spot with a few small holes in the lid so oxygen can get in).

Several designs of commercial incubators are available and suitable for incubating tortoise eggs, but they can be quite pricey and range from a very simple design to something much more complex. Makes/models used by breeders on the Tortoise Protection Group include the Hovabator, Brindsea Hatchmaker, Curfew, and Ecostat.

A list of commercially made incubators and suppliers can be found in Appendix 10.

Hovabator Incubator

Curfew Incubator

Brindsea Hatchmaker Incubator

It should also be noted that 'Homemade' incubators can be very good. A fact sheet developed by the Tortoise Protection Group on “Making your own Incubator” can be found in Appendix 11.

The main feature in any incubator is that it should be able to maintain a suitable, stable temperature and the humidity required for successful egg incubation. A light for heat control should be in the incubator, plus a thermometer (either hung on inside wall or placed next to eggs) and a small container of water or wetted-down sphagnum moss for necessary humidity. Eggs incubated without minimal humidity tend to cave in, dry out and not hatch. Most eggs require a small container of water near the eggs, replenished regularly (as the water evaporates).[47,85]

What to look for when purchasing an incubator:

A basic incubator should include:
• Thermometer

If using a separate thermometer make sure it is sufficiently sensitive and accurate over the range 25°C-34°C. It is important to use one that has been made for use with an incubator (garden

thermometers etc. are often inaccurate). Temperature stability can be more accurately maintained using a digital maximum/minimum thermometer.

• Heater
• Thermostat to enable maintenance of a constant temperature
• Ventilation grill to allow air flow
• Tray for easy cleaning or holding water for humidity
• Still-air type

More expensive models in addition may have:

• A Celsius/Fahrenheit interchangeable facility
• Humidity setting and control/hygrometer
• Alarm system for water addition
• Facility to add a rotation turner, but this is NOT required for hatching tortoise eggs. Unlike bird eggs, tortoise eggs must NOT be rotated during incubation and doing so could lead to the death of the developing embryo.

For the successful hatching of tortoise eggs the still-air type (dry type) of incubator is recommended. This is where the heat is spread evenly throughout the incubator from a heating element by a process of radiation and convection. The temperature is controlled by means of an electronic thermostat of the sort used by tropical fish hobbyists. It is extremely accurate and very reliable. Wet type incubators are better suited for Box turtle or Terrapin eggs and for most tropical tortoise eggs where a high humidity level is required throughout incubation.[85]

11.2 Incubation Temperature and Humidity

Details on how to use and set up the incubator selected for tortoise egg incubation can be found in Appendix 12.

Regardless of the incubation method chosen, temperature is the most important factor. For most tortoise species, including the Indian Star Tortoise, temperatures of 26.1-28.9°C will result in primarily male offspring while temperatures from 30.6-33.3°C will result in mostly female offspring. For Indian Star Tortoises, the temperature should be maintained at 30°C to ensure an equal number of female and male tortoises being hatched.[36,38,47]

Incubation temperatures below 25.0°C will not typically result in any live births. Higher incubation temperatures will shorten the total length of incubation required, however, be very careful to not use incubation temperatures above that of 35.0°C as this can lead to very low fertility rates and even deformations or even death within the shell to the developing young.[36,38]

When it comes to the humidity levels within the incubator, for Indian Star Tortoises, humidity should be maintained at around 65-70%.

The humidity levels during incubation should not exceed 95% for more than 15 minutes. If this happens, water can pass through the egg shell and in turn drown the developing tortoise. At the same time, humidity levels should not drop below 50%. Low humidity leads to loss of water from

the egg. If a small amount of water is lost, then the hatchling will be smaller than normal, whereas a loss of a large amount of water will cause the egg contents to solidify and prevent embryonic development.[36,38,47]

11.3 Desired % Egg Mass Loss

The actual weight loss depends on the temperature and humidity in the incubator. Eggs will normally fail to hatch if they lose 25% or more of their weight during incubation.[36]

11.4 Hatching Temperature and Humidity

Unlike birds, tortoises do not require a different temperature and humidity level within the incubator prior to hatching. The incubator should be kept at the same temperature and humidity levels as it was during the incubation period.[36,38]

11.5 Normal Pip to Hatch Interval

The crucial lesson for captive breeders is not to expect all the eggs in a brood to hatch 'on time' and under no circumstances to make the mistake of artificially cracking open what are assumed to be 'late' eggs.

Hatching can take some considerable time; between 2-5 hours on average. The moment that hatching begins, the eggs should be kept under continuous observation. Some tortoises can escape from their egg within minutes of puncturing it, while others can take a couple of days. There have been reports of three weeks difference between the first and last hatchling emerging safely in one brood. Once access to the open air has been achieved, and the immediate demand for oxygen satisfied, a young tortoise will often stay in the egg for a day or more, gradually gaining strength and allowing time for the egg-sac to be properly absorbed. Do not be tempted to interfere with the hatching process; let nature take its course, unless a hatchling is in obvious trouble and is clearly weakening, only then should careful assistance be given.[38,70,86]

As the hatching process begins, the hatchlings will first pierce the eggshell using an egg-tooth, a hard, sharp projection situated on the snout, which is shed after hatching. The hatchling will use the egg tooth like an appendage gradually enlarging this opening by biting small pieces from the eggshell and pushing with the front legs, until they are free of the shell.[38]

11.6 Diet and Feeding Routine

When environmental conditions are right, most tortoise hatchlings will begin eating within 48 hours of hatching. If a juvenile is still absorbing part of the remaining yolk sac, then it may not eat until the yolk is totally absorbed, which can be up to 5 days after hatching.

A.C. Highfield highly recommends providing the newly hatched juveniles with the eggshells that they have recently vacated when they are placed in the hatchling unit. The eggshells with provide an excellent source of calcium in the critical early days of hatchling development and many hatchlings will avidly gnaw at them. Failure to provide access to the eggshells (often discarded as

of no value by many keepers!) can result in early stage calcium deficiencies, calcium must be fed from the first meal along with Vitamin D3.[36,38]

To ensure that hatchlings are getting all the vitamins and minerals they require, regularly dust their food with a vitamin and mineral supplement such as Nutrobal or Vetark. Cuttlefish bone can also be given whole, to be gnawed which will keep the mouth trimmed or grated onto food. Cuttlefish alone will not provide sufficient calcium. Calcium carbonate can be purchased in powder form from a chemist and this can be sprinkled on picked foodstuffs and on growing weeds where it will be absorbed through the roots of the plants. You should also ensure regular exposure to full, unfiltered sunlight, as this is essential to vitamin D3 synthesis but no over-exposure as it will cause rapid dehydration and death. Without an adequate source of calcium AND vitamin D3 90% of baby tortoises die within 12 months![37,47,70]

Base diet foods need to have a calcium to phosphorous level of 2:1 although wild diets are often 10:1 or even 50:1 (dandelions and sow thistles have a calcium phosphorous levels of 3:1. Snail shells are often eaten in the wild which is another source of calcium.[37]

Hatchling tortoises should be offered the same foods as adult, although in different amounts and with a somewhat higher than normal calcium requirement. Avoid feeding excessive quantities of fruits or 'soft' leaves such as lettuce - coarse weeds (vetches, dandelions, grasses etc.) are much better. These not only tend to have the correct calcium:phosphorus balance, but they are also high in fibre. This latter is essential to healthy gut function.

Feed once per day only. Do not overfeed. In the wild food would not always be readily available and they would eat far less than those in captivity. It is better for hatchlings to be slightly hungry than over-fed. Tortoises which are over-fed are lethargic and unhealthy. Over-fed hatchlings will grow too rapidly and may develop 'lumpy' shells.[36,37,47]

Water should be available at all times. A shallow dish is best as tortoises like to wade in with the water being no deeper than the tortoise's chin. It should be changed frequently and kept clean. Hatchlings can fall over on their backs on slippery surfaces so a flat stone or small flat piece of slate in the dish can guard against this. The young tortoises will appreciate a soak in tepid water about every 2 weeks. Clean the shell gently with a baby's toothbrush. The majority of tortoises will only drink when they are actually stood in the water, rather than put their head into a dish.[37,70]

11.7 Specific Requirements

Neonates should not be removed from the incubator until they had completely crawled out of the eggshell. Once they are free from the egg it is a good idea to give them a lukewarm, very shallow bath, to wash off the sticky membrane surrounding them and to enable them to take their first drink, ensuring care is taken especially if some yolk sac is still visible on the carapace. They can then be moved to a hatchling unit, separate from that of the incubator, as the vibrations of newly hatched tortoises can affect those still in the process of hatching.[36,38]

Once the yolk sac has finally been absorbed, the hatchlings can be moved to a cage with the conditions, i.e. heat, humidity, and UVB light, like that of the adults of the species. The habitat

prepared for the juveniles should be as interesting as possible. There should be an open area for basking, a heavily overgrown area for retreat, as well as a variety of hides, rocks and native plants. They should have a full spectrum fluorescent lamp and an incandescent or ceramic lamp for basking. Heat pads can be used but you should use enough substrate so that they don't come in direct contact with the pad, which can lead to fatal burning of the skin and shell.[38]

Provided that they are protected from predators and accidental injury they should therefore be treated identically.

11.8 Data Recording

Daily Observations

1. Is the hatchling's activity level the same as normal?
   A healthy tortoise is mobile; it moves in and out of the hot spots and utilises the temperature gradient within the enclosure. Is it only sitting in one spot and not moving around? It is typical for a sick tortoise to sit half in and half out of a basking spot/
2. How do the eyes look? Are the eyes clear and shiny or clouded or glassy looking? Is the tortoise having difficulty opening them?
   Looking into the eyes of a tortoise will often tell you something is wrong early on.
3. Is the breathing normal?
   It is not uncommon for a young tortoise to pump its head and front legs a bit when breathing. It is <u>not</u> typical for there to be any bubbles from the nose, sneezing or wheezing.
4. What does the shell look and feel like? Is it firm or soft and spongy?
   Hatchlings shells will firm up soon after hatching. However if the tortoise is more than a month old and the shell is still soft then it is an indication of a potential problem. Softness in the shell usually manifests first in the plastron.
5. Is the shell shiny as normal? Has it lost its luster? Are there any spots or areas that are very dull or hazy looking?
   Caught early enough problems such as these can be dealt with easily. If allowed to linger they can be disfiguring or life threatening.
6. Notice any peculiar smells?
   If you are dealing with a particular individual or group on a daily basis you should notice very quickly and become aware of any out of place odours. Determine where they are coming from and what they could mean.
7. How do the beak and claws look? Is it time for a trim?
8. Is there evidence of defaecation or urination within the enclosure? What was the consistency like? Is it form or runny?
   During cleaning, a hatchling can be placed in very shallow tepid water. This will allow the individual to have a drink and potentially trigger defaecation. As stated before, look at the consistency of the faecal matter. If it is runny then the tortoise may need more roughage/fibre in the diet and less leafy greens and fruits. The best way to develop a hatchlings diet is to monitor faecals regularly.
9. Is the tortoise eating normally? Is a lot of food being left within the enclosure?
   A substantial change in the daily pattern of eating could be an early warning to underlying problems.

Once every week or so all hatchlings should be weighed on the most accurate balance available. A ten percent weight loss in a week could be a warning sign or also mean that a very good bowel movement has just taken place. Keep records of weights and look for trends. A steady weight loss is a problem as it too rapid weight gain. Take regular SCL (straight carapace length) measurements. You want to maintain slow, natural growth.[37,70]

11.9 Identification Methods

- Microchip or passive integrated transponders (PIT Tagging) - Small, implantable devices that allow the permanent identification of individuals, and are a technique often suggested as a preferred alternative to toe clipping by animal ethics committees *Best Option*
- Temporary marks (paints, dyes, fluorescent powders, adhesive tapes, etc.) Temporary identification can be accomplished with adhesive tape strips or polish placed on the shell
- Documentation (photo identification, drawings, descriptions, passports) - An advantage of photo documentation over microchip transponders is that the animal can often be compared to the photo identification, drawing or description without the need to catch it Photo identification of young animals is more problematic as their characteristics may change substantially between birth and adulthood, which means that documentation, must be repeated to ensure continuous tracking of the changes in characteristics.[96]

11.10 Hygiene

Whilst the yolk sac is present, it represents a risk of infection so any hatchlings displaying a residual yolk-sac must be kept under the most rigorous conditions of hygiene.

During the first few days of life after hatching when the juveniles are absorbing the remaining yolk sac, newspaper, paper towels or even polythene sheets make good substrates for the enclosure in which the young are being held. They should be changed regularly throughout the day to keep them clean and hygienic. You can gently smear some KY jelly on the yolk so that it doesn't dry out, stick to the cage floor or tear. A thin smear of KY on the floor can also help to prevent any sticking. Under no circumstance should the yolk sac be interfered with or any attempt made to remove it.[36,38,55]

If the hatchling rips the yolk sac on the edges of the shell during hatching, then hygiene is essential to prevent any infection from developing. Gently run warm water over the remaining yolk sac and was off any incubator substrate, dirt or debris. A thick coating of antibiotic first-aid ointment should then be applied over the entire yolk sac area as well as the rip. Keep the hatchling away from the others in the clutch in a covered plastic container within the hatchling unit or in a separate area. Use damp paper towels as a substrate, replacing them a couple of times a day to keep them clean, and replace the antibiotic ointment daily. The yolk sac should gradually be absorbed and will dry off; after which the hatchling can rejoin the rest of the clutch.[38,55]

Once the yolk sac has been fully absorbed, then the environmental requirements for hatchlings are absolutely identical to that of the adults of the species.[36,38]

11.11 Behavioural Considerations

All juvenile tortoises are very fragile physically so need to be housed under very safe and secure conditions. While adult tortoises are tough, hardy animals, they are subject to stress, as is any other living creature. New hatchlings especially should be raised in a low stress environment. This is easily accomplished by paying close attention to your husbandry regimen, and by limiting handling of baby tortoises.

Some resources state that you should not mix adults (particularly males) and small juveniles in the same environment, for at least 3-6 months after the immediate hatchling phase of development, as nasty accidents can happen, especially during feeding. However others have found that when compared to the males, females and hatchlings are placid and can be kept in groups. They will accept shared facilities, each going about their own business and totally ignoring the others.[36,38]

Fighting is normally only a problem if a stranger is introduced, and even then it is unacceptable if the newcomer is sick and the sitting tenant(s) are dominant. A change in behaviour patterns, particularly in males, will occur at the onset of sexual maturity, at about five years of age.[36,38]

Separation of juveniles from adults will depend on the individual personalities of each tortoise within the collection.

Other than taking such precautions, once hatched from the egg, the juveniles can be placed in smaller vivaria or aquariums, with setups similar to that of enclosures housing adults.

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- Page 11 – *Indian Star Tortoise* – Obtained from http://www.tortoisetrust.org – Ulf Edgvist
- Page 12 – Figure 2 - *Morphometrics of Indian Star Tortoise* – Obtained from The Reptipage. *The Reptipage: The Chelonian Body plan*. URL: http://reptilis.net/chelonia/bodyplan.html
- Page 13 - Figure 3 – Male *Geochelone elegans* - Obtained from Differentiating Male and Female *Geochelone elegans* (Indian Star Tortoise) - Chris Tabaka DVM - http://www.chelonia.org/sexing/sexing_Geochelone_elegans.htm
- Page 13 - Figure 4 – Female *Geochelone elegans* - Obtained from Differentiating Male and Female *Geochelone elegans* (Indian Star Tortoise) - Chris Tabaka DVM http://www.chelonia.org/sexing/sexing_Geochelone_elegans.htm
- Page 14 - Figure 5 – *Geochelone elegans* carapace - McCloud, Kenneth. 2008. Obtained from - A Photographic Identification Guide to Star-Patterned Tortoises www.lab.fws.gov/idnotes/starpatterntortoise.pdf
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- Page 14 - Figure 8 - *Geochelone elegans* carapacial scute - McCloud, Kenneth. 2008. A Photographic Identification Guide to Star-Patterned Tortoises, Obtained from www.lab.fws.gov/idnotes/starpatterntortoise.pdf
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- Page 18 – Figure 15 - Insulated shed with access ramp - Obtained from Anastasi, Jeffrey S. 2004. *Raising and Breeding Tortoises: A Practical Guide*. pp.7-53, 82-88 http://www.geocities.com/carolinatortoises/Raising_and_Breeding_Tortoises.pdf
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- Page 21 – Plastic Storage Box - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html
- Page 22 – Plastic Storage Box - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html
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- Page 23 – Plastic Storage Box - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html
- Page 23 – Glass Tank - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html

