Husbandry Guidelines for

Titan Stick Insect
Acrophylla titan

Insecta: Phasmatodea: Phasmatidae

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DISCLAIMER

These husbandry guidelines were produced by the compiler/author at TAFE NSW – Western Sydney Institute, Richmond College, N.S.W. Australia as part assessment for completion of Certificate lll in Captive Animals, Course number 18913. Since the husbandry guidelines are the result of student project work, care should be taken in the interpretation of information therein, - in effect, all care taken but no responsibility is assumed for any loss or damage that may result from the use of these guidelines. It is offered to the ASZK Husbandry Manuals Register for the benefit of animal welfare and care. Husbandry guidelines are utility documents and are ‘works in progress’, so enhancements to these guidelines are invited.

WORK HEALTH AND SAFETY RISKS

Risk Category: The titan stick insect (*Acrophylla titan*) is classified as innocuous.

Possible risks: The female titan stick insect has sharp spines on her legs that may draw blood on soft skin if handled incorrectly.

Methods to reduce risks: Wear (rubber) gloves when handling the titan stick insect (TSI). When changing the leaf, let the phasmids walk on to the fresh leaf, so you don't have to handle them.

Biological: Zoonoses (diseases that are transmissible from animals to humans and from humans to animals) such as a virus, fungus or bacteria are potentially present in TSIs. It is very important to always wash your hands with soap before and after handling the phasmids. Make sure you rinse your hands thoroughly before you come in contact with them.
To minimise the risk of any diseases it is important to have good hygiene procedures.

Chemical: Chemicals that might be required to be used in the cleaning and maintenance of the TSIs enclosure include:

- Methyl 4-hydrosybenzoate. This prevents eggs moulding (see Appendix 16.1 MSDS).
- F10 SC – a veterinary disinfectant. This can be used to clean the enclosure. It kills all types of fungi, bacteria and viruses (see Appendix 16.2 MSDS).

It is very important to rinse disinfected surfaces before the TSI comes in contact with them.
Before using any of the chemicals make sure to read the Material Safety Data Sheets (MSDS) specific to the individual chemicals' usage and wear the Personal Protection Equipment (PPE) recommended on the MSDS.

Physical: When cutting browse (leaf) for the phasmids;

- wear PPE; suitable clothing (long sleeved shirts, long pants and closed in shoes) hard helmet and gloves,
- be competent in working with the equipment (like a hand saw),
- make sure you have a safe environment to work in (not next to a busy road or a second person to hold the ladder if you need to get leaf high up the tree).

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1. Introduction

Some of Australians stick insects are among the largest of all insects in the world and the TSI is one of them.
TSIs are mottled greyish-brown, with large chequered hind wings. It is the only species with long, wavy cerci (Brock & Hasenpusch 2009, p. 94).
Females can grow up to 260 mm. For a long time the TSI was considered to be the longest stick insect in Australia, but a few years ago an even longer stick insect was discovered; the *Ctenomorpha gargantuan* (Brock & Hasenpusch 2009, p. 3). The TSI lives mainly in woodland in the coastal regions of eastern Australia.

The TSI was described for the first time by William Sharp Mac Leay in 1826: "This immense insect, which is nearly a foot long, is now for the first time described, although it seems to be not uncommon in New South Wales" (*Annulosa* 2006).

Little is known about most of the 100 or so species found in Australia. It is unfortunate that even basic information about most phasmid species, such as which plants they eat, is rarely recorded. Many species have not been studied for years and some, mainly from the rich rainforest regions of north-east Queensland, are still undescribed (Brock & Hasenpusch 2009, p. ix).

There is not a lot known about the TSI, but in the last few years more research is being done by entomologists (a zoologist who studies insects) on stick and leaf insects, which helps us understand these amazing insects better. It is not known if the TSI is endangered, as there is insufficient sighting history. They are great phasmids to display in zoos to educate people. They are interesting to watch due to their large size and colourful wings and body. Despite this not many zoos in Australia are displaying phasmids.
Some zoos have captive breeding programs for certain insects that are endangered in the wild – such as the Melbourne Zoo with its program for the endangered Lord Howe Island phasmid (*Dryococelus* australis), a large, flightless stick-insect (Gullan & Cranston p. 14). The TSI is not known to be endangered but can be used for research to learn more about phasmids in general.

1.1 ASMP Category

The ASMP Terrestrial Invertebrates TAG is 'Not Evaluated' for the TSI (*Census and Plan* 2012).

1.2 IUCN Category

Not applicable to this species.

1.3 EA Category

Not applicable to this species.

1.4 NZ and PNG Categories and Legislation

Not applicable to this species.