- Page 24 – Tortoise Table 1 - Obtained from Indoor Housing http://www.tortoise-world.com/indoorhousing.htm
- Page 24 – Tortoise Table 2 - Obtained from Indoor Housing http://www.tortoise-world.com/indoorhousing.htm
- Page 24 – Tortoise Table 3 - Obtained from Tortoise Table Ready Made http://www.petzoo.co.uk/product_info.php?cPath=130&products_id=274
- Page 24 – Tortoise Table 4 - Obtained from Tortoise Table Ready Made http://www.petzoo.co.uk/product_info.php?cPath=130&products_id=274
- Page 25 – Tortoise Table in 5 Easy steps - Obtained from Tortoise Table (heated, indoor tortoise house) http://www.pettortoise.co.uk/tortoise_table.php
- Page 26 – Open Topped Enclosure - Obtained from Constructing a Simple Open-topped Tortoise Enclosure By Sue Brooks http://www.tortoisetrust.org/articles/Tortoisetable.htm
- Page 27 - Open Topped Enclosure - Obtained from Constructing a Simple Open-topped Tortoise Enclosure By Sue Brooks http://www.tortoisetrust.org/articles/Tortoisetable.htm
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- Page 30 – Figure 21 - Natural Vegetation for cover/shelter - Obtained from SO...HOW SHOULD A TORTOISE or TURTLE BE HOUSED? http://www.turtlestuff.com/enclosures.html
- Page 31 – Figure 22 – *Clamp light with ceramic socket* - Obtained from Understanding reptile heating systems. A. C. Highfield http://www.tortoisetrust.org/articles/heating.html
- Page 31 – Figure 23 – *Undercage heater* - Obtained from http://my1.bizshop.com.au/reptiletrader/index.php?main_page=product_info&cPath=4_31&products_id=265
- Page 32 – Figure 24 - *Ceramic Heat Lamp* - Obtained from HTTP://WWW.TINYTORTOISES.CO.UK/HEATING%20&%20LIGHTING.HTML
- Page 32 – Figure 25 - *Reptile Lamp Stand* - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html
- Page 32 – Figure 26 - *Habistat Thermostat* - Obtained from Understanding reptile heating systems. A. C. Highfield http://www.tortoisetrust.org/articles/heating.html
- Page 33 – Figure 27 – *Bearded Dragon Impaction* - Obtained from Suitable Substrates For Herptiles http://www.repvet.co.za/herp_substrates.php,
- Page 33 – Figure 28 – *Leopard Gecko Impaction* - Obtained from Suitable Substrates For Herptiles http://www.repvet.co.za/herp_substrates.php,
- Pages 34-39 – All pictures within Substrate section obtained from Suitable Substrates For Herptiles http://www.repvet.co.za/herp_substrates.php, Understanding Vivarium Substrates. By A. C. Highfield http://www.tortoisetrust.org/articles/substrates.html
- Page 41 – Commercially made hides/shelters - Obtained from http://www.reptilesupply.com/index.php?cName=caves%2C+huts%2C+hides&cPath=31_35
- Page 41 – Figure 29 – *Home-made Hide* - Obtained from How much does it cost to put up a baby Star tortoise? http://startortoises.net/housing.html
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- Page 52 – Figure 31 & 32 – *How to measure the carapace length of a tortoise without calipers* – Measuring Tortoise Size, Obtained from http://www.tortoisegroup.org/infosheet03.html
- Page 54 – Figure 33 - *Prickly Pear Cactus (Opunita spp.)* - Obtained from - PLANTING PRICKLY PEAR PADS FOR TORTOISES. http://www.tortoisegroup.org/infosheet12.html
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- Page 62 – *Tortoise in water dish* - Obtained from - Indian Star Tortoise Profile Portrait of a Star http://startortoises.net/profile.html
- Page 65 - Figure 36 - *Weighing a tortoise on Dial/Analogue Scales* - Obtained from General Mediterranean Tortoise Care, URL: http://www.tortoisesoutheast.co.uk/index.php?f=data_general_care&a=0
- Page 66 - Figure 37 - *Approved Shipping Containers* - Obtained from Container Requirement 43 Live Animal Regulations International Air Transport Association (IATA) 27th Edition, Effective 1st October 2000, Montreal Quebec, Canada
- Page 66 - Figure 38 - *Approved Shipping Containers* - Obtained from Container Requirement 43 Live Animal Regulations International Air Transport Association (IATA) 27th Edition, Effective 1st October 2000, Montreal Quebec, Canada
- Page 67 - Figure 39 - *Box measuring done over Straight-line carapace* - Obtained from Container Requirement 43 Live Animal Regulations International Air Transport Association (IATA) 27th Edition, Effective 1st October 2000, Montreal Quebec, Canada
- Page 74 – Figure 40 - *How to measure the carapace length of a tortoise without calipers* – Measuring Tortoise Size, Obtained from http://www.tortoisegroup.org/infosheet03.html
- Page 76- Carapace shell rot in *M. parkeri* – Obtained from www.tortoisetrust.org/articles/Emergency.htm
- Page 76 - Plastron shell rot *Trachemys scripta elegans* – Obtained from http://www.reptileforums.co.uk/shelled-turtles-tortoise/155007-everybody-elses-tortoises-shell-looks.html
- Page 76 - Abscess under the shell caused by using a substrate that is far too damp – Obtained from www.tortoisetrust.org/articles/habitatdesign.htm
- Page 76 – Overgrown beak in an Elongated Tortoise – Obtained from www.tortoisetrust.org/articles/Emergency.htm
- Page 77 - *Gopherus (Xerobates) agassizii* with a classic (and advanced) case of Metabolic Bone Disease – Obtained from turtlestuff.com/mbd.html
- Page 77 – Fatal deformity in a Leopard Tortoise attributed to MDV – shell deformities, splayed legs – Obtained from turtlestuff.com/mbd.html
- Page 78 – Painted turtle blowing bubbles – indication of Pneumonia – Obtained from www.tortoisetrust.org/articles/Emergency.htm
- Page 82 – Box Turtle with Swollen Eyes – Obtained from http://www.tortsmad.com/ailments.htm
- Page 83 - X-ray showing example of egg retention in female tortoise – Obtained from http://www.britishcheloniagroup.org.uk/vetscorner/stasis.htm
- Page 84 – Prolapse in juvenile Burmese Star – Obtained from www.tortoisetrust.org/articles/Emergency.htm
- Page 87 – *Indian Star Tortoises mating* - Obtained from http://farm3.static.flickr.com/2314/1878837658_a7788a44de.jpg?v=0
- Page 88 – *Bathing Indian Star Tortoise* – Obtained from: Indian Star Tortoise Profile Portrait of a Star URL: http://startortoises.net/profile.html
- Page 90 – *Indian Star Tortoise with Prickly Pear Cactus* – Obtained from: PLANTING PRICKLY PEAR PADS FOR TORTOISES URL: http://www.tortoisegroup.org/infosheet12.html

- Page 94 – *Indian Star female laying eggs* – Obtained from: Some Background Information about The Indian Star - Star Tortoise UK. URL: http://www.startortoiseuk.co.uk/indian.asp
- Page 95 – Indian Star females eating Cuttle fish – Obtained from: Some Background Information About The Indian Star - Star Tortoise UK. URL:http://www.startortoiseuk.co.uk/indian.asp
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- Page 98 - Hovabator Incubator – Obtained from: WA Poultry Equipment. URL: http://www.wapoultryequipment.net.au/products/incubator-hovabator-60-egg-man-turnthe-best-small-incubator-in-the-world
- Page 98 - Curfew Incubator - Obtained from: Just Greys Incubators. URL: http://www.justgreys.com/photo-equip-1.htm
- Page 98 - Brindsea Hatchmaker Incubator - Obtained from: Ascott Dairy Online Catalogue. URL: http://www.ascott-dairy.co.uk/acatalog/Complete_Poultry_Incubators.html
- Page 100 – Hatching Indian Star Tortoise – Obtained from: Star Tortoise Basics - Ulf Edqvist. URL: http://www.tortoisetrust.org/articles/elegans.html

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GLOSSARY OF TERMINOLOGY

- ADAPTION - Morphological or behavioral modifications evolved over a period in response to environment or mode of life.
- AESTIVATE - Means to pass the summer in a certain manner or condition, often in a dormant or torpid state. As many tortoises are desert or semi-desert animals, some species can go into a state of torpor or hibernation in response to very dry conditions or hot temperatures. Not to be confused with hibernation.
- ALLANTOIS - Sac-like growth surrounding an embryo. Assists with respiration and waste management.
- AMBIENT TEMPERATURE – The overall temperature of the environment.
- ANTERIOR – Pertains to the front or head end.
- ANTERIOVENTRAL – Pertains to the front of the lower surface.
- AMNION - A fluid filed sac enclosing an embryo.
- ANAL - Pertaining to the anal region; e.g., the anal suture of the plastron.
- ANOXIA - Lack of oxygen. Suffocation.
- ANTERIOR - Towards the front or head.
- AQUATIC - Living in water.
- AREOLA - The central region of the scute. May be marked or raised.
- BASKING - Behavior designed to gain maximum absorption of heat from the sun. Often involves positioning on slopes.
- BEAK - The horny outer covering of the jaws.
- BIMODALITY - The term used to describe non-simultaneous hatching.
- BIOCLIMATIC RANGE - The forces of temperature and humidity, among other factors, which influence distribution of a species.
- BODY TEMPERATURE - The interior rather than exterior surface temperature of the body. Usually measured *per cloaca.*
- CARAPACE - The hard bony upper shell of the tortoise or turtle.
- CARNIVORE - An animal which eats the flesh of other animals. Not common in tortoises but frequent in freshwater turtles. e.g., Snapping turtles.
- CAUDAL - Pertaining to the tail region.
- CHARACTER - Any key feature used to diagnose species or sex.
- CHELONIAN - A collective term meaning any turtle and tortoises. Scientifically, all turtles, tortoises, and terrapins belong to the order 'chelonia'. A shield reptile.
- CITES - Stands for 'The Convention on International Trade in Endangered Species'. Sets world wide standards and restrictions on the trade in certain animals, plants, and products derived from them.
- CLINE - A gradual morphological variation within a species from one part of its range to another.
- CLOACA - The vent or common opening (bottom) in tortoises and turtles through which the intestinal, urinary, and reproductive tracts empty.
- CLUTCH - The collective term for all the eggs laid by a female at one time.
- CLUTCH DENSITY - The number of eggs in a single clutch.
- CONTIGUOUS - A sequential or unbroken series or distribution.
- COPROPHAGOUS - Dung or faeces eating.
- COSTAL - The series of plates located at the side and middle of a chelonians shell between the vertebrals and marginals.

- CRANIAL - Pertaining to the skull.
- CUTANEOUS - Of or pertaining to the skin.
- DEFRA - The Department for Environment, Food and Rural Affairs. Responsible for monitoring the trade in endangered chelonians in the UK.
- DIMORPHISM - Two distinct forms within a species. Sexual dimorphism is the existence of morphological divergence between male and female.
- DIURNAL - Active during the day.
- DORSAL - Pertaining to the upper part.
- DORSOLATERAL – Pertains to the upper sides.
- DYSTOCIA - See egg-binding.
- ESD - Acronym for Environmental Sex Determination.
- ECOSYSTEM - The natural symmetry between organisms and their environment.
- ECTOPARASITE - A parasite that lives outside the body or on its surface.
- ECTOTHERM - An animal that cannot regulate its own body temperature, rather it mainly relies upon environmental sources to sustain its body temperature, so they often bask for heat, burrow or hibernate.
- EGG BINDING - A condition which occurs in female tortoises involving difficulty in laying eggs (Dystocia).
- EGG CARUNCLE - A small projection on the beak of hatchlings used for the purposes of piercing the egg.
- EGG TOOTH - See egg caruncle.
- ENDEMIC - Zoogeographically restricted species, race or form.
- ENDOPARASITE - An internal parasite, e.g., a 'worm'.
- ENDOTHERM - An animal which self-generates heat by metabolic action, e. g., a mammal.
- ESTIVATE - See aestivate.
- EXOTHERM - See ectotherm.
- FSL - Acronym for Full Spectrum Lighting, 'artificial sunlight'.
- FAMILY - The taxonomic category below Order and above Genus.
- FAUNA - The animal life of a locality.
- FENESTRATED - Pierced. With gaps or holes.
- FORM - A population or 'variety'; not necessarily deserving of separate systematic recognition but also sometimes denoting a true species or subspecies.
- GENETIC - Pertaining to genes and inheritance.
- GENUS - The taxonomic category below Family and above Species. Contains one or more species.
- GESTATION - In tortoises, the period between fertilization of an egg and laying.
- GRAVID – A female bearing eggs or embryos.
- GREGARIOUS - Tending to congregate in groups.
- GULAR - Pertaining to the throat region; in tortoises usually refers to the plastral scutes below the head.
- GUT - The alimentary canal, especially the intestine.
- HABITAT - The environment in which an animal lives.
- HATCHLING - The young animal just after it leaves the egg; any juvenile phase tortoise to about 6 months.
- HEPATIC - Pertaining to the liver.
- HERBIVORE - An animal which eats plants rather than other animals. A vegetarian.

- HERPETILE – Reptiles and amphibians together.
- HERPETOLOGY - The science and study of reptiles and amphibians.
- HIBERNATION - Winter dormancy characterised by specific biological and biochemical changes including lowered blood pressure and respiration rate.
- HINGE - A mobile suture; as seen in Box Turtles or Hinge-back tortoises which allows part of the shell to be closed.
- HOMOGENOUS - A relatively intact distribution of genetic material within a population. Little diversity from one locality to another within the range.
- HYBRID - An individual resulting from a mating of parents who are not genetically identical, e.g., those that belong to different species.
- INCUBATION - The developmental phase of an egg prior to hatching which requires warmth.
- INFRARED - Invisible heat rays beyond the visible light spectrum.
- INTERGRADE - A hybrid form.
- INTRODUCED - A species not native to a region but which now occur there as a result of artificial transport or escapes from captivity etc.
- INTROFLEXED - Turned inwards.
- JUVENILE - Not sexually mature.
- KEEL - A ridge sometimes seen in the vertebral region of the carapace.
- KERATIN - A tough fibrous protein present in epidermal structures such as carapace shields, beaks and claws.
- KINESIS - Mobile. As in a box turtle or Hinge-back shell.
- LATERAL - Pertaining to the side.
- MARGINAL - The series of smaller scutes at the very edge of the carapace. Usually 11 on each side in most species.
- MELANISTIC - Darker or blacker than normal.
- MESIC - An intermediate humidity habitat.
- METABOLIC RATE - The rate of energy expenditure by an organism.
- METABOLISM - The chemical or energy changes which occur within an animal necessary to sustain life.
- MICROCLIMATE - The climate immediately surrounding an animal. May differ profoundly from the general climate in the case of burrowing tortoises.
- MIDDORSAL – Pertaining to the middle of the back.
- MIDVENTRAL – Pertaining to the middle of the belly.
- MORPHOLOGY - Pertaining to shape and form.
- MORPHOMETRY - The technique of measuring and comparing shapes, e.g., the shape of a turtle shell.
- MYELITIS - Tissue destruction due to infection.
- NARES - Paired openings of the nasal cavity.
- NASAL - Pertaining to the nose or nares.
- NOCTURNAL - Active at night.
- NUCHAL - A small scute at the front of the carapace, above the head.
- OEDEMA - Fluid retention. Can signify renal disease or bruising. Any swelling.
- OMNIVORE - An animal which feeds on both plant and animal tissue.
- OPTIC - Pertaining to the eyes.
- OSTEOLOGICAL - Pertaining to the bones and their structure.
- OVIPAROUS – An animal who lays eggs, and then later the eggs hatch.

- OVIPOSITION - The act of egg laying.
- P.O. - Preferred Optimum.
- PARENTERAL - Via injection.
- PHENETIC - Apparent similarity on the basis of external characters.
- PHYLOGENY - Pertaining to evolutionary relationships.
- PLASTRON - The lower surface of the chelonian shell.
- POIKILOTHERM - See ectotherm.
- POPULATION - A group of the same species living in a discreet geographical area.
- POSTERIOR - The rear or back part.
- RACE - A population of a species distinguishable from the rest of that species. A subspecies.
- RADIAL - Like the spokes of a wheel.
- RENAL - Pertaining to the kidneys.
- SAVANNAH - A habitat of open plains and low grassy vegetation.
- SCL - Acronym for Straight Carapace Length (not over the curve).
- SCUTE - A horny, chitinous, or bony external plate or scale, as on the shell of a chelonian. Also called *scutum*.
- SERRATED - Jagged or saw-like.
- SUBSPECIES - A subdivision of a single species given a unique name which is expressed after the generic and species name. See race.
- SUBSTRATE - In herpetology, usually refers to vivarium flooring material.
- SUPRA - Pertaining to above.
- SUPRACAUDAL - The scute above the tail.
- SUTURES - The 'seams' between two boney or horny plates.
- SYMPATRIC - Living in the same geographical area.
- SYNONYM - One of several different names applied to an identical taxonomic category only one of which is valid. The invalid names only are called synonyms. The valid name is selected by priority.
- SYSTEMIC - Whole body treatment. Not topical. Usually by injection.
- TAXON - A taxonomic category, e.g a Family, Genus or Species.
- TAXONOMY - The science of classification.
- TEMPERATE - Latitudes where summer and winter seasons are experienced.
- TERRAPIN - Any chelonian which lives in freshwater for all or part of the time.
  TERRARIUM – The cage or container for keeping reptiles and amphibians.
- TERRESTRIAL - Living on the ground. Not Aquatic.
- THERMOREGULATE - To regulate body temperature. Most reptiles cannot produce their own body heat and must rely on external or environmental heat sources. They control their core body temperatures by moving in and out of areas with varying temperatures and humidity levels
- TOPICALLY - Pertaining to surface application.
- TORTOISE - Any chelonian which lives solely on land
- Tortoise Table - An indoor enclosure for tortoises (often made of wood) with an open top and low walls to provide adequate ventilation and allowing correct heating/lighting etc.
- TROPICAL - Pertaining to equatorial regions where winter and summer seasons are not experienced.
- TUBERCLE - The 'spur' on tortoises' thighs.

- TURTLE - Semi-terrestrial chelonians and marine chelonians. Sometimes applied interchangeably with 'tortoise'. This is a mostly European definition of the word. In America all chelonians are called turtles regardless of where they live
- TYMPANITIC - Pertaining to the ear.
- TYPE - The original specimen upon which a species is erected.
- TYPE LOCALITY - The place where the Type was collected or originated.
- VENTRAL - Pertaining to the underside.
- VERTEBRAL - Pertaining to the spinal region. The central row of scutes along the top of the carapace.
- VIVARIUM - An indoor artificial environment containing animals.

Complied from:

- *Reptile Glossary of Terms.*
  http://animal-world.com/encyclo/reptiles/information/reptile_glossary.php
- *Glossary of Chelonian Terminology*
  http://www.tortoisetrust.org/articles/glossary.html
- *Glossary*
  http://online-field-guide.com/glossary.htm
- *Glossary*
  Shell shack The Tortoise Reference Website http://www.shellshack.co.uk/glossary.php

APPENDICES

APPENDIX 1

ANNUAL CYCLE OF MAINTENANCE ACTIVITIES

Daily

- Remove faeces and uneaten food
- Wipe up water spills and urates
- If using sand substrate, use sand sifter to clean
- Clean inside of cage with cleaning solution (relocate tortoise before cleaning commences)
- Clean outside and inside of exhibit glass (Indoor exhibit)
- Rake outdoor exhibit substrate (gravel etc.)
- Check outside enclosure drains, remove debris if blocked
- Clean food and water dishes
- Check for pests, take appropriate control measures if needed or apply preventative measures

Weekly

- Remove all furniture in the cage
- Bag and discard disposable substrate
- Clean all cage surfaces with soap and hot water, and rinse well
- Loosen tough spots with a commercial herp-safe terrarium cleaner, a toothbrush, or putty knife
- Wash all furniture and non-disposable substrate, such as indoor/outdoor carpet, with hot, soapy water
- Scrub with brushes to remove wastes and dried liquids. Rinse well
- After washing and rinsing the cage and accessories, use a disinfectant. Be sure to rinse the cage and accessories with hot water until all residues are removed
- Re-install furniture. Replace any decoration, especially wood, which will not easily dry.
- Be sure to thoroughly clean and disinfect all equipment, sponges, buckets, gloves, and sinks
- Check waterproofing of outdoor shelters
- Check pond for any leaks

Monthly

- Full furniture clean and/or change out
- Full pest control/preventative measures carried out
- Outdoor natural vegetation pruning/maintenance
- Check/change any lights or heating elements/lamps
- Complete clean of drains and catching baskets
- Check all locks/gates, lubricate if needed
- Fix any damaged fencing

Every 6 months

- Full substrate change
- Plant/vegetation change out or rotation

- Feeding (fertilizer) of any natural vegetation/plants
- Completely drain outdoor ponds, total clean (air pressure/steam clean), refill
- Staining of any wood paneling
- Touch ups on any indoor enclosure backgrounds

Yearly

- Check any electrics/plumbing in outdoor and indoor exhibit, fix if needed
- Re-painted any painted surfaces/fences
- Make any repairs to damaged furniture, parts of the enclosure
- Update sign information on enclosure to include new details

APPENDIX 2

TOXIC PLANTS

Acokanthera	Aconite (monk's hood)	Amaryllis
Amsinckia (tarweed)	Anemone	Apple seeds
Apricot seeds	Autumn crocus	Avocado
Azalea	Baneberry	Beach pea
Betal nut palm	Belladonna	Bittersweet
Bird of paradise	Black locust	Bleeding heart
Bloodroot	Bluebonnet	Bottlebrush
Boxwood	Buckeye horse chestnut	Buttercup
Caladium	Calla lily	Cardinal flower
Carolina jessamine	Casava	Castor bean
Chalice of trumpet vine	Cherry seeds	Cherry laurel
China berry tree	Christmas berry	Christmas cactus (euphorbia)
Christmas rose	Columbine	Common privet
Coral plant	Crocus	Croton
Cyclamen	Daffodil	Daphne
Death camus	Deadly nightshade	Delphinium
Destroying angel (death cap)	Dogwood	Dumb cane
Eggplant	Elderberry	Elephant ear (taro)
English ivy	Euphorbia (spurges)	False hellebore
Fiddleneck (senecio)	Fly agaric (amanita, deathcap)	Four o'clock
Foxglove	Gelsemium	Golden chain
Hemlock roots (water & poison)	Henbane	Holly, English and American
Horse chestnut	Horsetail reed (equisetum)	Hyacinth
Hydrangea	Impatiens (touch-me-not)	Iris (flags)
Ivy (all forms)	Jack-in-the-pulpit	Jasmine
Jasmine, star	Jatropha	Jerusalem cherry
Jessamine	Jimson weed (thorn apple)	Johnson grass, wilted
Lambkill (sheep laurel)	Lantana camara	Larkspur
Laurel	Lily of the valley	Lobelia
Locoweed	Locust	Lupine
Machineel	Marijuana	May apple
Mescal	Milk weed	Mistletoe

Moccasin flower	Monkshood	Moonseed
Morning glory	Mountain laurel	Mushrooms (some wild forms)
Narcissus	Natal cherry	Nectarine (seeds)
Nicotine, tree, bush, flowering	Nightshades	Oak trees
Oleander	Peach (seeds)	Pear (seeds)
Pennyroyal	Peony	Periwinkle
Philodendron	Pinks	Plum (seeds)
Poinsettia	Poison hemlock	Poison ivy
Poison oak	Poison sumac	Pokewood or Pokeberry
Poppy (except California)	Potato (raw foliage and sprouts)	Privet
Redwood	Rhubarb (uncooked foliage, stems)	Rhododenderon
Rosary pea	Rosemary	Russian Thistle
Sage	Salmonberry	Scarlet pimpernel
Scotch broom	Senecio (fiddle neck)	Skunk cabbage
Snapdragon	Spanish bayonet	Squirrel corn
Sudan grass, wilted	Star of Bethlehem	Sundew
Sweetpea	Tansy	Taro (elephant ears)
Tarweed	Tiger Lily	Toad flax
Tomato plant (foliage and vines)	Toyon berry	Tree of heaven
Trillium	Trumpet vine	Tulip
Venus flytrap	Verbena	Vetch
Virginia creeper	Water hemlock	Wild parsnip
Wisteria	Yellow star thistle	Yew

Obtained from: Jen Swofford's Iguana Pages
URL: http://www.baskingspot.com/iguanas/igbook/table3.html

APPENDIX 3

NON TOXIC PLANTS

- ABELIA *(Abelia grandiflora)*
- AFRICAN VIOLET *(Saintpaulia ionantha)*
- ALOE (*Aloe* species).
- SWEET ALYSSUM *(Allyssum sp.)*
- ASPERAGUS FERN *(Asperagus setaceus plumosis)*
- ASTER *(Aster sp.)*
- BABY TEARS *(Helxine soleirolii)*
- BERMUDA GRASS (*Cynodon dactylon*).
- BLUE HIBISCUS (*Alyogyne huegelii*)
- BIRD'S NEST FERN *(Asplenium nidus)*
- BOSTON FERN *(Nephrolepsis exalta)*
- BOTTLE BRUSH *(Callistemom)*
- BOUGANVILLEA *(Bouganvillea)*
- BRIDAL VEIL *(Tripogandra multiflora)*
- BROMELIADS *(Aechmea; Bilbergia; Cryptanthus)*
- CACTUS, SPINELESS (Astrophytum)
- CAMELLIA *(Camellia japonica)*
- CHINESE LANTERN (*Abutilon hybridum*)
- COLEUS *(Coleus)*
- CORN PLANT *(Dracaena fragrans)*
- CREEPING CHARLIE *(Pilea nummulariifolia)* - Not to be confused with another "creeping charlie," *Glecoma heteracea* which is toxic
- CROTON (Codiaeum sp.)
- DANDELION (*Taraxacum officinale*)
- DAY LILLIES (*Hemerocallis* species)
- DRACAENA (Dracaena)
- EDIBLE FIG (*Ficus carica*)
- EMERALD RIPPLE (Peperomia caperata)
- EUGENIA (Peperomia caperata)
- FUSCHIA (Fuschia)
- GERANIUM (*Pelargonium* species) - Ivy Geranium known as the Balcon Geranium (*Pelargonium peltatum*), Rose Geranium (*P. graveolens*), Peppermint Geranium (*P. tomentosum*).
- GRAPES (*Vitis vinifera* and *V. labrusca*)
- HEN AND CHICKS SUCCULENT (Echeveria)
- HIBISCUS (Hibiscus rosa-sinensis)
- HOYA (Hoya exotica)
- ICEPLANT (Mesembryanthemum crystallinum)
- IMPATIENS (Impatiens)
- JADE PLANT (*Crassula argentea*)
- JAPANESE ARALIA (Fatsia japonica)
- JASMINE (Jasminum officinale: J. grandifloum)
- JOHNNY-JUMP-UPS
- KALE (*Brassica oleracea*)
- LAVENDER (Lavandula officinalis)
- MARGUERITE DAISY (*Chrysanthemum frutescens*)
- MARIGOLD (Calendula officinalis)
- MONKEY PLANT (Ruellia makoyana)
- MOTHER OF PEARL (Graptopetalum paraguayen)
- MULBERRY (*Morus alba* and *M. nigra*) - *Morus alba* "Pendula" (fruiting) and *M. alba* "Chaparral" (non-fruiting)
- NASTURTIUMS (*Tropaeolum majus*),
- NATAL PLUM (Carissa grandiflora)
- ROSE (*Rosa* species) - Rosa rugosa species, Rosa rugosa "Cecile Brunner" and "Belle of Portugal"
- ORNAMENTAL STRAWBERRY (*Fragaria chiloensis*)

- PAINTED NETTLE (Coleus)
- PALMS (Areca sp.)
- PAMPAS GRASS (Cortaderia selloana)
- PANSIES (*Viola*)
- PARLOR PALM (Chamaedorea elegans)
- PEPEROMIA (Peperomia caperata)
- PETUNIA (Petunia)
- PHOENIX (Phoenix roebelenii)
- PIGGYBACK PLANT (Tolmiea menziesii)
- PILEA (Pilea sp.)
- PINEAPPLE GUAVA (*Feijoa sellowiana*)
- PINK POLKA-DOT PLANT (H. ypoestes sang.)
- PONYTAIL PLANT (Beaucarnea recurvata)
- PRAYER PLANT (Maranta leuconeura)
- PURPLE PASSION: PURPLE VELVET (Gynura)
- SPIDER PLANT (Chlorophytum comosum)
- SPINELESS PICKLY PEAR CACTUS (*Opuntia* species)
- STAGHORN FERN (Platycerium bifurcatum)
- SWEDISH IVY (Plectranthus australis)
- TREE MALLOW (Lavatera assurgentiflora)
- TROPICAL HIBISCUS (*Hibiscus rosa-sinensis*)
- UMBRELLA PLANT (Eriogonum umbrellum) - ** Not to be confused with another "umbrella" plant, Schefflera actinophylla which is toxic.
- VELVET PLANT (Gynura aurantaca)
- VIOLETS
- WANDERING JEW (Tradescantia albiflora)
- WARNECKII (Dracaena deremensis)
- WATER HYACINTH (*Eichhornia crassipes*)
- WAX PLANT (Hoya exotica)
- YUCCA (*Yucca* species)
- ZEBRA PLANTY (Calathea zebrina)
- ZINNIAS (Zinnia sp.)

Complied from:

- Cohen. M. *Edible Landscaping for Tortoises.* Tortuga Gazette 28(1): 6-7, January 1992. Accessed Online 2nd May 2009. URL:http://www.tortoise.org/general/edibplan.html
- Thomas B. & J. *Growing Plants for Tortoise Yards Plants We Have Found Which Work Well*. Tortuga Gazette 35(3): 6-7, March 1999. Accessed Online 5th May 2009. URL: http://www.tortoise.org/general/tttplant.html
- LLL Reptile. *List of non-toxic plants for your terrarium*. Accessed Online 5th May 2009. URL: http://lllreptile.com/info/library/care-and-husbandry-articles/-/list-of-nontoxic-plants-for-your-terrarium/

APPENDIX 4

CHEMICAL AGENTS & MAIN GROUP OF DISINFECTANTS

There are live main groups of disinfectants used with reptiles:

1. Quaternary ammonium compounds (Roccal-D, Upjohn Co.)

2. Chlorhexidine products (Nolvasan, Aveco Co.)

3. Household bleach (Sodium hypochlorite - many brands)

4. Ammonia (many brands)

5. Inorganic iodine products (e.g., povidone-iodine -many brands)

Regardless of the product used, for adequate disinfection to occur most manufacturers recommend a contact time of 15 10 20 minutes. While this may be impractical for large cages, water dishes and cage furniture may be soaked and then well-rinsed. Large enclosures can be sprayed with an appropriate dilution of the disinfectant, which is then rinsed well after the appropriate contact time. Some soap residues can partially inactivate disinfectants such as the quaternary ammonium products, so a thorough rinsing after cleaning is imperative. Some reptiles, such as some of the water turtles and amphibians, are more sensitive to these agents and special attention has to he paid to the rinsing process. Cutaneous absorption of these products could prove to he fatal. Some containers used in animal housing are not totally impervious to these products. Plastic tends to retain some of the cleaning agents and disinfectants. At the National Aquarium in Baltimore, povidone-iodine was implicated in the deaths of some poison dart frogs. If a chlorine product is used, then a dechlorinizing agent should be added to the rinse water. A thorough rinsing of both the cleaning agents and disinfectants is important to prevent accidental absorption via residues, to limit contact irritants, and to remove odors that could harm the respiratory system of the cage occupant.

Quaternary Ammonium Compounds (Quats) (Examples: Barquat, Omega, Parvosol, Roccal, Zephiran, Quintacide)

Quaternary ammonium products like Roccal-D are very useful and easy to use. They are generally organic compounds combined with ammonia, that are inexpensive, relatively safe and inactivate many types of bacteria, some viruses and Chlamydophila. They should not be used for removing spores, Mycobacteria (the organisms causing TB), fungi, many nonenveloped viruses and Pseudomonas. Because of their chemical composition, these agents may function as a detergent and help to remove organic debris from contaminated objects. Despite rumors to the contrary, Roccal-D has not been shown to be carcinogenic. All cleaning agents used prior to using the disinfectant must be rinsed well or some inactivation of the product may occur. Ingestion of quats and possibly inhalation can cause respiratory paralysis and even death! These agents are not recommended for objects that will be in direct contact with herps. Chlorhexidine products are less harsh and are more commonly used. These products are often combined with cleansing agents

(e.g., Nolvasan scrub), but this would he a fairly expensive product to use for general cleaning/disinfection. It is more reasonable to use a good cleaning agent, rinse well, and then apply the chlorhexidine (1%) as a spray; which is ultimately rinsed. This will work equally well for cages, cage furniture, and water dishes. Roccal-D is fairly harsh to skin and prolonged contact is to be avoided.

Iodines (Examples: Betadyne, Povidone iodine, Prepodyne, Virac)

Povidone-iodine products can also he combined with cleansing agents to produce surgical scrub solutions. These products may penetrate some plastics and should be used with caution in sensitive reptiles. Staining of containers can also occur. The povidone-iodine products are effective for resistant organisms such as Entamoeba spp., although true sterilization is preferred.

Ammonia

Ammonia products are irritating to skin and the respiratory, tract and are infrequently used. However, ammonia-based products in a 5% solution are perhaps the agent of choice for Cryptosporidia spp., which are extremely resistant to disinfection. Mycobacterium spp. are also resistant to most disinfectants, and true sterilization may be required to control these pathogens.

Bleach (Examples: Clorox, Purex, Bleach)

Perhaps the most frequently used cleaning/disinfection combination used by veterinarians is bleach with a soap product. Bleach is available in liquid and powder forms. It is a powerful oxidizer that can destroy many if not most microorganisms, including bacteria and viruses, but it has limited activity against spores of some bacteria and fungi. One ounce (30 ml) of household chlorine bleach is combined with 1 teaspoon (5 ml) of a soap product like Palmolive or Dawn dish detergent in 1 quart of water. Because of the low cost of this mixture, new batches should he mixed with each cleaning/disinfection job. While good results are obtained, this mixture is also irritating to the skin and respiratory system. Chlorine bleach must never be combined with ammonia owing to the potential production of poisonous chlorine gases. Bleach is also corrosive to metals and produces carcinogenic (cancer-causing) by-products.

Each practitioner must make his or her own choice based on preference of the products mentioned. Products already in use in the veterinary clinic can be adapted for use with reptiles. Clients should be encouraged to use similar products, but their use must he thoroughly discussed with them if recommended. A handout on cleaning and disinfection techniques may prove to be useful.

Suggested Disinfectants to Use To Clean Your Reptile's Housing, Water Tub/Pond/Pool, and Cage Accessories (Melissa Kaplan)

Roccal-D (Wintrhop, New York NY)

Nolvasan (Fort Dodge Laboratories, Fort Dodge IA)

Avinol (Veterinary Products Laboratory, Phoenix AZ)

One-Stroke Environ (Ceva, Overland Park KS)

Syn-Phenol-3 (Veterinary Products Laboratories, AZ)

10% Chlorine bleach solution

ADDITIONAL AGENTS

Stabilized Chlorine Dioxide (Examples: Dent-A-Gene, Oxyfresh)

This is considered safe and is used by many municipalities as the principle agent for eliminating potential pathogens from drinking water. Unlike bleach, it does not form carcinogenic compounds. Stabilized chlorine dioxide is rapidly inactivated by organic debris and exposure to sunlight.

Glutaraldehydes (Examples: Cidex, Wavecide, Sporcide, Sterol)

These chemicals have the ability to rapidly inactivate many microbial agents, including most bacteria (including Mycobacteria, which cause TB), many viruses and Chlamydophila. They are effective against many viruses, even in the presence of organic material, and once made up into a solution, they are stable for two to four weeks. While these chemicals are very effective, they are not frequently used because of the widespread side effects, which may cause eye irritation, respiratory tract irritation and skin lesions (including cracking, peeling and bleeding) in both humans and animals. Some glutaraldehydes are corrosive, others are not.

Phenols (Examples: Avinol-3, Lysol, Environ, One Stroke, Staphhene)

Sodium orthophenol is the active ingredient in most phenol-containing disinfectants. Phenols can inactivate many bacteria, including Pseudomonas and the bacteria responsible for causing TB, fungi and some viruses. Organic material can affect the activity of phenols, as can the temperature, pH and concentration of the disinfecting solution. Phenols are inexpensive and rinse off easily, so that they don't leave much of a toxic residue. However, they are toxic to many tissues; irritating to the skin, eyes and respiratory tract; and are especially toxic to felines and reptiles, so it is important to rinse phenols off well from anything that may come in contact with herps.

Alcohols

Seventy percent ethanol (alcohol) inactivates many bacteria and viruses; however, this usually requires a long contact time of at least 20 minutes. Alcohols perform best in the presence of moisture. Some viruses are resistant to inactivation by alcohol. Alcohols will dissolve some plastics, rubber and glues, and must be used cautiously around those items. Alcohol fumes can be irritating to the eyes and mucus membranes.

Formalin and Formaldehyde

These are extremely dangerous and toxic compounds, and should not be used routinely for disinfection.

Soaps and Detergents

These are divided into two groups: anionic soaps (with a negative charge) and synthetic detergents (positively charged). Soaps and detergents work by reducing the attraction of greases and dirt to an object. In some cases, specific chemical disinfectants are combined with a soap or detergent. These agents are primarily used to clean and disinfect areas or objects that are contaminated with

large quantities of organic debris. Household detergents are great for cleaning bowls, dishes, enclosures, rocks and hide boxes, and as with all cleaning agents, items should be rinsed well and dried thoroughly before being replaced in the cage.

Steam and Heat

Commercially available units are now available that release steam that can be used to clean, remove debris and disinfect surfaces. I have a steamer for cleaning cages, and it is easy to use, is safe and very effective in removing many harmful organisms and debris. Of course, be very careful to not burn or melt plastics, and never steam clean with the herps in the enclosures, as severe burns can occur. I use a steam cleaner routinely to clean my cages and cage equipment, and I recommend them highly.

Complied from

- Kaplan, M. *Information on Disinfectants from the Reptile Veterinary Literature*. Melissa Kaplan's Herp Care Collection. Accessed Online 30th March 2009. URL: http://www.anapsid.org/disinfectants.html
- Wissman, M. A. *Cleaning Reptile Cages: How do you clean, disinfect and sanitize a reptile cage?* Accessed Online 30th March 2009. URL: http://www.reptilechannel.com/reptile-health/cleaning-snake-cages.aspx

APPENDIX 5

MSDS

Material
Safety Data Sheet
WW MSDS No. 30-0403

Nolvasan S

Section 1. Product and Company Identification	
Manufactured/ Supplied by	Fort Dodge Animal Health 800 5th Street NW P.O. Box 518 Fort Dodge, IA 50501 Phone: 515-955-4600 Fax: 515-955-9149
Product Trade Name	Nolvasan S
Common Name	Not applicable.
Synonyms	Nolvasan Scented Disinfectant; Chlorsan Scented Disinfectant.
Chemical Formula	Mixture.
Chemical Family	Disinfectants.
Material Uses	Pharmaceutical: Antiseptic.
Packaging	Container, medium.
Formula Type	Not available.

Date of Preparation 17 January 2002
Product No. 30-0403
Formula No. Not available
CAS No. Mixture
U.N. No. UN1993
EINECS No. Not applicable

In Case of Emergency 515-955-6033

Section 2. Composition – Information on Ingredients				
Name of Ingredients	CAS No.	Conc.	EU Symbol	R Phrase
1) Chlorhexidine Acetate	56-95-1	2	Xn	R22
2) Isopropanol	67-63-0	7.9	F	R11
3) Inert Ingredients		90.1	Not controlled.	Not Controlled.

Section 3. Hazards Identification – Summary of Primary Effects and Critical Hazards	
Acute Health Effects	Adverse health effects are associated with chronic high level exposures
Chronic Health Effects	Potential organ systems affected are: Kidneys, Nervous System Adverse effects could include: nausea/vomiting headache respiratory tract irritation
Environmental Hazards	No known significant effects or critical hazards

Section 4. First Aid Measures – (by medical responders using "Universal Precautions")	
Eye Contact	Flush eyes with plenty of water for 15 minutes, occasionally lifting upper and lower eyelids. (Check person for contact lenses and remove is present.) If redness or irritation persists have eyes examined by doctor immediately
Skin Contact	Flush skin with plenty of soap and water for at least 15 minutes (remove all contaminated clothing and shoes). Get medical attention if symptoms persist
Inhalation	No specific treatment, treat symptomatically. If breath is difficult give oxygen, if respiratory arrest occurs give artificial respiration and seem immediate medical assistance

Ingestion	No specific treatment, treat symptomatically. Call medical doctor or poison control centre if large quantities are ingested
Notes to Medical Doctor	Direct treatment at control of symptoms

Section 5. Fire-Fighting Measures	
Extinguishing Media and Instruction	Follow your company's procedures. Use an extinguishing agent suitable for the surrounding class of fire
Special Exposure Hazards	None. Dispose of fire debris and contaminated fire fighting water in accordance with regulations.
Special Fire Fighting Protective Equipment	No special precautions or equipment

Section 6. Accidental Release Measures	
Small Spill Guidelines	Follow your company's spill procedures. Keep people away from spill. Put on appropriate personal protective equipment (see section 8). Use a tool to scoop up solid or absorbed material and put into appropriate labeled waste container
Large Spill Guidelines	Initiate company's spill response procedures immediately. Keep people out of area. Put on appropriate personal protective equipment (see Section 8).
Environmental Precautions	No special measures are typically indicated.

Section 7. Handling and Storage	
Handling (ventilation and fore prevention)	Avoid contact with eyes, skin, and clothing. Avoid generating or breathing product aerosol. Wash after handling.
Storage (conditions and limitations)	Store tightly closed in original container. Keep containers in a well ventilated, secure location.