1.5 Wild Population Management

Not applicable to this species.

1.6 Species Co-ordinator

Not currently applicable for invertebrates.

1.7 Studbook Holder

Not currently applicable for invertebrates.

2 Taxonomy

2.1 Nomenclature

Class: Insecta
Order: Phasmatodea/Phasmida
Family: Phasmatidae
Subfamily: Phasmatinae
Genus: *Acrophylla*
Species: *titan*

2.2 Subspecies

No known sub species.

2.3 Recent Synonyms

- *Cyphocrania titan* (Macleay, 1826)
- *Diura titan* (Macleay, 1826)
- *Phasma titan* (Macleay, 1826)
- *Vetillia titan* (Macleay, 1826)

2.4 Other Common Names

- Titan Stick Insect

3 Natural History

There are about 3000 species of phasmids worldwide who live mainly in the tropics. In 2009 there were 101 species of stick insects and three species of leaf insects recognised in Australia. These are only the recognised species, there are likely more to be discovered.
Their main mechanism of defence is their ability to remain motionless, resembling sticks or leaves, which can make them difficult to find (Brock & Hasenpusch 2009, p. 1).

Stick insects are by far the longest insects in the world, several species measuring close to, or over, half a meter when their outstretched legs are included (Brock & Hasenpusch 2009, p. 1).

The Australian stick and leaf insect fauna (although less than four per cent of the global richness) includes many of the most striking phasmid species found anywhere in the world.
It is fortunate these insects still survive, as widespread clearing of habitat in the past had changed the Australian landscape and adversely affected the numbers of insects in general. It is pleasing that farmers and other individuals and organisations, supported by government policies, are keen on habitat conservation (Brock & Hasenpusch 2009, p. 2).

When the TSI is disturbed, it might drop to the ground and walk away rapidly to find suitable cover. Both males and females may flash their wings and hold them open for several seconds. Males are good fliers and the mottled wing pattern forms an excellent camouflage (Brock & Hasenpusch 2009, p. 94).

The TSI holds the record for number of eggs laid (over 2050) in captivity by any phasmid.