Section 8. Exposure Controls and Personal Protections – (normal and intended use)				
Exposure Guidelines				
Component	REG Limit	OSHA (PEL)	ACGIH (TLV®)	Company Guideline
1) Isopropanol	TWA: STEL:	400 ppm 500 ppm	400 ppm 500 ppm	
Engineering Design and Control Measures	General Ventilation is typically sufficient to keep airborne levels below established values. Provide eye wash and quick drench shower close to work station. Clean, appropriate launder or dispose of all potentially contaminated work clothing, foot wear, and protective equipment after use.			
Protective Clothing Eyes	Safety glasses. Goggles, face shield, or other full-face protection where if the potential exists for direct exposure to aerosols or splashes.			
Skin	Lab coat			
Hands	Gloves, Chemical resistant			
Respiratory	Respirator selection must be based on anticipated exposure levels, product hazards, and the safe working limits of the selected respirator. A respirator is not needed under normal and intended conditions of product use. If using the product for aerosol fogging, use a NIOSH-approved respirator with pesticide filter cartridges with a protection factor appropriate for the exposure levels associated with the application.			

Section 9. Physical and Chemical Properties	
Physical State and appearance	Liquid
Molecular Weight	Mixture
Boiling Point	Not available
Melting/Freezing Point	May start to solidify at -86°C (-122.8°F) based on data for: Isopropanol.
Density/Bulk Density	0.98 (Water = 1)
Vapor Pressure	33 mm of Hg (@ 20°C) (Isopropanol).
Vapor Density	Weighted average: 2.07 (Air = 1)
Viscosity	Not available.
Partition Coefficient	Not available.
Solubility	Nolvasan S: Easily soluble in cold water, hot water.
Flash Point	OPEN CUP: 39.722°C (103.5°F).
Auto ignition Point	Not applicable.
Explosion Limits	Not applicable.
Dust Explosivity	Not applicable.

Odour Not available
Colour Clear Blue.
pH Not available

Section 10. Stability and Reactivity	
Conditions to avoid and Incompatibility	Extremely reactive or incompatible with oxidizing agents, metals. Reactive with acids, alkalis.
Decomposition Products	These products are carbon oxides (CO, CO2), nitrogen oxides (NO, NO2...), halogenated compounds.

Section 11. Toxicological Information

Acute Effects

Component	Test	Result	Route	Species
1) Chlorhexidine Acetate	LD50	2000 mg/kg	Oral	Mouse
2) Isopropanol	LD50	3600 mg/kg	Oral	Mouse
	LD50	5045 mg/kg	Oral	Rat
	LD50	12800 mg/kg	Dermal	Rabbit

Eye Contact	Severely irritating (USA). Risk of serious damage (EU).
Skin Contact	Slightly irritating (USA). Irritating (EU)
Inhalation	Moderately irritating (USA). Irritating (EU). Moderately toxic via inhalation.
Ingestion	Harmful if swallowed.
Chronic Effects	
Target Organs	Potential organ systems effected are: Kidneys, Nervous System.
Adverse Effects Statements	Adverse effects could include: nausea/vomiting headache respiratory tract irritation. May cause allergic reactions in persons sensitive to chlorhexidine.
Sensitization	May cause allergic reactions in persons sensitive to chlorhexidine.
Carcinogenic Effects	Classified 3 (Not classifiable for human.) by IARC [Isopropanol].
Mutagenic Effects	Not mutagenic in a standard battery of genetic toxicological tests.
Teratogenic Effects	No known human teratogenic effect
Reproductive Effects	No evidence of human reproductive effects.
Other Effects	FDA C - Risk cannot be ruled out.

Section 12. Ecological Information			
Environmental Fate	Not available		
Environmental Hazards	No known significant effects or critical hazards.		
Ecotoxicity Component	Species	Period	Result
No hazardous ingredients			
Other	Not available		

Section 13. Disposal Considerations	
Waste Handling and Disposal	Avoid disposal, make attempts to use product completely in accordance with intended use. Incinerate unwanted products and waste materials.
Note: The waste generator must be informed of and follow all applicable rules and regulations for the handling and disposal of waste.	

Section 14. Transport Information	
Proper Shipping Name, Primary Class, UNNA Number, Pakaging Group	Not controlled
ADR/RID Classification (Road and Rail Transport)	Not available
ADNR Classification (Inland Waterways)	Not available
IMO/IMDG Class (Maritime Transport)	Not available
ICAO/IATA (Air Transport)	Not available
CEFIC Tremcard	Not available
U.S.A. DOT Class	Not available
RQ	Not applicable
Packaging Intructions	Not available

HI Kemler Not available

NFPA

Section 15. Regulatory Information and Warning Labels	
R) Risk Phrases	R10- Flammable. R22- Harmful if swallowed. R23- Toxic by inhalation. R36- Irritating to eyes.
(S) Safety Phrases	S2- Keep out of reach of children. S40- To clean the floor and all objects contaminated by this material, use water. S43- In case of fire, refer to the appropriate section in the Material Safety Data Sheet for this product. S25- Avoid contact with eyes S39- Wear eye/face protection S42- During fumigation/spraying wear suitable respiratory equipment

10- Flammable.

NOTE: This product has been classified in accordance with applicable country-specific regulations.

Section 16. Other Key Information
Other Considerations See product label and package insert for additional information.
19 January 2002 Responsible for MSDS: Global Engineering, Environmental and Safety Fort Dodge Animal Health -- within American Home Products Corporation
Notice to Reader ** This symbol indicates information which has changed from the previous MSDS.* *The information provided in this MSDS is based on current knowledge; however, this does not constitute a warranty by the Company for that information. The product user is responsible for the appropriate and intended handling, use, and disposal of this product in accordance with label or package precautions and this information. All materials may present unknown hazards and should be used with caution.*
MSDSs available in multiple languages

Vetafarm 3 Bye St, P.O. Box 5244 Wagga Wagga NSW Australia
Telephone (02) 6925 6222 Fax (02) 6925 6333
Email: vetafarm@vetafarm.com.au
Internet: http://www.vetafarm.com.au
International Phone 61 2 6925 6222 Fax 61 2 6925 6333

MATERIAL SAFETY DATA SHEET AVISAFE

Date of Issue: 17 February, 1999	Issue 1
Not classified as Hazardous according to criteria of Worksafe Australia	

IDENTIFICATION			
Product Name:	Avisafe	UN Number:	None Issued
		Hazchem Code:	None Issued
Other Name:	None	Dangerous Goods Class and Sub-risk	None Issued
Manufacturers Code:	B-0002	Poison Schedule:	None Issued
		Packaging Group:	None Issued

Use: Avian disinfectant cleanser, effective against a wide range of viruses, bacteria and fungi found in bird keeping.

Physical Description/Properties:	
Appearance:	Clear, pale green liquid
Odour:	Lemon
pH (10% soln)	9-10
Boiling point (°C)	~ 100°C
Solubility in Water:	Miscible in all proportions
Specific Gravity:	1.000

Ingredients:		
Chemical Entity: Halogenated Tertiary Amines	CAS No: N/A	Proportion: 10 %
Ingredients Determined Not to be Hazardous		

HEALTH HAZARD INFORMATION

Health Effects:

Acute:

Swallowed:	May be irritating.
Eye:	May cause redness or irritation.
Skin:	May be irritating on prolonged and repeated contact.
Inhaled:	Spray mist may be irritating.

Chronic: No effects reported following long term exposure

Swallowed:	Do NOT induce vomiting. Give milk. Contact a doctor or Poisons Information Centre and show the container label.
Eye:	Hold eyelids open and flush eyes with cold water for at least 15 minutes and see a doctor.
Skin:	Remove contaminated clothing and wash skin thoroughly. Seek medical advice if symptoms persist.
Inhaled:	Remove to fresh air. Seek medical advice if symptoms persist.

First Aid:

First Aid Facilities:	Clean running water.

Advice to Doctor: Treat symptomatically.

PRECAUTIONS FOR USE	
Exposure Standards:	This product does not contain any relevant quantities of material with critical values that have to be monitored in the workplace.
Engineering Controls:	Avoid inhaling spray mist. Use with adequate ventilation.
Personal Protection:	Wear safety glasses to prevent contact with eyes. Avoid contact with skin. Wear gloves for prolonged and repeated contact.
Flammability:	Not flammable.

SAFE HANDLING INFORMATION	
Storage and Transport:	No special precautions for transportation. Store away from food and keep container closed when not in use.
Spills and Disposal:	Remove and dispose according to government regulations for large spills, contain using sand or earth. Prevent run-off into drains and waterways. Collect and seal in suitably labelled drums for disposal. Wash away residue and small spills with large amounts of water.
Fire/Explosion Hazard:	Not combustible.

Physical Description/Properties:

CONTACT POINT: Vetafarm Pty Ltd
Head Office: (02) 69 256 222 (b/h)

MATERIAL SAFETY DATA SHEET

SECTION 1 -- CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME	Bleach (3.0% Regular, Lemon, Floral, Fresh)

PRODUCT BRAND	101 Bleach

ISSUE DATE	January 11, 2007

MANUFACTURER
STREET ADDRESS
CITY, STATE, ZIP

James Austin Company
115 Downieville Road
Mars, PA 16046

EMERGENCY TELEPHONE NUMBERS

Medical Information: 1-866-359-5662
Transportation: 1-800-424-9300*
* For spill, leak, fire or transport accident emergencies.
Product Information: 1-724-625-1535

SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS COMPONENT	CAS NO.	% by wt.	EXPOSURE LIMITS OSHA PEL	ACGIH TLV	NIOSH REL
Sodium hypochlorite	7681-52-9	3.00-3.50	None	None	None

SECTION 3 -- HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW	IRRITANT; may cause severe skin and eye irritation or chemical burns to broken skin. Vapors extremely irritating to eyes and respiratory tract. Harmful and potentially fatal if swallowed. If mixed with other prohibited chemicals or materials, chlorine gas will be released which is also irritating to eyes, lungs, mucous membranes and in some cases can be fatal. (see Setion 10 for more information)

POTENTIAL HEALTH EFFECTS	
INGESTION	Can cause corrosion of mucous membranes, severe esophageal burns and perforation of esophagus or stomach.
INHALATION	Inhalation of vapors can cause bronchial irritation, coughing, difficulty in breathing, nausea and pulmonary edema.
EYE CONTACT	Irritating to the eyes; may cause severe and permanent damage.
SKIN CONTACT	Severe irritant; contact can produce blistering and eczema.

SECTION 4 -- FIRST AID MEASURES

INGESTION	If swallowed, DO NOT induce vomiting. Immediately drink a large quantity of water or milk. Do not give liquids if victim is unconscious. Do not use acidic antidotes or sodium bicarbonate (baking soda). Do not administer alcohol. Call a physician or poison control center immediately.
INHALATION	If exposed to excessive vapor levels, remove to fresh air and seek medical attention if cough or other symptoms develop.
EYE CONTACT	Immediately flush eye with plenty of cool, running water. Remove contact lenses if applicable, and continue flushing for at least 15 minutes. Get medical attention immediately.
SKIN CONTACT	Flush affected skin area with copious amounts of water and wash with soap and water. If irritation develops or persists, get medical attention. Remove clothing and wash before reuse.
NOTE TO PHYSICIAN	Information pertaining to ingestion toxicology, therapy, symptomatology and treatment can be found in Clinical Toxicology of Commercial Products, authored by Gosselin, Smith and Hodge and published by Williams & Wilkins, Baltimore, Maryland. See listing for Hypochlorite in Therapeutics Index, Section III.

SECTION 5 -- FIRE FIGHTING MEASURES

FLASH POINT / METHOD	None / N.A.	FLAMMABLE LIMITS	Not flammable or combustible
EXTINGUISHING MEDIA	If involved in a fire, alcohol foam, carbon dioxide, dry chemical or water fog. Use extinguishing media that is appropriate for surrounding fire.		
SPECIAL FIRE FIGHTING PROCEDURES	Avoid fumes from spilled or exposed liquid. Firefighters should wear full protective clothing and OSHA/NIOSH self-contained breathing apparatus. Cool fire-exposed containers with water spray from a safe distance.		
FIRE AND EXPLOSION HAZARDS	Sodium hypochlorite bleach is a strong oxidizing agent and decomposes when heated. Decomposition products may cause containers to explode. Vigorous reactions may occur with organic materials or oxidizable materials, causing fires.		

SECTION 6 -- ACCIDENTAL RELEASE MEASURES

RESPONSE TO SPILLS	Small spills: Dilute product by flooding area with large quantity of water and flush to sanitary sewer. Large spills: Contain run-off by dyking with suitable material. Soak up liquid on inert absorbent and transfer to approved container. Prevent spill from entering sewers or waterways.

SECTION 7 -- HANDLING AND STORAGE

HANDLING PRECAUTIONS	Wash after handling and before eating. Use personal protective equipment and wear suitable chemical-resistant clothing. Keep container tightly closed when not in use. Follow label directions closely.
STORAGE PRECAUTIONS	Store upright in a cool (below 85 F), dry, well-ventilated area. Keep away from heat or direct sunlight. Separate from incompatible materials, such as acids, ammonia, soap-based products or organic materials. Protect containers from physical damage. Keep away from children.

SECTION 8 -- EXPOSURE CONTROLS / PERSONAL PROTECTION

HYGIENIC PRACTICES	Avoid breathing vapors. Do not store near food stuffs, water or feed. Protect eyes, skin and clothing from contact with this product.
ENGINEERING CONTROLS	Use local ventilation to remove vapors at the source. Facilities using this product must be equipped with an eyewash station.

PERSONAL PROTECTIVE EQUIPMENT

X	RESPIRATOR	Not normally necessary; use NIOSH approved respirator for concentrated vapors
X	GOGGLES / FACE SHIELD	Required; goggles should be chemical splash type. Face shield is best choice
X	APRON	Recommended to avoid skin contact and protect clothing from damage
X	GLOVES	Required; use impervious PVC or Neoprene with long gauntlet
X	BOOTS	Recommended to protect shoes and feet when using product for floor cleaning

SECTION 9 -- PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE	Clear pale yellow liquid	BOILING POINT	212 deg F
ODOR	Chlorine	FREEZING POINT	28 deg F
pH	12.0 - 12.8	VAPOR PRESSURE	17.5 mm Hg @ 20 C
SPECIFIC GRAVITY	1.080	VAPOR DENSITY	Not applicable
SOLUBILITY IN WATER	Complete	EVAPORATION RATE	Not applicable

SECTION 10 -- STABILITY AND REACTIVITY

CHEMICAL STABILITY		STABLE	X		UNSTABLE		
CONDITIONS TO AVOID	Heat or direct sunlight; temperatures above 85 F. NEVER mix with solutions containing ammonia.						
INCOMPATIBILITY	Acids, ammonia, ether, urea, oxidizable materials, soaps, oils, greases, phenolic disinfectants and metals (including nickel, copper, tin, aluminum and iron).						
HAZARDOUS PRODUCTS OF DECOMPOSITION	Chlorine gas -- from contact with highly acidic materials. Chloramines -- from contact with ammonia. Polychlorinated phenols -- from contact with phenolic disinfectants.						
POLYMERIZATION		WILL NOT CCUR	X		UNSTABLE		
CONDITIONS TO AVOID	Not applicable						

SECTION 11 -- TOXICOLOGICAL INFORMATION

CARCINOGENICITY

THIS PRODUCT CONTAINS A KNOWN OR SUSPECTED CARCINOGEN	
X	THIS PRODUCT DOES NOT CONTAIN ANY KNOWN OR ANTICIPATED CARCINOGENS ACCORDING TO THE CRITERIA OF THE NTP ANNUAL REPORT ON CARCINOGENS AND OSHA 29 CFR 1910, Z

OTHER EFFECTS

ACUTE	Toxicity arises from corrosive activity; stems from oxidizing potency, a function of concentration
CHRONIC	Not determined

SECTION 12 -- ECOLOGICAL INFORMATION

BIODEGRADABILITY	CONSIDERED BIODEGRADABLE	X		NOT BIODEGRADABLE	

BOD / COD VALUE	Not established
ECOTOXICITY	No data available

SECTION 13 -- DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD	If in accordance with an NPDES permit or approved by local sewage treatment plant authority, small amounts may be flushed to a sanitary sewer with plenty of water. Large amounts of unused product must be disposed of as hazardous waste at an approved hazardous waste management facility.
RCRA CLASSIFICATION	Hazardous, corrosive D002 (if pH is equal to or greater than 12.5)

RECYCLE CONTAINER	YES	X		CODE	2 - HDPE		NO	

SECTION 14 -- TRANSPORT INFORMATION

DOT CLASSIFICATION	HAZARDOUS			NOT HAZARDOUS	X

DOT Proper Shipping Name	Not regulated as per DOT/IMDG/IATA
Hazard Class	N/A
Identification Number	N/A
Packing Group	N/A
Label/Placard	None
RQ	None
EXCEPTIONS	

SECTION 15 -- REGULATORY INFORMATION

REGULATORY STATUS

EPA REGISTERED (UNDER FIFRA)	No
FDA REGULATED	No
KOSHER	No
SARA TITLE III MATERIAL	Bottled product not regulated
USDA AUTHORIZED	No

SECTION 16 – OTHER INFORMATION

NFPA CLASSIFICATION

1	BLUE	HEALTH HAZARD Federal Specification O-S-602E
0	RED	FLAMMABILITY Commercial Item Description A-1427C
0	YELLOW	REACTIVITY
COR	WHITE	SPECIAL HAZARD

Approved Specifications

Federal Specification O-S-602E
Commercial Item Description A-1427C

Information contained in this MSDS refers only to the specific material designated and does not relate to any process or use involving other materials. This information is based on data believed to be reliable, and the Product is intended to be used in a manner that is customary and reasonably foreseeable. Since actual use and handling are beyond our control, no warranty, express or implied, is made and no liability is assumed by James Austin Company in connection with the use of this information.

Material Safety Data Sheet

PALMOLIVE DISH - ORIGINAL

Infosafe no. CP00U Issue Date August 2005 Status ISSUED by COLGATE

Not classified as hazardous according to criteria of Worksafe Australia

COMPANY DETAILS

Company Name	Colgate-Palmolive Pty Ltd (ACN 002 792 163)
Address	Level 15, 345 George Street, Sydney NSW 2000
Emergency Tel.	1800 638 556
Tel/Fax	Tel: (02) 9229 5600 Fax: (02) 9232 8448

IDENTIFICATION

Product Code		
Product Name	PALMOLIVE DISH - ORIGINAL	
Proper Shipping Name	None Allocated	
Other Names	Name	Manf. Code
	PLD ORIGINAL	
	PLD REGULAR	
	PALMOLIVE DISH - REGULAR	
	PALMOLIVE REGULAR DISH - ORIGINAL	
UN Number	None Allocated	
DG Class	None Allocated	
Packing Group	None Allocated	
Hazchem Code	None Allocated	
Poisons Schedule	Not Scheduled	
Product Use	Household dishwashing detergent.	

Physical Data

Appearance	Clear green viscous liquid.
Melting Point	Not avialable.
Boiling Point	Not available.
Vapour Pressure	Not available.
Specific Gravity	1.020
Flash Point	Not applicable.
Flamm. Limit LEL	Not applicable.
Flamm. Limit UEL	Not applicable.
Solubility in Water	Soluble.

Other Properties

Autoignition Temp.	Not applicable.
Vapour Density	Not avialable.
pH Value	7.0-8.0
Odour	Not available.
Viscosity	400-600 cps (25°C)
Stability	Stable under normal conditions of storage, handling and use.
Materials to Avoid	Strong oxidising agents.

Ingredients

Ingredients	Name	CAS	Proportion
	Ethanol	64-17-5	1-5 %
	Ingredients determined to be nonhazardous		(Balance to 100%)
Information on Composition	A mixture of water and additives.		

HEALTH HAZARD INFORMATION

Health Effects

Acute – Swallowed	Ingestion of this product may irritate the gastric tract causing nausea and vomiting.
Acute - Eye	May cause eye irritation, tearing, stinging, blurred vision, and redness.
Acute - Skin	May cause redness, itching and irritation in senstive individuals.
Acute – Inhaled	Not usually hazardous by inhalation. However, for sensitive individuals inhalation of product vapours may cause irritation of the nose, throat and respiratory system.
Chronic	Prolonged or repeated exposure to this material may result in skin irritation leading to dermatitis.

First Aid

Swallowed	Do NOT induce vomiting. Wash out mouth with water. If symptoms develop seek medical attention.
Eye	If contact with the eye(s) occurs, wash with copious amounts of water holding eyelid(s) open. Take care not to rinse contaminated water into the non-affected eye. If symptoms persist seek medical attention.
Skin	Wash affected area thoroughly with water. If symptoms develop seek medical attention.
Inhaled	First aid measures not usually required. However for sensitive individuals, if inhaled, remove from contaminated area. Apply artificial respiration if not breathing. If symptoms develop seek medical attention.

Advice to Doctor

Advice to Doctor	Treat symptomatically.

Other Health Hazard Information

PRECAUTIONS FOR USE

Exposure Limits

Name	STEL(mgm3)	STEL(ppm)	TWA(mgm3)	TWA(ppm)	FootNote
Ethanol				1000	TWA:ACGIH TWA

Eng. Controls No special engineering controls required.

Personal Protection

Respirator Type (AS 1716)	Generally not required. However for industrial use, reference should be made to Australian Standards AS/NZS 1715, Selection, Use and maintenance of Respiratory Protective Devices; and AS/NZS 1716, Respiratory Protective Devices.
Eye Protection	Generally not required. However for industrial use, reference should be made to Australian Standard AS/NZS 1337 - Eye Protectors for Industrial Applications.
Glove Type	Generally not required. However for industrial use, reference should be made to AS/NZS 2161.1: Occupational protective gloves - Selection, use and maintenance.
Clothing	Generally not required. However for industrial use, wear appropriate clothing including chemical resistant apron where clothing is likely to be contaminated. It is advisable that a local supplier of personal protective clothing is consulted regarding the choice of material.

Flammability

SAFE HANDLING INFORMATION
Storage and Transport

Storage Precautions	Store in a cool, dry, well-ventilated area, out of direct sunlight. Keep containers closed when not in use. Store in suitable, labelled containers.
Transport	Not classified as Dangerous Goods, according to the Australian Code for the Transport of Dangerous Goods by Road and Rail.
Handling	When dealing with this product, repeated or prolonged skin exposure without protection should be prevented in order to lessen the possibility of skin disorders. It is essential that all who come into contact with this material maintain high standards of personal hygiene ie. Washing hands prior to eating, drinking, smoking or using toilet facilities.
Proper Shipping Name	None Allocated

Spills and Disposal

Spills & Leaks

Fire/Explosion Hazard

Hazardous Combustion Products	Not combustible.
Hazardous Decomposition or Byproducts	None known.
Extinguishing Media	Use extinguishing media suitable for surrounding environment.
Hazchem Code	None Allocated

OTHER INFORMATION

Environ. Protection	Prevent large quantities of the material from entering the environment.
Safety Statement	S25 Avoid contact with eyes.

CONTACT POINT

Contact	24Hr Emergency Response - 1800 638 556 The information on this sheet is limited to the material identified and is believed by Colgate-Palmolive Pty Ltd to be correct based on its knowledge and information as of the date noted. Colgate Palmolive Pty Ltd makes no representation, guarantee or warranty, expressed or implied, as to the accuracy, reliability or completeness of the information and assumes no responsibility for injury, damage or loss resulting from the use of the material.

APPENDIX 6

NUTRITIONAL CONTENT OF FRUITS AND VEGETABLES

Food Item	serving	wt	pro	fat	A	Na	Ca	Mg	Zn	K	P	Fe	Ca:P
acerola	1 cup	98	0.4	0.3	75	7	12	18	x	143	11	0.2	1.09 : 1
adzuki beans	1 cup	230	17.3	0.2	1	18	63	120	4.06	1224	385	4.6	0.16 : 1
alfalfa sprouts	1 cup	33	1.3	0.2	5	2	10	9	0.3	26	23	0.32	0.43 : 1
amaranth	1/2 cup	66	1.4	0.1	183	14	138	36	x	423	47	1.49	2.94 : 1
apple, w/o skin	1 med	128	0.2	0.4	6	0	5	4	0.05	144	9	0.09	0.56 : 1
apple, w/skin	1 med	138	0.3	0.5	7	1	10	6	0.05	159	10	0.25	1.00 : 1
apricot	3 med	106	1.5	0.4	277	1	15	8	0.28	313	21	0.58	0.71 : 1
arrowhead	1 med	12	0.5	0	0	2	1	6	x	106	24	0.15	0.04 : 1
artichoke	1 med	300	2.8	0.2	17	79	47	47	0.43	316	72	1.62	0.65 : 1
artichoke hearts	1/2 cup	84	1.9	0.1	12	55	33	33	0.3	221	50	1.13	0.66 : 1
asparagus	1/2 cup	90	2.3	0.3	75	4	22	17	0.43	279	54	0.59	0.41 : 1
avocado, California	1 med	173	3.6	30	106	21	19	70	0.73	1097	73	2.04	0.26 : 1
avocado, Fla	1 med	304	4.8	27	186	14	33	104	1.28	1484	119	1.6	0.28 : 1
bamboo shoots	1/2 cup	76	2	0.2	2	3	10	2	x	405	45	0.38	0.22 : 1
banana	1 med	114	1.2	0.6	9	1	7	33	0.19	451	22	0.35	0.32 : 1
beet greens	1/2 cup	72	1.9	0.1	367	173	82	49	369	654	29	1.37	2.83 : 1
beets	1/2 cup	85	0.9	0	1	42	9	31	0.21	266	26	0.53	0.35 : 1
black beans	1 cup	172	15.2	0.9	1	1	47	121	1.92	611	241	3.6	0.20 : 1
black turtle beans	1 cup	185	15.1	0.6	1	6	103	91	1.41	801	282	5.27	0.37 : 1
blackberries	1/2 cup	72	0.5	0.3	12	0	23	14	0.2	141	15	0.41	1.53 : 1
blueberries	1 cup	145	1	0.6	15	9	9	7	0.16	129	15	0.24	0.60 : 1
breadfruit	1/4 sm	96	1	0.2	4	2	17	24	0.11	470	29	0.52	0.59 : 1
broadbeans	1 cup	171	12.9	0.7	3	8	62	73	1.72	456	212	2.54	0.29 : 1
broccoli	1/2 cup	44	1.3	0.2	68	12	21	11	0.18	143	29	0.39	0.72 : 1
brussels sprouts	1/2 cup	78	2	0.4	56	17	28	16	0.25	247	44	0.94	0.64 : 1
burdock root	1 cup	125	2.6	0.2	0	62	49	x	x	450	116	0.96	0.53 : 1
cabbage, chinese	1/2 cup	35	0.5	0.1	105	23	37	7	x	83	13	0.28	2.85 : 1
cabbage, red	1/2 cup	35	0.5	0.1	1	4	18	5	0.07	72	15	0.17	1.20 : 1
cabbage, savoy	1/2 cup	35	0.7	0	35	10	12	10	x	81	15	0.14	0.80 : 1
cabbage. green	1/2 cup	35	0.4	0.1	4	6	16	5	0.06	86	8	0.2	2.00 : 1
cantaloupe	1 cup	160	1.4	0.4	516	14	17	17	0.25	494	29	0.52	0.59 : 1
carambola	1 med	127	0.7	0.4	62	2	6	12	0.15	207	20	0.33	0.30 : 1
carissa	1 med	20	0.1	0.3	1	1	2	3	x	52	1	0.26	2.00 : 1
carrots	1 med	72	0.7	0.1	2025	25	19	11	0.14	233	32	0.36	0.59 : 1
casaba melon	1 cup	170	1.5	0.2	5	20	9	14	x	257	12	0.68	0.75 : 1
cauliflower	1/2 cup	50	1	0.1	1	7	14	7	0.09	178	23	0.29	0.61 : 1
celery	1 stalk	40	0.3	1	5	35	14	5	0.07	114	10	0.19	1.40 : 1
chard, swiss	1/2 cup	88	1.7	0.1	276	158	51	76	x	483	29	1.99	1.76 : 1
cherimoya	1 med	547	7.1	2.2	5	x	126	x	x	x	219	2.74	0.58 : 1
cherry	10 chs	68	0.8	0.7	15	0	10	8	0.04	152	13	0.26	0.77 : 1
chickory greens	1/2 cup	90	1.5	0.3	360	41	90	27	x	378	42	0.81	2.14 : 1
chickory witloof	1/2 cup	45	0.5	0.1	0	3	x	6	x	82	9	0.23	0.00 : 1
chickpeas	1 cup	164	14.5	4.3	4	11	80	78	2.51	477	275	4.74	0.29 : 1
chives	1 T	3	0.1	0	19	0	2	2	x	8	2	0.05	1.00 : 1
collards	1 cup	190	2.1	0.3	422	36	148	21	1.22	177	19	0.78	7.79 : 1
coriander (cilantro)	1/4 cup	4	0.1	0	11	1	4	1	x	22	1	0.08	4.00 : 1
corn, yellow	1/2 cup	82	2.7	1.1	18	14	2	26	0.39	204	84	0.5	0.02 : 1
cowpeas	1 cup	171	13.2	0.9	3	6	42	91	2.2	476	266	4.29	0.16 : 1
crabapple	1 cup	110	0.4	0.3	4	1	20	7	x	213	17	0.39	1.18 : 1

cranberry	1 cup	95	0.4	0.2	4	1	7	5	0.12	67	8	0.19	0.88 : 1
cucumber	1/2 cup	52	0.3	0.1	2	1	7	6	0.12	78	9	0.14	0.78 : 1
currants, euro. black	1/2 cup	56	0.8	0.2	13	1	31	14	0.15	180	33	0.86	0.94 : 1
currants, red & white	1/2 cup	56	0.8	0.1	7	1	18	7	0.13	154	24	0.56	0.75 : 1
dandelion greens	1/2 cup	28	0.8	0.2	392	21	52	10	x	111	18	0.87	2.89 : 1
dates	10 dts	83	1.6	0.4	4	2	27	29	0.24	541	33	0.96	0.82 : 1
dock	1/2 cup	67	1.3	0.5	268	3	29	69	x	261	42	1.61	0.69 : 1
eggplant	1/2 cup	41	0.5	0	3	1	15	5	0.06	90	13	0.22	1.15 : 1
elderberries	1 cup	145	1	0.7	87	55	x	x	x	406	57	2.32	0.96 : 1
endive	1/2 cup	25	0.3	0.1	51	6	13	4	0.2	79	7	0.21	1.86 : 1
figs	1 med	50	0.4	0.2	7	1	18	8	0.07	116	7	0.18	2.57 : 1
figs	10 figs	187	5.7	2.2	25	20	269	111	0.94	1332	128	4.18	2.10 : 1
french beans	1 cup	177	12.5	1.3	0	11	111	99	1.13	655	181	1.92	0.61 : 1
fruit cocktail	1/2 cup	128	0.5	0.1	26	7	8	7	0.11	112	14	0.36	0.57 : 1
garden cress	1/2 cup	25	0.7	0.2	23	x	x	20	x	x	x	x	0.33 : 1
garlic	3 clvs	9	0.6	0.1	0	2	16	2	x	36	14	0.15	1.14 : 1
ginger root	1/4 cup	24	0.4	0.2	0	3	4	10	x	100	7	0.12	0.57 : 1
gooseberries	1 cup	150	1.3	0.9	44	1	38	15	0.18	297	40	0.47	0.95 : 1
grapefruit (white)	1/2 med	118	0.8	0.1	1	0	14	11	0.08	175	9	0.07	1.56 : 1
grapefruit (pink)	1/2 med	123	0.7	0.1	32	0	13	10	0.09	158	11	0.15	1.18 : 1
grapes (slip skin)	1 cup	92	0.6	0.3	9	2	13	5	0.04	176	9	0.27	1.44 : 1
grapes (adherent skin)	1 cup	160	1.1	0.9	12	3	17	10	0.03	296	21	0.41	0.81 : 1
great northern beans	1 cup	177	15.8	0.8	0	4	121	88	4.55	692	293	3.77	0.41 : 1
green beans	1/2 cup	62	1.2	0.2	41	29	2	16	0.23	0.182	24	0.79	1.21 : 1
guava	1 med	90	0.7	0.5	71	2	18	9	0.21	256	23	0.28	0.78 : 1
guava, stberry	1 cup	244	1.4	1.5	22	89	52	41	x	713	67	0.53	0.78 : 1
honeydew mellon	1/4 cup	100	0.8	0.3	4	12	14	x	x	251	16	0.4	0.88 : 1
hyacinth beans	1 cup	194	15.8	1.1	x	13	77	159	5.53	653	233	8.88	0.33 : 1
jackfruit	3.5 oz	100	1.5	0.3	30	3	34	37	0.42	303	36	0.6	0.94 : 1
java plum	1 cup	135	1	0.3	0	18	25	21	x	106	23	0.25	1.09 : 1
jerusalem artichoke	1/2 cup	75	1.5	0	2	x	10	13	x	x	58	2.55	0.17 : 1
jew's ear (pepeao)	1 cup	99	0.5	0	0	9	16	25	x	42	14	0.55	1.14 : 1
jujube	3.5 oz	100	1.2	0.2	4	3	21	10	0.05	250	23	0.48	0.91 : 1
jute, potherb	1/2 cup	43	1.6	0.1	223	5	91	27	x	237	31	1.35	2.94 : 1
kale	1/2 cup	65	1.2	0.3	481	15	47	12	0.15	157	18	0.59	2.61 : 1
kale, scotch	1/2 cup	65	1.2	0.3	481	14	47	12	0.15	148	18	0.59	2.61 : 1
kidney beans, red	1 cup	177	15.4	0.9	0	4	50	80	1.89	713	252	5.2	0.20 : 1
kiwifruit	1 med	76	0.8	0.3	13	4	20	23	x	252	31	0.31	0.65 : 1
kohlrabi	1/2 cup	82	1.5	0.1	2	17	20	16	x	279	37	0.33	0.54 : 1
kumquats	1 med	19	0.2	0	6	1	8	2	0.02	37	4	0.07	2.00 : 1
lambsquarters	1/2 cup	90	2.9	0.6	873	x	232	x	x	x	41	0.63	5.66 : 1
leeks	1/4 cup	26	0.4	0.1	2	5	15	7	x	47	9	0.55	1.67 : 1
lemon	1 med	58	0.6	0.2	2	1	15	x	0.04	80	9	0.35	1.67 : 1
lentils	1 cup	198	17.9	0.7	2	4	37	71	2.5	731	356	6.59	0.10 : 1
lettuce, iceberg	1 leaf	20	0.2	0	7	2	4	2	0.04	32	4	0.1	1.00 : 1
lettuce, looseleaf	1/2 cup	28	0.4	0.1	53	3	19	3	x	74	7	0.39	2.71 : 1
lettuce, romaine	1/2 cup	28	0.5	0.1	73	2	10	2	x	81	13	0.31	0.77 : 1
lima beans	1 cup	188	14.6	0.7	0	5	52	97	1.87	729	231	4.36	0.23 : 1
lime	1 med	67	0.5	0.1	1	1	22	x	0.07	68	12	0.4	1.83 : 1
longans	31 frts	100	1.3	0.1	x	0	1	10	0.05	266	21	0.13	0.05 : 1
loquats	10 med	100	0.4	0.2	153	1	16	13	0.05	266	27	0.28	0.59 : 1
lupins	1 cup	166	25.8	4.8	x	7	85	90	2.29	407	212	1.99	0.40 : 1
lychees	10 med	100	0.8	0.4	0	1	5	10	0.07	171	31	0.31	0.16 : 1
mammy apple	1/8 med	100	0.5	0.5	23	15	11	x	x	47	11	0.7	1.00 : 1
mango	1 med	207	1.1	0.6	806	4	21	18	0.07	322	22	0.26	0.95 : 1

mothbeans	1 cup	177	13.8	1	2	17	6	184	1.04	538	265	5.56	0.02 : 1
mulberries	1 cup	140	2	0.6	4	14	55	25	x	271	53	2.59	1.04 : 1
mung beans	1 cup	202	14.2	0.8	4	4	55	97	1.7	536	2041	2.83	0.03 : 1
mung beans, sprouted	1/2 cup	52	1.6	0.1	1	3	7	11	0.21	77	28	0.47	0.25 : 1
mungo beans	1 cup	180	13.6	1	6	13	95	113	1.5	416	280	3.14	0.34 : 1
mushrooms	1/2 cup	35	0.7	0.2	0	1	2	4	0.17	130	36	0.43	0.06 : 1
mustard greens	1/2 cup	70	1.6	0.2	212	11	52	10	x	141	29	0.49	1.79 : 1
mustard spinach	1/2 cup	75	1.7	0.2	743	x	158	x	x	x	21	1.13	7.52 : 1
navy beans	1 cup	182	15.8	1	0	2	128	107	1.93	669	285	4.51	0.45 : 1
nectarine	1 med	136	1.3	0.6	100	0	6	11	0.12	288	22	0.21	0.27 : 1
new zealand spinach	1/2 cup	28	0.4	0.1	123	36	16	11	x	36	8	0.22	2.00 : 1
oheloberries	1 cup	140	0.5	0.3	116	2	10	9	x	54	14	0.13	0.71 : 1
okra	1/2 cup	80	1.5	0.1	46	4	50	46	0.44	257	45	0.36	1.11 : 1
onions, spring	1/2 cup	50	0.9	0.1	250	2	30	10	0.22	128	16	0.94	1.88 : 1
onions, spring	1/2 cup	50	0.9	0.1	250	2	30	10	0.22	128	16	0.94	1.88 : 1
onoins	1/2 cup	80	0.9	0.2	0	2	20	8	0.14	124	23	0.29	0.87 : 1
orange, navel	1 med	140	1.4	0.1	26	1	56	15	0.08	250	27	0.17	2.07 : 1
orange, valencia	1 med	121	1.3	0.4	28	0	48	12	0.07	217	21	0.11	2.29 : 1
papaya	1 med	304	1.9	0.4	612	8	72	31	0.22	450	16	0.3	4.50 : 1
parsley	1/2 cup	30	0.7	1	156	12	39	13	0.22	161	12	1.86	3.25 : 1
parsnips	1/2 cup	78	1	0.2	0	8	29	23	0.2	287	54	0.45	0.54 : 1
passion fruit	1 med	18	0.4	0.1	13	5	2	5	x	63	12	0.29	0.17 : 1
peach	1 med	87	0.6	0.1	47	0	5	6	0.12	171	11	0.1	0.45 : 1
pear	1 med	166	0.7	0.7	3	1	19	9	0.2	208	18	0.41	1.06 : 1
peas, green	1/2 cup	80	4.3	0.2	48	2	22	31	0.95	217	94	1.24	0.23 : 1
peas, green	1/2 cup	78	4.2	0.3	50	4	19	26	0.97	190	84	1.15	0.23 : 1
peas, split	1 cup	196	16.4	0.8	1	4	26	71	1.96	710	195	2.52	0.13 : 1
peppers, hot chili	1 pepr	45	0.9	0.1	35	3	8	11	0.14	153	20	0.54	0.40 : 1
peppers, sweet	1/2 cup	50	0.4	0.2	26	2	3	7	0.09	98	11	0.63	0.27 : 1
persimmon	1 med	25	0.2	0.1	x	0	7	x	x	78	7	0.63	1.00 : 1
persimmon, japanese	1 med	168	1	0.3	364	3	13	15	0.18	270	28	0.26	0.46 : 1
pineapple	1 cup	155	0.6	0.7	4	1	11	21	0.12	175	11	0.57	1.00 : 1
pink beans	1 cup	169	15.3	0.8	0	3	88	110	1.63	858	279	3.89	0.32 : 1
pinto beans	1 cup	171	14	0.9	0	3	82	94	1.85	800	273	4.47	0.30 : 1
pitanga	1 cup	173	1.4	0.7	260	5	16	21	x	178	19	0.35	0.84 : 1
plum	1 med	66	0.5	0.4	21	0	2	4	0.06	113	7	0.07	0.29 : 1
pomegranate	1 med	154	1.5	0.5	x	5	5	x	x	399	12	0.46	0.42 : 1
potato, no skin	1 ptto	112	2.3	0.1	x	7	8	24	0.44	6.8	52	0.85	0.15 : 1
pricklypear	1 med	103	0.8	0.5	5	6	58	88	x	226	25	0.31	2.32 : 1
prunes	10 prns	84	2.2	0.4	167	3	43	38	345	626	66	2.08	0.65 : 1
pummelo	1 cup	190	1.4	1	0	2	7	12	0.15	411	32	0.22	0.22 : 1
quince	1 med	92	0.4	0.1	4	4	10	7	x	181	16	0.64	0.63 : 1
radish	10 rdsh	45	0.3	0.2	0	11	9	4	0.13	104	8	0.13	1.13 : 1
raisins, gold seedless	2/3 cup	100	3.4	0.5	4	12	53	35	0.32	746	115	1.79	0.46 : 1
raisins, seeded	2/3 cup	100	2.5	0.5	0	28	28	30	0.18	825	75	2.59	0.37 : 1
raisins, seedless	2/3 cup	100	3.2	0.5	1	12	49	33	0.27	751	97	2.08	0.51 : 1
raspberries	1 cup	123	1.1	0.7	16	0	27	22	0.57	187	15	0.7	1.80 : 1
rice, brown	1 cup	195	4.9	1.2	0	x	23	x	x	137	142	1	0.16 : 1
rice, white, enriched	1 cup	205	4.1	0.2	x	x	21	x	x	57	57	1.8	0.37 : 1
rose apple	3.5 oz	100	0.6	0.3	34	0	29	5	0.06	123	8	0.07	3.63 : 1
roselle	1 cup	57	0.6	0.4	16	3	123	29	x	118	21	0.84	5.86 : 1
rutabaga	1/2 cup	85	0.9	0.2	0	15	36	18	0.26	244	42	0.4	0.86 : 1
sapodilla	1 med	170	0.7	1.9	10	20	36	x	x	328	20	1.36	1.80 : 1
sapote	1 med	225	4.8	1.4	92	21	88	68	x	773	63	2.25	1.40 : 1
shallots	1 T	10	0.3	0	x	1	4	x	x	33	6	0.12	0.67 : 1