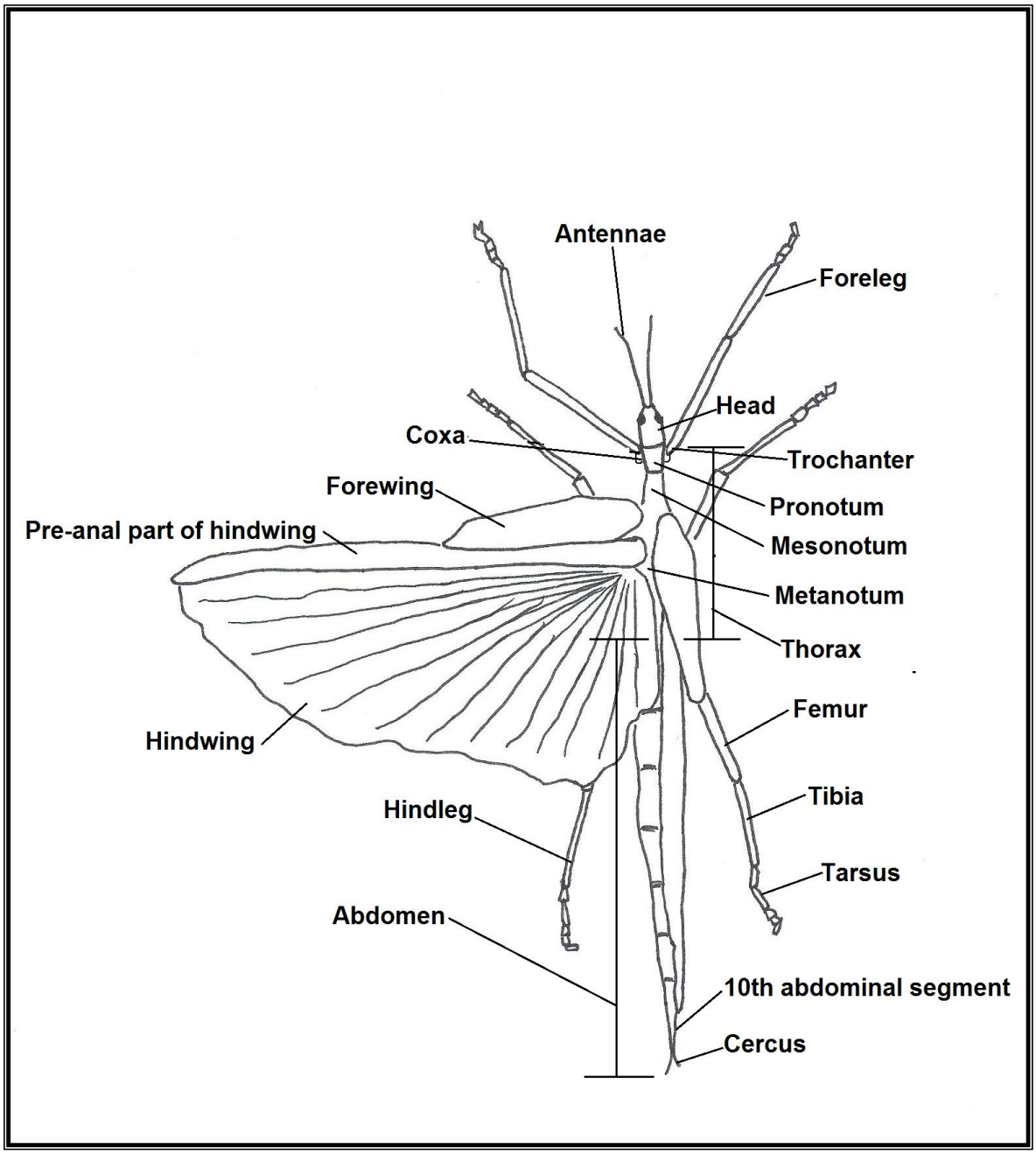


Figure 1: Basic Phasmid Anatomy (Veenstra 2013).

3.1 Measurements

3.1.1 Mass and Basic Body Measurements

Mass:

- Male: Approximately 10g.
- Female: Approximately 15g.

Body Length:
Head to tip of abdomen:

- Male: 135 – 150 mm.
- Female: 200 – 260 mm.

(Brock & Hasenpusch 2009, p. 94)

First segment of thorax:

- Male: 30mm.
- Female: 35 mm.

(Chew, 2009)

Abdomen:

- Male: 80mm.
- Female: 110 mm.

(Chew, 2009)

Legs:

- Male: Approximately 70mm.
- Female: Approximately 90mm.

(Chew, 2009)

Antennae:

- Male: Approximately 70 mm.
- Female: Approximately 35mm.

(Chew, 2009)

Wings:

- Male:

Forewings: 23mm long and covering part of the hind wings.
Hind wings: 60mm long and covering ⅔ of the abdomen.

- Female:

Forewings: 30mm long and covering part of the hind wings.
Hind wings: 80mm long and covering half of the abdomen.
(Chew, 2009)

3.1.2 Sexual Dimorphism

Males have a characteristic ‘bump’ (sub genital plate) on the underside of their abdomens (see Picture 1), which is absent in females. The operculum in females is boat-like, often fairly flat (see Picture 2). Males are smaller than females (half the size) (Brock & Hasenpusch 2009, p. 12).

Picture 1: Male abdomen (Veenstra 2012).

Picture 2: Female abdomen (Veenstra 2012).

3.1.3 Distinguishing Features

The TSI is mottled greyish-brown, with large chequered hind wings. Its mesonotum has bold conical tubercles and its cerci are rather long and ragged. It could be confused with *Acrophylla enceladus*, but the TSI has a less spiny thorax and more serrate legs. It is the only species with long, wavy cerci (Brock & Hasenpusch 2009, p. 94).

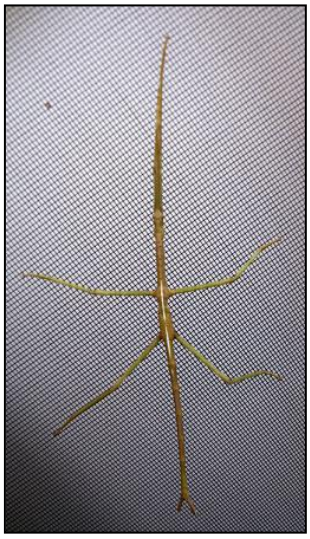
Female:
The general colour of the wings is blackish-brown, but irregularly spotted and banded with white; the costal area is of a greenish-black irregularly spotted with a dull brick-red colour. The forewings serving to cover the hind wings are similar to the last in colour and markings, but with a white spot near the centre of each; the head and prothorax are of a greyish colour; the former has three distinct stemmata in front; the mesothorax is reddish, but with scattered sharp tubercles; the abdomen is orange, with the tip and leaflets of a grey colour, the latter rather short in proportion to those which some species possess, and are quite differently formed from the others, being trigonal and dentated; the legs are also short and very much dentated, but the fore ones are trilateral (Miller, P 2003).