soursop	1 cup	225	2.3	0.7	1	31	32	46	x	626	61	1.35	0.52 : 1
soybeans, green	1/2 cup	90	11.1	5.8	14	x	131	x	x	x	142	2.25	0.92 : 1
soybeans, mature	1 cup	172	28.6	15.4	2	1	175	158	1.98	886	421	8.84	0.42 : 1
spinach	1/2 cup	28	0.8	0.1	188	22	28	22	0.15	156	14	0.76	2.00 : 1
squash, summer	1/2 cup	65	0.8	0.1	13	1	13	15	0.17	126	23	0.3	0.57 : 1
stberries	1 cup	159	0.9	0.6	4	2	21	16	0.19	247	28	0.57	0.75 : 1
sugar apple	1 med	155	3.2	0.5	1	15	37	33	x	384	50	0.93	0.74 : 1
sweet potato	1 ptto	114	2	0.1	2488	12	32	23	0.33	397	62	0.52	0.52 : 1
tamarind	1 cup	120	3.4	0.7	4	33	89	110	x	753	136	3.36	0.65 : 1
tangerine	1 med	84	0.5	0.2	77	1	12	10	x	132	8	0.09	1.50 : 1
tofu, okara	1/2 cup	61	2	1.1	0	6	49	16	x	130	37	0.79	1.32 : 1
tofu, raw	1/2 cup	124	10	5.9	11	9	130	127	1	150	120	6.65	1.08 : 1
tomato, green	1 tmto	123	1.5	0.3	79	16	16	13	0.09	0.251	35	0.63	0.46 : 1
tomato, red	1 tmto	123	1.1	0.3	139	10	8	14	0.13	254	29	0.59	0.28 : 1
turnip	1/2 cup	78	0.6	0.1	0	39	18	6	x	106	15	0.17	1.20 : 1
turnip greens	1/2 cup	28	0.4	0.1	213	11	53	9	0.05	83	12	0.31	4.42 : 1
water chestnuts	1/2 cup	62	0.9	0.1	0	9	7	14	x	362	39	0.37	0.18 : 1
watercress	1/2 cup	17	0.4	0	80	7	20	4	x	56	10	0.03	2.00 : 1
watermelon	1 cup	160	1	0.7	58	3	13	17	0.11	186	14	0.28	0.93 : 1
zucchini	1/2 cup	65	0.8	0.1	22	2	10	14	0.13	161	21	0.28	0.48 : 1

Key:
Wt = weight(g)
pro = protein(g)
fat = fat(g)
A = vitamin A(RE)
Na = salt(mg)
Ca = calcium(mg)
Mg = magnesium(mg)
Zn = zinc(mg)
K = potassium(mg)
P = phosphorus(mg)
Fe = iron(mg)
Ca:P = calcium to phosphorus ratio

Obtained from: Jen Swofford's Iguana Pages
URL: http://www.baskingspot.com/iguanas/igbook/table1.html

APPENDIX 7

CALCIUM TO PHOSPORUS RATIOS

Key: The "Ca:P" column gives the calcium to phosphorus ratio of each food item. The ideal Ca:P ratio for a fully grown adult Indian Star Tortoise diet is about 1.25:1 (with 2:1 for growing tortoises).

Food Item	Serving	wt	Ca	P	Ca:P
collards	1 cup	190	148	19	7.79 : 1
mustard spinach	1/2 cup	75	158	21	7.52 : 1
roselle	1 cup	57	123	21	5.86 : 1
lambsquarters	1/2 cup	90	232	41	5.66 : 1
papaya	1 med	304	72	16	4.50 : 1
turnip greens	1/2 cup	28	53	12	4.42 : 1
coriander	1/4 cup	4	4	1	4.00 : 1
rose apple	3.5 oz	100	29	8	3.63 : 1
parsley	1/2 cup	30	39	12	3.25 : 1
amaranth	1/2 cup	66	138	47	2.94 : 1
jute, potherb	1/2 cup	43	91	31	2.94 : 1
dandelion greens	1/2 cup	28	52	18	2.89 : 1
cabbage, chinese	1/2 cup	35	37	13	2.85 : 1
beet greens	1/2 cup	72	82	29	2.83 : 1
lettuce, looseleaf	1/2 cup	28	19	7	2.71 : 1
kale	1/2 cup	65	47	18	2.61 : 1
kale, scotch	1/2 cup	65	47	18	2.61 : 1
figs	1 med	50	18	7	2.57 : 1
pricklypear	1 med	103	58	25	2.32 : 1
orange, valencia	1 med	121	48	21	2.29 : 1
chickory greens	1/2 cup	90	90	42	2.14 : 1
figs	10 figs	187	269	128	2.10 : 1
orange, navel	1 med	140	56	27	2.07 : 1
cabbage, green	1/2 cup	35	16	8	2.00 : 1
carissa	1 med	20	2	1	2.00 : 1
kumquats	1 med	19	8	4	2.00 : 1
new zealand spinach	1/2 cup	28	16	8	2.00 : 1
spinach	1/2 cup	28	28	14	2.00 : 1
watercress	1/2 cup	17	20	10	2.00 : 1
onions, spring	1/2 cup	50	30	16	1.88 : 1
onions, spring	1/2 cup	50	30	16	1.88 : 1

endive	1/2 cup	25	13	7	1.86 : 1
lime	1 med	67	22	12	1.83 : 1
raspberries	1 cup	123	27	15	1.80 : 1
sapodilla	1 med	170	36	20	1.80 : 1
mustard greens	1/2 cup	70	52	29	1.79 : 1
chard, swiss	1/2 cup	88	51	29	1.76 : 1
leeks	1/4 cup	26	15	9	1.67 : 1
lemon	1 med	58	15	9	1.67 : 1
grapefruit	1/2 med	118	14	9	1.56 : 1
blackberries	1/2 cup	72	23	15	1.53 : 1
tangerine	1 med	84	12	8	1.50 : 1
grapes (slip skin)	1 cup	92	13	9	1.44 : 1
celery	1 stlk	40	14	10	1.40 : 1
sapote	1 med	225	88	63	1.40 : 1
tofu, okara	1/2 cup	61	49	37	1.32 : 1
green beans	1/2 cup	62	29	24	1.21 : 1
cabbage, red	1/2 cup	35	18	15	1.20 : 1
turnip	1/2 cup	78	18	15	1.20 : 1
grapefruit (pink)	1/2 med	123	13	11	1.18 : 1
crabapple	1 cup	110	20	17	1.18 : 1
eggplant	1/2 cup	41	15	13	1.15 : 1
garlic	3 clves	9	16	14	1.14 : 1
jew's ear (pepeao)	1 cup	99	16	14	1.14 : 1
radish	10 rdsh	45	9	8	1.13 : 1
okra	1/2 cup	80	50	45	1.11 : 1
acerola	1 cup	98	12	11	1.09 : 1
java plum	1 cup	135	25	23	1.09 : 1
tofu, raw	1/2 cup	124	130	120	1.08 : 1
pear	1 med	166	19	18	1.06 : 1
mulberries	1 cup	140	55	53	1.04 : 1
apple, w/skin	1 med	138	10	10	1.00 : 1
chives	1 T	3	2	2	1.00 : 1
lettuce, iceberg	1 leaf	20	4	4	1.00 : 1
mammy apple	1/8 med	100	11	11	1.00 : 1
persimmon	1 med	25	7	7	1.00 : 1
pineapple	1 cup	155	11	11	1.00 : 1
elderberries	1 cup	145	55	57	0.96 : 1
mango	1 med	207	21	22	0.95 : 1

gooseberries	1 cup	150	38	40	0.95 : 1
jackfruit	3.5 oz	100	34	36	0.94 : 1
currants, euro black	1/2 cup	56	31	33	0.94 : 1
watermelon	1 cup	160	13	14	0.93 : 1
soybeans, green	1/2 cup	90	131	142	0.92 : 1
jujube	3.5 oz	100	21	23	0.91 : 1
cranberry	1 cup	95	7	8	0.88 : 1
honeydew mellon	1/4 cup	100	14	16	0.88 : 1
onoins	1/2 cup	80	20	23	0.87 : 1
rutabaga	1/2 cup	85	36	42	0.86 : 1
pitanga	1 cup	173	16	19	0.84 : 1
dates	10 dtes	83	27	33	0.82 : 1
grapes (adherent skin)	1 cup	160	17	21	0.81 : 1
cabbage, savoy	1/2 cup	35	12	15	0.80 : 1
guava	1 med	90	18	23	0.78 : 1
cucumber	1/2 cup	52	7	9	0.78 : 1
guava, stberry	1 cup	244	52	67	0.78 : 1
cherry	10 chrs	68	10	13	0.77 : 1
lettuce, romaine	1/2 cup	28	10	13	0.77 : 1
casaba melon	1 cup	170	9	12	0.75 : 1
currants, red & white	1/2 cup	56	18	24	0.75 : 1
stberries	1 cup	159	21	28	0.75 : 1
sugar apple	1 med	155	37	50	0.74 : 1
broccoli	1/2 cup	44	21	29	0.72 : 1
apricot	3 med	106	15	21	0.71 : 1
oheloberries	1 cup	140	10	14	0.71 : 1
dock	1/2 cup	67	29	42	0.69 : 1
shallots	1 T	10	4	6	0.67 : 1
artichoke hearts	1/2 cup	84	33	50	0.66 : 1
tamarind	1 cup	120	89	136	0.65 : 1
artichoke	1 med	300	47	72	0.65 : 1
prunes	10 prns	84	43	66	0.65 : 1
kiwifruit	1 med	76	20	31	0.65 : 1
brussels sprouts	1/2 cup	78	28	44	0.64 : 1
quince	1 med	92	10	16	0.63 : 1
french beans	1 cup	177	111	181	0.61 : 1
cauliflower	1/2 cup	50	14	23	0.61 : 1
blueberries	1 cup	145	9	15	0.60 : 1

carrots	1 med	72	19	32	0.59 : 1
loquats	10 med	100	16	27	0.59 : 1
breadfruit	1/4 sm	96	17	29	0.59 : 1
cantaloupe	1 cup	160	17	29	0.59 : 1
cherimoya	1 med	547	126	219	0.58 : 1
fruit cocktail	1/2 cup	128	8	14	0.57 : 1
ginger root	1/4 cup	24	4	7	0.57 : 1
squash, summer	1/2 cup	65	13	23	0.57 : 1
apple, w/o skin	1 med	128	5	9	0.56 : 1
kohlrabi	1/2 cup	82	20	37	0.54 : 1
parsnips	1/2 cup	78	29	54	0.54 : 1
burdock root	1 cup	125	62	116	0.53 : 1
soursop	1 cup	225	32	61	0.52 : 1
sweet potato	1 potto	114	32	62	0.52 : 1
raisins, seedless	2/3 cup	100	49	97	0.51 : 1
zucchini	1/2 cup	65	10	21	0.48 : 1
persimmon, japanese	1 med	168	13	28	0.46 : 1
raisins, gold seedless	2/3 cup	100	53	115	0.46 : 1
tomato, green	1 tomto	123	16	35	0.46 : 1
peach	1 med	87	5	11	0.45 : 1
navy beans	1 cup	182	128	285	0.45 : 1
alfalfa sprouts	1 cup	33	10	23	0.43 : 1
pomegranate	1 med	154	5	12	0.42 : 1
soybeans, mature	1 cup	172	175	421	0.42 : 1
great northern beans	1 cup	177	121	293	0.41 : 1
asparagus	1/2 cup	90	22	54	0.41 : 1
lupins	1 cup	166	85	212	0.40 : 1
peppers, hot chili	1 peppr	45	8	20	0.40 : 1
raisins, seeded	2/3 cup	100	28	75	0.37 : 1
rice, white, enriched	1 cup	205	21	57	0.37 : 1
black turtle beans	1 cup	185	103	282	0.37 : 1
beets	1/2 cup	85	9	26	0.35 : 1
mungo beans	1 cup	180	95	280	0.34 : 1
hyacinth beans	1 cup	194	77	233	0.33 : 1
banana	1 med	114	7	22	0.32 : 1
pink beans	1 cup	169	88	279	0.32 : 1
pinto beans	1 cup	171	82	273	0.30 : 1
carambola	1 med	127	6	20	0.30 : 1

broadbeans	1 cup	171	62	212	0.29 : 1
chickpeas (garbanzos)	1 cup	164	80	275	0.29 : 1
plum	1 med	66	2	7	0.29 : 1
avocado, Fla	1 med	304	33	119	0.28 : 1
tomato, red	1 tomto	123	8	29	0.28 : 1
nectarine	1 med	136	6	22	0.27 : 1
peppers, sweet	1/2 cup	50	3	11	0.27 : 1
avocado, California	1 med	173	19	73	0.26 : 1
mung beans, sprouted	1/2 cup	52	7	28	0.25 : 1
peas, green	1/2 cup	80	22	94	0.23 : 1
peas, green	1/2 cup	78	19	84	0.23 : 1
lima beans	1 cup	188	52	231	0.23 : 1
bamboo shoots	1/2 cup	76	10	45	0.22 : 1
pummelo	1 cup	190	7	32	0.22 : 1
kidney beans, red	1 cup	177	50	252	0.20 : 1
black beans	1 cup	172	47	241	0.20 : 1
water chestnuts, chin.	1/2 cup	62	7	39	0.18 : 1
jerusalem artichoke	1/2 cup	75	10	58	0.17 : 1
passion fruit	1 med	18	2	12	0.17 : 1
adzuki beans	1 cup	230	63	385	0.16 : 1
rice, brown	1 cup	195	23	142	0.16 : 1
lychees	10 med	100	5	31	0.16 : 1
cowpeas (blackeyes)	1 cup	171	42	266	0.16 : 1
potato (no skin)	1 potto	112	8	52	0.15 : 1
peas, split	1 cup	196	26	195	0.13 : 1
lentils	1 cup	198	37	356	0.10 : 1
mushrooms	1/2 cup	35	2	36	0.06 : 1
longans	31 lngn	100	1	21	0.05 : 1
arrowhead	1 med	12	1	24	0.04 : 1
mung beans	1 cup	202	55	2041	0.03 : 1
corn, yellow	1/2 cup	82	2	84	0.02 : 1
mothbeans	1 cup	177	6	265	0.02 : 1

Obtained from: Jen Swofford's Iguana Pages
URL: http://www.baskingspot.com/iguanas/igbook/table2.html

APPENDIX 8

COMMERICALLY AVAILABLE SUPPLEMENTS AND SUPPLIERS

Supplement Manufacturers/Producers

Zoo Med - http://zoomed.com/cm/Home.html

Zoo Med Laboratories Inc.
3650 Sacramento Drive
San Luis Obispo, CA 93401

Office Hours:
8:00 a.m. and 5:00 p.m.
Monday through Friday (Pacific Time).

Our toll free telephone number is (888) 496-6633,
or you can FAX us at (805) 542-9295.

If you are in Europe, please email our European Office: info@zoomed.eu

Please Note: Zoo Med do not sell product directly online, Visit the national retail locator for pet stores in your area (America and Canada only) as well as online retailers (Online Retailers below).

Online Retailers

- PETCO - http://www.petco.com/key/zoomed/page.aspx
- PetSmart - http://www.petsmart.com/search/index.jsp?kwCatId=&kw=zoo%20med&origkw=zoo%20med&sr=1
- LLL Reptile - http://www.lllreptile.com/
- Reptile Direct - http://www.reptiledirect.com/index.asp?PageAction=MFGSEARCH&ManfID=1077&Page=1
- That Pet Place - http://www.thatpetplace.com/pet/product/advancedSearch.web?command=Search&searchParams.keywords=zoo%20med&searchParams.size=10#resultBody
- The Bean Farm - http://www.beanfarm.com/store/agora.cgi?cart_id=531454.29319&product=ZooMed
- Herp Supplies - http://www.herpsupplies.com/search.cfm?searchstring=zoomed
- ReptileSupply.com - http://www.reptilesupply.com/index.php?manufacturers_id=12&rssid=st9epg81pn1s96lpeq2p5tdpf3
- Big Apple Pet Supply - http://www.bigappleherp.com/AQUARIUM-SUPPLIES?search=zoo+med
- Drs. Foster and Smith Pet Supply Retailer - http://www.drsfostersmith.com/Product/NavResults.cfm?N=0&Np=1&Ntt=zoo%20med&Ntx=mode+matchallpartial&Ntk=All&Nty=1&pc=1

Zoo Med Products

Repti Calcium without D3™

Repti Calcium is an ultra fine Precipitated Calcium Carbonate Supplement. It is a phosphorus-free calcium supplement for reptiles and amphibians. It has a unique shape/high surface area per gram resulting in increased calcium bioavailability.

Additional Information:
Highly bioavailable source of calcium carbonate
Free of harmful impurities (not from Oyster Shells)
Safe levels of Vitamin D3
Use with reptiles that are able to meet their Vitamin D3

Product Options
Item Number: A33-3 - Size: 3 OZ
Item Number: A33-8 - Size: 8 OZ
Item Number: A33-12 - Size: 12 OZ
Item Number: A33-48 - Size: 48 OZ

Repti Calcium with D3™

Repti Calcium is an ultra fine Precipitated Calcium Carbonate Supplement with Vitamin D3. It is a phosphorus-free calcium supplement for reptiles and amphibians. It has a unique shape/high surface area per gram resulting in increased calcium bioavailability

Additional Information:
Highly bioavailable source of calcium carbonate
Free of harmful impurities (not from Oyster Shells)
Safe levels of Vitamin D3; Use for additional supplementation

Product Options
Item Number: A34-3 - Size: 3 OZ
Item Number: A34-8 - Size: 8 OZ
Item Number: A34-12 - Size: 12 OZ
Item Number: A34-48 - Size: 48 OZ

Reptivite without D3™

Zoo Med is proud to offer Reptivite without D3™, a complete vitamin, mineral, and amino acid complex specifically formulated for reptiles. Reptivite without D3™, is calcium based to ensure healthy bone growth with the correct 2:1 calcium to phosphorus ratio. Originally developed for the San Diego Zoo to correct soft-shell problems in turtles, it is now used by some of the most respected zoos and animal parks throughout the world. The first reptile vitamin to include the complete amino acid complex, an essential component in protein digestion. Reptivite without D3™, does not contain artificial additives or fillers like soy, yeast, or sucrose.

Additional Information:
Use 2-3 times weekly on your reptile's food.
Reptivite without D3™, on food: Dust lightly over vegetables, fruits or turtle paste.
Reptivite without D3™, on insects: Dust lightly over insects

Product Options
Item Number: A35-80 - Size: 5 LBS
Item Number: A35-40 - Size: 2 1/2 LBS
Item Number: A35-16 - Size: 16 OZ
Item Number: A35-8 - Size: 8 OZ
Item Number: A35-2 - Size: 2 OZ

Reptivite with D3™

Zoo Med is proud to offer Reptivite™, a complete vitamin, mineral, and amino acid complex specifically formulated for reptiles. Reptivite™ is calcium based to ensure healthy bone growth with the correct 2:1 calcium to phosphorus ratio. Originally developed for the San Diego Zoo to correct soft-shell problems in turtles, it is now used by some of the most respected zoos and animal parks throughout the world. The first reptile vitamin to include the complete amino acid complex, an essential component in protein digestion. Reptivite™ does not contain artificial additives or fillers like soy, yeast, or sucrose.

Additional Information:
Use 2-3 times weekly on your reptile's food.
Reptivite on food: Dust lightly over vegetables, fruits or turtle paste.
Reptivite on insects: Dust lightly over insects.

Product Options
Item Number: A36-80 - Size: 5 LBS
Item Number: A36-40 - Size: 2 1/2 LBS
Item Number: A36-16 - Size: 16 OZ
Item Number: A36-8 - Size: 8 OZ
Item Number: A36-2 - Size: 2 OZ

Zilla - http://www.zilla-rules.com

Zilla Products
Central Garden & Pet
9675 South 60th St.
Franklin, WI 53132

You can also reach us M-F 7:00 AM – 4:00 PM CST @ 1-800-255-4527 or write to:

Zilla Products

Calcium Supplement - *Just a spray a day for better bone strength*

- Easy way to add calcium for stronger bones
- Spray-on liquid absorbs easily through reptile foods
- Choose direct droplet feeding for a quick calcium treatment

Be certain that prized reptiles enjoy the extra boost of healthy calcium a UVA and UVB light can't always provide. Use the convenient spray bottle to apply Calcium Supplement to any reptile food (including crickets, mealworms, mice or vegetables) wait 15 seconds and feed as normal. This proven formula is readily absorbed into virtually any reptile or amphibian's bloodstream, assimilated directly into bone tissue. In extreme cases, three drops applied directly to a pet's mouth will effectively treat common calcium deficiencies.

Product - Calcium Supplement 8.0 oz.
Size - 8.0 oz.
Dimensions (inches) - H: 7.37 W: 2.00 L: 2.00
UPC Code - 096316700079
Item # - 100011536

Fluker's - http://www.flukerfarms.com/
Fluker's Farms Customer Care
1333 Plantation Ave
Port Allen, La. 70767-4087
By Phone: Local (225) 343-7035 Toll Free (800) 735-8537
By Fax: (225) 336-0671
By Email: Help@flukerfarms.com

Fluker's Products

Calcium

This dietary supplement for lizards and turtles provides the required calcium to phosphorus ratio your pet needs for strong, healthky bones and vital bodily functions. Recommended for reptiles who eat small amounts of high-phosphorus foods (crickets, mealworms, wax worms, mice).
Price: From $6.44 to $12.50

Repta-Calcium

A premium calcium supplement for lizards, snakes, turtles and frogs, Fluker's Repta-Calcium Dietary Supplement provides the calcium your pet needs for strong, healthy bones and vital bodily functions. Recommended for reptiles or amphibians who eat large amounts of high-phosphorus foods (crickets, mealworms and wax worms).

Price: From $5.50 to $12.17

Repta Vitamin

Flukers Repta-Vitamin is a multi-vitamin containing beta carotene and essential vitamins, amino acids (from pure crystalline form), trace elements and minerals that your pet needs. Contains potent color enhancers to bring out your pets natural beauty.

Price: From $9.53 to $15.73

Liquid Vitamin

Fluker's Liquid Vitamin contains the essential nutrient beta carotene, which reptiles convert to Vitamin A as needed. This premium spray ensures your reptile's proper nutrition by supplying essential multi-vitamins, amino acids, trace minerals and electrolytes that all reptiles need for vital bodily functions and longer, healthier lives. Spray Fluker's Liquid Vitamin onto the food of carnivorous, herbivorous and omnivorous reptiles. Can be used in addition to powder dietary supplements. For best results, use with every feeding. Price: $13.09

Wombaroo
Wombaroo Food Products
PO Box 151
Glen Osmond
South Australia 5064
Ph/fax: (08) 8391 1713
Email: Wombaroo@adelaide.on.net
Web: http://www.wombaroo.com.au

Wombaroo Products

Reptile Supplement
A versatile high protein supplement which can be added to fruits and vegetables, insects, meat or made as soft pellets. Can be fed to all reptiles including tortoises, dragons, lizards and snakes.
Available in 250g, 1kg and 5kg packs

Vetafarm – http://www.vetafarm.com.au
Address: 3 Bye Street, Wagga Wagga, NSW Australia 2650
Postal Address:PO BOX 5244, Wagga Wagga, NSW Australia 2650
Phone: (02) 6933 0400
Fax:(02) 6925 6333
Email: vetafarm@vetafarm.com.au

HERPAVET HERPABOOST 100mL
$17.50

HERPAVET HERPABOOST 1L
$64.70

HERPAVET HERPABOOST 250mL
$25.85

HERPAVET HERPABOOST 500mL
$38.95

HERPAVET HERPABOOST 50mL
$27.05

HERPAVET HERPASHED 100mL
$9.00

HERPAVET HERPASHED 500mL
$14.10

HERPAVET HERPAVITE 50mL
$15.60

HERPAVET MULTICAL DUST 200g
$12.85

SPARK LIQUID CONCENTRATE 125mL
$16.40

SPARK LIQUID CONCENTRATE 250mL
Sl $24.85
1L
$65.55

SPARK LIQUID CONCENTRATE 500mL
$39.30

SPARK LIQUID CONCENTRATE 50mL
$13.20

SPARK LIQUID CONCENTRATE 5L
$208.35

Rep-Cal - http://www.repcal.com/
Rep-Cal Research Labs
P.O. Box 727
Los Gatos, CA
95031
Phone: 1-800-406-6446
408-356-4289

Fax: 408-356-3687

Rep-Cal Australia
Phone: 03-9363-6841

Rep-Cal Japan
Phone: 06-6351-2633

Rep-Cal Products

Rep-Cal Herptivite Multivitamin
Vitamin A requirement from Beta Carotene

Rep-Cal's HERPTIVITE is a superior multi-vitamin, multimineral and amino acid food supplement developed from the latest findings in reptile and amphibian nutritional research. Its formulation contains all natural source ingredients with a base of "sea vegetation." Unlike other companies which use non-nutritional "bases," Rep-Cal's "sea vegetation" base is rich in essential trace elements and minerals. Furthermore, HERPTIVITE contains precise levels of vitamins and minerals combined in perfect balance to ensure correct utilization of protein and other essential nutrients for growth, reproduction, maintenance and many aspects of your reptile's bodily functions. HERPTIVITE is the first reptile vitamin without Vitamin A. Instead we use Beta Carotene which is an anti-oxidant that is converted into Vitamin A in a regulated way, so there is no threat of Vitamin A toxicity. Make Rep-Cal's HERPTIVITE the dietary supplement of choice for your reptiles.

Size	Item #	UPC #
Herptivite Multivitamin		
3.2 oz	300	7-88286-00300-6
6 lbs	310	7-88286-00310-2

Dosage: We ask that you mix Rep-Cal with our vitamin supplement Herptivite. If we premixed the products, the "beadlets" of beta carotene in Herptivite may possibly be damaged during manufacturing by the calcium in Rep-Cal. Mix with vegetables, fruits, and pastes approximately 1/2 tablespoon Rep-Cal with 1/2 tablespoon Herptivite per pound of food.
Before feeding insects:
1) Thoroughly mix a 1:1 ratio of Rep-Cal and Herptivite in a plastic bag.
2) Place insects in the bag.
3) Shake slowly until they are completely covered.
No other supplementation is required. Contains no added starch, sugar, soy preservatives, artificial coloring, flavoring, or fragrance. Consult your veterinarian for any special nutritional problems or advice.

Rep-Cal Calcium with Vitamin D3
Phosphorous - Free Original powder

Rep-Cal Original Powder is an excellent source of calcium for all reptiles and amphibians. Scientifically formulated from 100% natural Oyster Shell phosphorous-free calcium carbonate with added Vitamin D3 to aid in the absorption of calcium.

Size	Item #	UPC #
Calcium with Vitamin D3 Original Powder		
5.2 oz	100	7-88286-00100-2
8 lbs	110	7-88286-00110-2

Dosage: We ask that you mix Rep-Cal with our vitamin supplement Herptivite. If we premixed the products, the "beadlets" of beta carotene in Herptivite may possibly be damaged during manufacturing by the calcium in Rep-Cal. Mix with vegetables, fruits, and pastes approximately 1/2 tablespoon Rep-Cal with 1/2 tablespoon Herptivite per pound of food.
Before feeding insects:
1) Thoroughly mix a 1:1 ratio of Rep-Cal and Herptivite in a plastic bag.
2) Place insects in the bag.
3) Shake slowly until they are completely covered.
No other supplementation is required.

Rep-Cal Calcium with Vitamin D3

Phosphorous - Free Ultrafine powder

Rep-Cal Ultrafine (fine grind) is an excellent source of calcium for all reptiles and amphibians. Scientifically formulated from 100% natural Oyster Shell phosphorous-free calcium carbonate with added Vitamin D3 to aid in the absorption of calcium.

Size	Item #	UPC #
Calcium with Vitamin D3 Ultrafine Powder		
4.1 oz	200	7-88286-00200-9
7 lbs	210	7-88286-00210-2

Dosage: We ask that you mix Rep-Cal with our vitamin supplement Herptivite. If we premixed the products, the "beadlets" of beta carotene in Herptivite may possibly be damaged during manufacturing by the calcium in Rep-Cal. Mix with vegetables, fruits, and pastes approximately 1/2 tablespoon Rep-Cal with 1/2 tablespoon Herptivite per pound of food.
Before feeding insects:
1) Thoroughly mix a 1:1 ratio of Rep-Cal and Herptivite in a plastic bag.
2) Place insects in the bag.

3) Shake slowly until they are completely covered.
No other supplementation is required.

Rep-Cal Calcium *Phosphorous Free - No Vitamin D3*

Calcium deficiency is a major dietary problem of captive reptiles and amphibians. Maintaining a proper calcium:phosphorous (Ca:P) ratio in the diet of 1.5:1 is believed to be just as important nutritionally as an adequate Ca intake. The problem in most cases is an improper Ca:P ratio, not too little Ca.

Ca:P ratios of common cultured food items are shockingly poor:

	Calcium	Phosphorous
Crickets	0.13	1
Meal Worms	0.06	1
Wax Worms	0.08	1
Pinky Mice	0.89	1

Using a calcium supplement that also adds phosphorous makes no sense as an adequate Ca:P ratio can never be achieved. Bone meal contains phosphorous. Rep-Cal contains only 100% Natural phosphorous-free oyster shell Calcium Carbonate for its calcium source.

Size	Item #	UPC #
Calcium No Phosphorous - No Vit D3		
4.1 oz	220	7-88286-00220-7
7 lbs	225	7-88286-00225-2

Dosage: Mix with vegetables, fruits and pastes approximately 1/2 to 1 tablespoon per pound of food.
To coat insects:
1) Place insects and calcium powder in a plastic bag.
2) Shake slowly until insects are completely covered.

Contains no added starch, sugar, soy, preservatives, artificial coloring, flavoring, or fragrance. Do not use if tamper proof seal is broken or missing. Consult your veterinarian for any special nutritional problems or advice.

Vetark - http://www.vetark.co.uk/
VETARK PROFESSIONAL,
PO Box 60,
Winchester, SO23 9XN

tel: 44 (0)1962-844316
fax: 44 (0)1962-877412
Contact us at: info@vetark.co.uk

Vetark Products (No Prices given online)

ON-FOOD VITAMINS

The key product is Nutrobal, this vitamin/mineral dusting powder is used worldwide by vets to correct dietary imbalances and by herpetologists for routine supplementation of growing reptiles and amphibia.

As animals grow to adulthood and their calcium needs fall then we suggest ARKVITS which also supplies significant levels of vitamins A, C and E which help in stressful times such as breeding.

ACE-High is a specialist supplement used to correct deficiencies in vitamin A, C or E, or when animals are especially stressed. it is a component of ARKVITS.

IN WATER SUPPLEMENTS

We also have a liquid multivitamin (BSP drops) for addition to the water, although whenever possible we recommend the use of a powdered vitamin mineral mix in the food.

Zolcal D is a very useful product. It is a combination of liquid calcium and vitamin D3 and is ideal for any situation where you may wish to dose directly or dose the drinking water.

Calcium lactate is also available, purely as a calcium source for supplementation where sufficient vitamin D3 is available from other sources.

Exo Terra - http://www.exo-terra.com/en/products/nutrition.php

For Retailers (No Address or email details given online)

Please contact:

- Canada: Rolf C. Hagen Inc., Montreal, QC H9X 0A2

- U.S.A.: Rolf C. Hagen (U.S.A.) Corp., Mansfield, MA. 02048
- U.K.: Rolf C. Hagen (U.K.) Ltd., Castleford, W. Yorkshire WF10 5QH
- France / Belgium: Hagen France SA., F-77388 Combs la Ville
- Deutschland: HAGEN Deutschland GmbH & Co. KG, 25488 Holm
- Malaysia: Rolf C. Hagen (SEA) SDN, 43200 Cheras, Selangor D.E., Malaysia
- España: Rolf C. Hagen España S.A., Av. de Beniparrell n.11 y 13, 46460 Silla, Valencia
- **Česká Republika:** Placek, s.r.o. Revoluční 1381/III, 290 01, Poděbrady
- Other European countries: HAGEN Deutschland GmbH & Co. KG, 25488 Holm
- All other countries: Rolf C. Hagen Inc., Montreal, QC H9X 0A2 (Canada)

4.10 No other ordering details given, except "Product related questions or problems

1. Always contact your local store first to help you out.

2. If your local store can not answer your question or resolve your problem you can post your issue on the customer service database. They will respond within 24h."

Unable to access Customer Service Database.

Exo-Terra Products

Sepia Bones

Exo Terra Sepia Bones are an excellent calcium source for reptiles and amphibians. The Exo Terra Sepia Bones can be used whole as a supplementary calcium source for terrapins, turtles and tortoises, the rough edible surface helps to trim the beaks of tortoises, turtles and terrapins as well as preventing unwanted chewing behaviour. They float making them ideal for aquatic turtles as well as being suitable for all types of lizards. The Exo Terra Sepia Bones can also be cut into smaller pieces or ground into a powder and used as a nutritional supplement for lizards such as geckos, agamas, iguanas, skinks, monitors, tegus etc.

- Excellent source of calcium
- Floats - ideal for aquatic turtles
- Helps trim beaks in tortoises, turtles and terrapins
- Suitable for all types of lizards

Calcium – Liquid Calcium Supplement

The chemical treatment of tap water, which makes it suitable for human consumption, leaves toxic residues of chlorine and chloramine in the water. Minute traces of toxic metals also make tap water unsafe to reptiles and amphibians. Always treat tap water with Calcium drinking water conditioner.

Calcium contains high levels of Calcium. Calcium deficiency is the major dietary problem in captive reptiles and amphibians.

- Removes Chlorine & Chloramine
- Neutralizes heavy metals
- Replenishes Calcium levels
- Prevents hypocalcaemia

Electrolyte – Electrolyte and Vitamin D3 Supplement

Electrolytes are minerals (magnesium, potassium, sodium, and calcium) that are lost through forms of dehydration, particularly in stress situations. Electrolyte maintains a balanced electrolyte flow within body fluids and supplies Vitamin D3 for proper calcium absorption. Vitamin D3 is vital for captive reptiles not exposed to UV-light to prevent or reverse metabolic bone disease.

- Restores and maintains electrolyte levels
- Prevents or reverses metabolic bone disease
- Helps in re-hydrating stressed animals
- Stimulates appetite, activity and normal behavior
- Strengthens the immune system

AristoPet - http://www.aristopet.com.au/?page=73

For information on any of our Aristopet Products contact Aristopet Sales by Phone, Fax, Post or email.
**This contact is designed for Trade and Wholesalers.*

Address: 874 Kingsford Smith Dr
Eagle Farm Q 4009
Postal: PO Box 2
Fortitude Valley Q 4006
Phone: +61 7 3630 2166
Fax: +61 7 3630 2177
Email: sales@aristopet.com.au

Aristopet Factory:
Address: 118 Links Ave South
Eagle Farm Q 4009
Phone: +61 7 3216 4100
Fax: +61 7 3868 1133
Email: factory@aristopet.com.au

AristoPet Products

170g Repti-Cal

200g Repti-Vite

Komodo - http://www.komodoproducts.com
If you would like to contact us to discuss Komodo reptile care products please use this email address: info@komodoproducts.com

Distributed by:
Underworld Products
Belton road west
Loughborough
LE11 5TR
www.underworldproducts.co.uk

Komodo Products

Komodo Calcium Supplement for Herbivores
Komodo Calcium Supplement For Herbivores contains a broad spectrum of vitamins and minerals with extra calcium and phosphorus to help
provide a balanced diet for herbivorous animals.

It is the ideal supplement for vegetarian animals
receiving natural or artificial UVB light and therefore requiring minimal levels of additional D3. Herbivore
Supplement is specially designed to apply to fresh vegetables and fruit.
CALCIUM SUPPLEMENT For Herbivores
105g CODE: 45400

Komodo Calcium Supplement with Vitamin D3
Komodo Calcium Supplement with Vitamin D3 is a superior high potency product designed to help provide a balanced diet and specifically formulated to aid in the prevention of conditions such as Metabolic Bone Disease, soft shell and other nutritional disorders.

Developed with the assistance of veterinary medical research and professional herptoculturilists. Expressly designed to provide safe and effective levels of D3 with a broad spectrum of additional vitamins and calcium for the widest range of reptiles and amphibians.

Particularly recommended by herpetologists for use with many species of tortoise.

CALCIUM SUPPLEMENT With Vitamin D3
115g CODE: 45408

Euro Rep - http://www.eurorep.net/
EURO REP LIMITED
The Cottage in the Wall, Dawley Road, Hayes, Middlesex UB3 1EF. UK.
sales@eurorep.co.uk 020 8573 4311

Euro Rep Products

Medivet. Reptavite. 100g

Medivet. Reptavite. 500g

Medivet.Pure Calcium Carbonate. 250 gram

Medivet. Repton.100g

Terra Tetra Fauna
http://www.tetra-fish.com/sites/tetrafish/catalog/ProductCategory.aspx?id=1276&cid=148

AUSTRALIA
MasterPet Australia
Sydney
1300 651 111

NEW ZEALAND
MasterPet New Zealand
Wellington
570-3232

Tetrafauna Products

ReptoCal™
2.12 oz
A powdered calcium and vitamin D2 supplement for all reptiles. The fine grade powder easily dusts, coats and adhere to feeder insects, rodents and fresh vegetation. ReptoCal provides a trace amount of phosphorus to ensure proper calcium utilisation.

ReptoLife™ Plus
1.76 oz
A powdered nutritional supplement providing vitamins, minerals, snit-oxidants, amino acids and natural colour enhancing ingredients. A perfect compliment for ReptoCal (you can alternate these two supplements to your reptile's staple diet. ReptoLife Plus can be sprinkled directly over your reptile's food or used to gut-load live insects.

T-Rex – http://www.t-rex.com

For general Customer Service needs and/or comments,
feel free to call: 800.991-T-REX(8739)
For any Sales needs please contact one of our
Customer Service Representatives

Josh Wright - Southeastern Sales Representative
813-610-0272 / Josh@t-rexproducts.com

Sara Beauchamp - Midwestern Sales Representative
619-694-8305 / Sara@t-rexproducts.com

Rachel Botterman - Western Sales Representative
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Fanny Hanano - Logistics Manager
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Jon Coote - Director of Research & Development
jgcoote@aol.com
Alan Botterman - President
619 482-4424 / alan@t-rexproducts.com
T-Rex Products

T-REX 2:1 CALCIUM SUPPLEMENT
Scientifically formulated to provide 2 to 1 ratio of calcium to Phosphorus required by herbivorous reptiles.

T-Rex 2:1 provides both minerals and vitamins in one easy to use product. 2:1 is designed for use with herbivorous reptiles whose vegetable diets may lack phosphorus and calcium. Scientifically formulated to provide the proper 2:1 ratio of calcium to phosphorus required by these animals. 2:1 is highly palatable, easily absorbed and cost effective.

Directions For Use:
Juvenile: Sprinkle generously on moistened food once daily.
Adult: Add one to two teaspoons two to three times weekly to moistened food.

Size: 60 grams & 240 grams

T-REX SANDFIRE FOODS - TORTOISE DUST (VF)

Developed by Alien Repashy (Sandfire Dragon Ranch), these are the first species-specific, all-inclusive, advanced feeding concept for reptiles.

A departure from the status quo in reptile foods, the super foods are made from fresh, human grade ingredients and are not extruded.

Vegetable Formulas

(VF, VGF & VMF) are used as complete diets by Sandfire Dragon Ranch. Species such as Bearded Dragons can now be maintained without ever having to use any live insects, with these growth and maintenance vegetable formulas.

Sandfire Super Foods - Tortoise Dust (VF) 50 grams

APPENDIX 9

TORTOISE HISTORY AND CLINICAL/PHYSICAL EXAMINATION FORM

HISTORY

Client's Name_____

Address_____
_____

Telephone No. _____

Tortoise Name_____

Tortoise Species_____

Sex_____

Approx. Age_____

Weight_____

Length_____

Normal Diet _____
_____
_____

Mineral/Vit Sups_____

Recent Worming_____

Number owned_____

How long owned_____

Hib. Date down_____

Hib. Date up_____

Hibernation and over wintering facilities_____
_____

Normal Environment_____
_____
_____

Recent and Related history
_____
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CLINICAL/PHYSICAL EXAMINATION

Jackson Calculation	Normal Over Under
Condition of eyes	Normal Swelling Discharge Cataract
Condition of ears	Normal (swelling/abscess)

Condition of mouth	Normal Erythema Necrosis Jaundice
Condition of nose	Normal Discharge (type)
Condition of skin	Normal Sloughing Exudation Oedema Jaundice Swelliing/abscess/trauma
Condition of shell	Normal Damage (draw) Discharge (type)
Condition of cloaca	Normal Discharge (type/trauma)
General demeanour	Active Hyperactive Lethargic Duration
Digestive system	Normal Vomition Anorexia Diarrhoea Parasites seen

APPENDIX 10

COMMERCIALLY MADE INCUBATORS AND SUPPLIERS

KIMANI - http://www.kimani.com.au/repti-hatch_incubator.html

Diana Andersen & Kym Gaunt
P.O. Box 605
Kalamunda
Western Australia 6076

Phone: 08 9291 9795
Mobile: 0416 146 465

Facsimile: 08 9291 3117
Email: kimani@wn.com.au

Repti-hatch Specifications
Dimensions:
490mm high, 450mm wide, 440mm deep

Capacity:
Two shelves- 410mm x 350mm

Construction:

- Professionally constructed. Molded fiberglass. Fully insulated. Aluminium framework finished with white powdercoated steel.
- Fan-forced:
- Heat circulates evenly throughout the unit.
- Thermostatically controlled:
- Fitted with a Kimani heating system- fully sealed element can be wiped over with disinfectant. Extremely accurate and stable.

Digital Microprocessor:

- Advanced models (KM-REP2) fitted with a digital thermostat that facilitates extreme accuracy. This dual display unit allows you to program a target temperature and visually monitor the actual temperature. The thermostat automatically adjusts to variations in ambient temperature to maintain the unit at the target level. See "Accessories" for further information.

Thermometer:

- Supplied with a quality digital thermometer.(KM-REP1 only. Not required for KM-REP2)

Perspex Viewing Door:

- Allows for easy monitoring of egg containers without disturbance.

Can Be Totally Disinfected:

- Quick and simple removal of the electrical panel housing the fan and element allows the unit to be totally disinfected. There are no cracks and crevices to trap bacteria, reducing the possibility of contamination.

Warranty:
Twelve months. Because of the ease of removal of the element and fan, in the event of any parts failure, these can be replaced by post with out the entire unit having to be returned. This results in minimal down-time and eliminates costly servicing and freight.

Repti-hatch 3 Specifications

Dimensions:
570mm high, 920mm wide, 475mm deep

Capacity:

Three shelves- 860mm x 350mm

Construction:

- Professionally constructed. Molded fiberglass. Fully insulated. Aluminium framework finished with white powdercoated steel.

Fan-forced:

- Fitted with two fans. Heat circulates evenly throughout the unit.

Digital Microprocessor:

- Fitted with a digital thermostat that facilitates extreme accuracy. This dual display unit allows you to program a target temperature and visually monitor the actual temperature. The thermostat automatically adjusts to variations in ambient temperature to maintain the unit at the target level. See "Accessories" for further information. Fully sealed element can be wiped over with disinfectant.

Perspex Viewing Doors:

- Allows for easy monitoring of egg containers without disturbance.

Can Be Totally Disinfected:

- Quick and simple removal of the electrical panel housing the fan and element allows the unit to be totally disinfected. There are no cracks and crevices to trap bacteria, reducing the possibility of contamination.

Warranty:

Twelve months. Because of the ease of removal of the element and fans, in the event of any parts failure, these can be replaced by post with out the entire unit having to be returned. This results in minimal down-time and eliminates costly servicing and freight.

BRINSEA - http://www.brinsea.com/products/hmakerr.html

By Post
Station Road
Sandford,
North Somerset.
BS25 5RA

By Phone
0845 2260120 or
+44 1934 823039 from outside UK
OR FAX
01934 820250

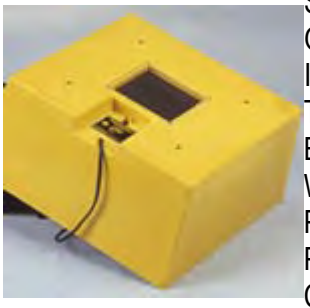
By Email
sales@brinsea.co.uk

Australian Supplier

Top Knot Poultry Supplies
PO Box 222
Deer Park
VICTORIA 3023

AUSTRALIA
Email: loi@tkpoultrysupplies.com.au
Tel: +61 411 720 732 (Australia call 0411-720-732)
Fax: +61 393 528 882 (Australia dial 03 9352-8882)
www.tkpoultrysupplies.com.au

Hatchmaker R



Specifications:
Overall incubator dimensions – 356mm x 356mm x 200mm high
Internal egg chamber dimensions – 280mm x 280mm x 50mm high
Typical egg capacities – Leopard geckos 120, European tortoises 70, Bull snakes 20
Weight – 3.5kg
Power consumption – 30W (max) 15W (typical)
Power supply – 230v 50 Hz, 115 v 60 Hz or 12v d.c. as ordered
Contents – incubator, reptilian incubation chamber, vermiculite, incubation thermometer, user instructions

GQF MANUFACTURING COMPANY INC. - https://www.gqfmfg.com/store/front.asp
2343 Louisville Rd.
Savannah, GA. 31415-1619
Phone: 912-236-0651
Fax: 912-234-9978

Email: sales@gqfmfg.com

Australian Supplier
Brookfield Poultry Equipment PTY LTD
91 McMullen Road
Queensland 4069
Phone: +61 7 33743031
Mobile Phone: 0420-775-313
www.brookfieldpoultryequipment.com
alec@smartchat.net.au

WA Poultry Equipment & Coast to Coast Vermin Traps
ABN 46074312277
1170 Baldivis Rd
Baldivis WA 6171
Phone: +61 8 95241251

Fax: +61 8 95241716
In Australia 1300881170
www.wapoultryequipment.com

Australian shopping cart:
www.wapoultryequipment.net.au

Incubator HovaBator

HovaBator Incubator 60 egg. Manual turn. Made of very dense / hard Poly styrene 220 Volt. This is a very smart incubator that works great. Still air is even better for duck eggs. Has a plastic tray under eggs to stop chicken manure reaching bottom of incubator. Also has water troughs in it to adjust humidity. Can take an auto turner that fits 42 chicken size eggs or 120 quail eggs. Also great for Reptiles

Repti Superhatch Digital Reptile Egg Incubator

Features:

- Digital Temperature Control via Electronic Thermostat - Raise and lower the temperature from 36° F to 140° F with a touch of a button.

- Large Digital LED Readout – Monitors the incubation temperature status as it reaches your pre-selected setting
- Interior LED White Light for interior lighting if needed - On/off switch on front of egg incubator controls the interior light.
- Main On/Off Switch - Switch is on front panel and turns the egg incubator on and off
- Compact, easy to use and very durable
- Slide out shelf to 3 adjustable height levels
- Drip tray for easy cleaning of egg incubator
- Extra Large see-thru window – ideal for observing the incubation process
- Chrome Self Locking Door Handle and Control Buttons
- Whisper quiet operation and very low power consumption
- Carry handle makes it easy to move around
- Lightweight with sleek trim line design

Specifications:
- Interior Dimensions: 9.5" x 10.5" x 14.5"
- Unit dimensions: 13" x 15" x 19"
- Weight: 15 lbs.

CURFEW
Curfew House
4103 Route De Vintimille
Piene Basse
06540 Breil Sur Roya

France

Tel: +33 493 044135
Fax: + 33 493 044947

REPTIPRO
Sparta, KY 41086
support@reptipro.com
859.907.5914

ReptiPro 5000 Digital Egg Incubator, Bird, Snake, Turtle, Tortoise, Lizard

This is one of the least expensive digital incubators on the market today! It heats AND cools, is extremely accurate and simple to use! It has a digital thermostat on the front, interior light and a big viewing window.

- Digital Temperature Control - Raise and lower the temperature from 36° F to 140° F
- Large Digital LED Readout - Monitors the temperature status as it reaches your pre-selected setting
- Interior LED White Light - On/off switch on front of incubator controls the interior light.
- On/Off Switch - Switch is on front panel and turns the unit on and off
- Extra Large see-thru window
- Carry Handle, Chrome Self Locking Door Handle and Control Buttons
- Slide out shelf and drip tray
- Lightweight with sleek trim line design
- Whisper quiet operation
- For home or car – includes 2 adapters

- Unit dimensions: 13" x 15" x 19" Unit weight: 15 lbs.

AVEY INCUBATORS - http://www.aveyincubator.com/reptile_pages.htm

By email: aveyincubator@gmail.com

By phone: 303-719-4253 voice

By fax: 303-328-3897

By US Mail: PO Box 279,
Hugo CO 80821

RCAB200 Reptile Cabinet Incubator

Digital temperature readout. Directly set the temperature on the Alphanumeric display. Hi and Low temperature alarms. Passcode protection. Clear polycarbonate door. The electronics control box lifts off the top of the cabinet for easy cleaning of the cabinet. Hose it, pressure wash it, and easily disinfect it. Outside Dimensions 28.5"x27.5"x16.5". Shelf dimensions: 13"x23.5"

"The Cooler Reptile Incubator" A basic reptile egg incubator with a digital control, hi and low temperature alarms, passcode protection, easy to clean and use. Remembers the last used settings even after being powered off. 3 sizes available. Owners manual included. Great for all but the most demanding eggs.

Small 24 quart cooler
outside dimensions - 17w"x13.5h"x13.5d"
inside dimensions - 14.25w"x9.5h"x9.5d"

Medium 34 quart cooler -
outside dimensions - 21w"x14h"x14d"
inside dimensions - 17.5w"x9.5h"x10.75d"

Large 48 quart cooler
outside dimensions - 23w"x16h"x15d"
inside dimensions - 19w"x11.5h"x11.5d"

APPENDIX 11

MAKING YOUR OWN INCUBATOR

Many incubators available on the high street are quite expensive. A simple, effective, and cheaper alternative is to make your own incubator, and for this you will need the following:

- Polystyrene box with lid (the type in which tropical fish are transported to aquatic centres and pet shops are good)
- Thermostat with probe
- Min/Max thermometer with probe
- Hygrometer (to measure humidity)
- Heat mat (to fit the size of the interior of the box)
- Metal grill or cake rack (cut to size)
- Two house bricks (these help to stabilize the temps within the incubator)

- Two plastic ice cream containers or similar
- Vermiculite

Place the heat mat in the bottom of the polystyrene box.

Run the electric cable from the heat mat up the side of the box. You might need to cut out a small section at the top, just enough for the cable to sit in to ensure the lid fits snugly on top. Alternatively, remove the plug from the cable and insert a small hole in the bottom corner of the box, thread the cable through and re-attach the plug.

Once the heat mat is in place, lay the bricks on their side at each end of the mat, and then place the grill/rack on top of the bricks.

Fill one of the plastic ice cream containers half-way up with vermiculite. This will be where the eggs are placed.

The other container should be part-filled with water, to provide a humidity reading on the hygrometer of around 70%.

The hygrometer may be placed either in the container with the eggs or on the rack.

Make sure you read the instructions on the hygrometer carefully, as it may need to be calibrated before you use it, but this procedure is easy to follow.

PLEASE NOTE: too much water in the container can cause condensation within the incubator, and this is not desirable.

The thermostat/thermometer units are placed outside the incubator.

When everything is set up inside the incubator, you need to make small air holes in the polystyrene lid. First make a hole in the middle: this is for the thermometer and thermostat probes to be threaded through. These probes can be placed directly on to the vermiculite, making sure they do not touch the eggs. By placing them on the vermiculite it will give you a more accurate reading of the incubation temperature of the eggs.

Eggs incubated at between 29.5°C–32°C (85°F–90°F) will usually hatch if fertile, but the best temperature for most species is between 30°C–31.5°C (86°F–88.7°F).

When you have completed the construction described above, your home-made incubator is ready to use.

Obtained From: Tortoise Protection Group. *Making Your Own Incubator*. Accessed Online 5th April 2010. URL: http://www.tortoise-protection-group.org.uk/site/154.asp

APPENDIX 12

HOW TO USE AND SET UP A TORTOISE EGG INCUBATOR

How to use the incubator

Ensure the incubator is placed on a level surface and will be in a permanent position whilst incubating the eggs. It is possible that damage may occur to the delicate membranes and organs of developing embryos caused by accidently bumping the incubator whilst moving it. The incubator should be positioned in an area which is not prone to vast fluctuations in temperature and humidity; so ensure it is not in a draughty environment or in direct sunlight and that it is positioned away from central-heating radiators. Most tortoise eggs will be incubated during the summer months, but sometimes tortoises surprise us and lay their eggs out of season. So remember that in winter, rooms do become very cold at night once the heating is off, and if there is too great a temperature drop, it is possible that the incubator will be unable to maintain a steady temperature. It is important to maintain a steady heat in the incubation room over the full 24-hour period.

Setting up the Incubator

1. The first task is to clean and disinfect the incubator with a proprietary reptile disinfectant such as F10. Set the incubator up at the first signs of the tortoise being gravid to enable the correct temperature and humidity to be established and to check on the normal functioning of the thermostat prior to introducing the eggs.

2. Follow the manufacturer's instructions about setting the temperature. In some still-air incubators, there is quite a large temperature gradient inside. An ideal temperature for tortoise eggs of Mediterranean species is between 30°C and 31.5°C, although a wider range of temperature can be utilised.

In some incubator models the thermometer is situated at the top where the air is warmer; so it is recommended that a separate thermometer, which is suitable for incubators, is placed at egg level to give an accurate reading of egg temperature.

3. After achieving the correct temperature, tape the wall plug over and/or make a small notice saying 'LEAVE ON' so as to avoid accidental switching off.

4. You may wish to consider using an audible temperature alarm so that if there is an alteration in temperature you get an early warning.

5. Humidity assists in balancing out the natural evaporation of fluid from within the egg as the embryonic tortoise develops and the air space increases. To prevent the eggs from drying out too quickly or losing sufficient water, keep the water tray topped up with warm water. Too much humidity at the wrong time is just as bad for a developing egg as is too dry an environment. Approximate humidity levels should be around 70%.

(N.B. Please note that this article deals only with the incubation of tortoise eggs and not the eggs of aquatic species, which need a humidity level of around 90%).

It is interesting to note that of the 20 breeders that responded to the survey only 8 use a hygrometer to accurately measure humidity. Although not asked, breeders included in their responses a statement acknowledging that they either filled a tray or a bowl of water inside the incubator for humidity. Even though some the breeders on the TPG list do not use a hygrometer, the importance of getting a correct humidity level, by the use of one to ensure normal egg development, is to be recommended for the novice. Thus if the incubator does not have a hygrometer you should consider purchasing one separately. A Haar Synth hair hygrometer is one that is recommended by several of the TPG approved breeders.

6. If ventilation holes/grills aren't provided the incubator lid must be opened daily to allow oxygen to circulate. Eggs require a suitable flow of air to supply enough oxygen for the embryos to develop and for the carbon dioxide which has been produced to be removed. The humidity and the temperature inside the incubator will be affected by opening it up, so this should be done quickly and left open for no more than 30 seconds to minimise temperature and humidity fluctuations.

7. Do check the incubator frequently to ensure that nothing has been placed on top of the incubator to interfere with airflow.

To summarise

The important factors to note for successful incubation are:

- Sanitation of equipment
- Appropriate still air incubator
- Suitable environment
- Stable temperature
- Correct Humidity
- Good air flow

Obtained From: Tortoise Protection Group. *Making Your Own Incubator*. Accessed Online 5th April 2010. URL: http://www.tortoise-protection-group.org.uk/site/156.asp