Male:
The male is thinner and broadly similar, with full size wings. The thorax is brownish and the tubercles more numerous and spine-like. Males are very good fliers (Miller, P 2003).

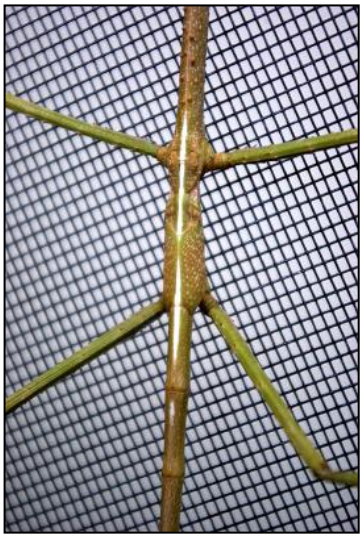
Nymph:
Nymphs are often green, but sometimes brown; there may be a bold white longitudinal stripe along the whole length of the body (Miller, P 2003).

Picture 3: Female TSI (Veenstra 2011).

Picture 4: Male TSI (Veenstra 2013).



Picture 5: Nymph (Veenstra 2012).



Picture 6: White stripe on the Nymphs' body (Veenstra 2012).

3.2 Distribution and Habitat

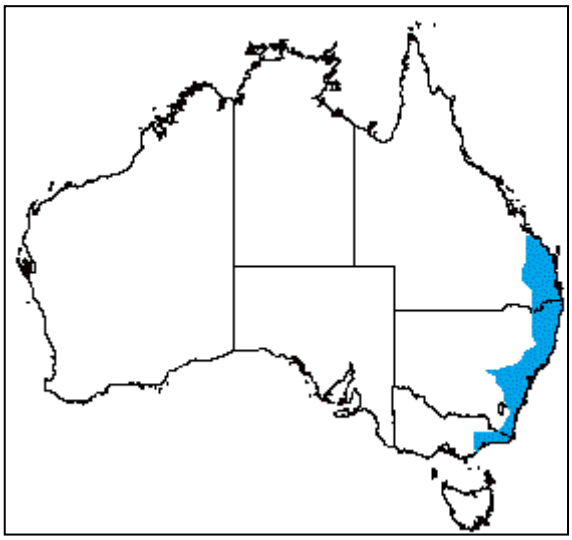


Figure 2: Distribution of *Acrophylla titan* (Veenstra 2012).

TSIs live in the coastal regions of eastern Australia, from South-east Queensland through New South Wales to Victoria. They mainly live in woodland.

It is found on many food plants including *Callistemon rigidus* (Myrtacae) and *Callitris columellaris* (*Cupressaceae*). In captivity it does well on *Acacia, Eucalyptus* and *Leptospermum* species, and in Europe it will feed on *Rubus fruticosus* (Brock & Hasenpusch 2009, p. 94)
It also lives in some garden plants such as raspberries and roses (*Titan Stick Insect (Acrophylla titan)*).

3.3 Conservation Status

The TSI has no IUCN listing.
The ASMP Terrestrial Invertebrates TAG is 'Not Evaluated' for the TSI (*Census and Plan* 2012).

It is not known if this species is endangered, as there is insufficient sighting history (Miller, P 2003).

3.4 Longevity

3.4.1 In the Wild

Longevity in the wild is not known.

3.4.2 In Captivity

The TSI lives for approximately 8-12 months after hatching.

3.5 Techniques Used to Determine Age in Adults

The only way to determine the age of an adult TSI is to know when it hatched and check on the records how old the phasmid is.

Future research
Research needs to be done by recording data about the weight of the TSI, especially during the development stages of the phasmid. The detailed records can be used in the future for people to estimate the age of individual phasmids.

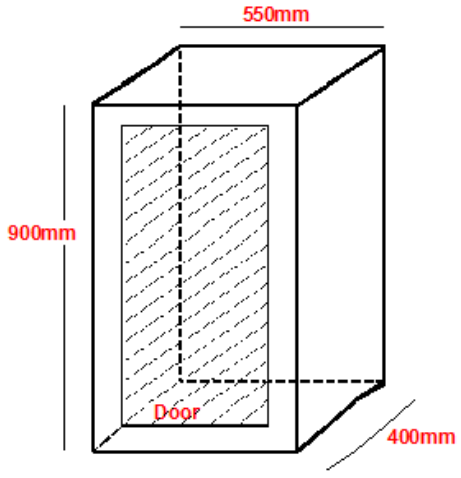
4 Housing Requirements

4.1 Exhibit/Enclosure Design (for both larval and adult stages)

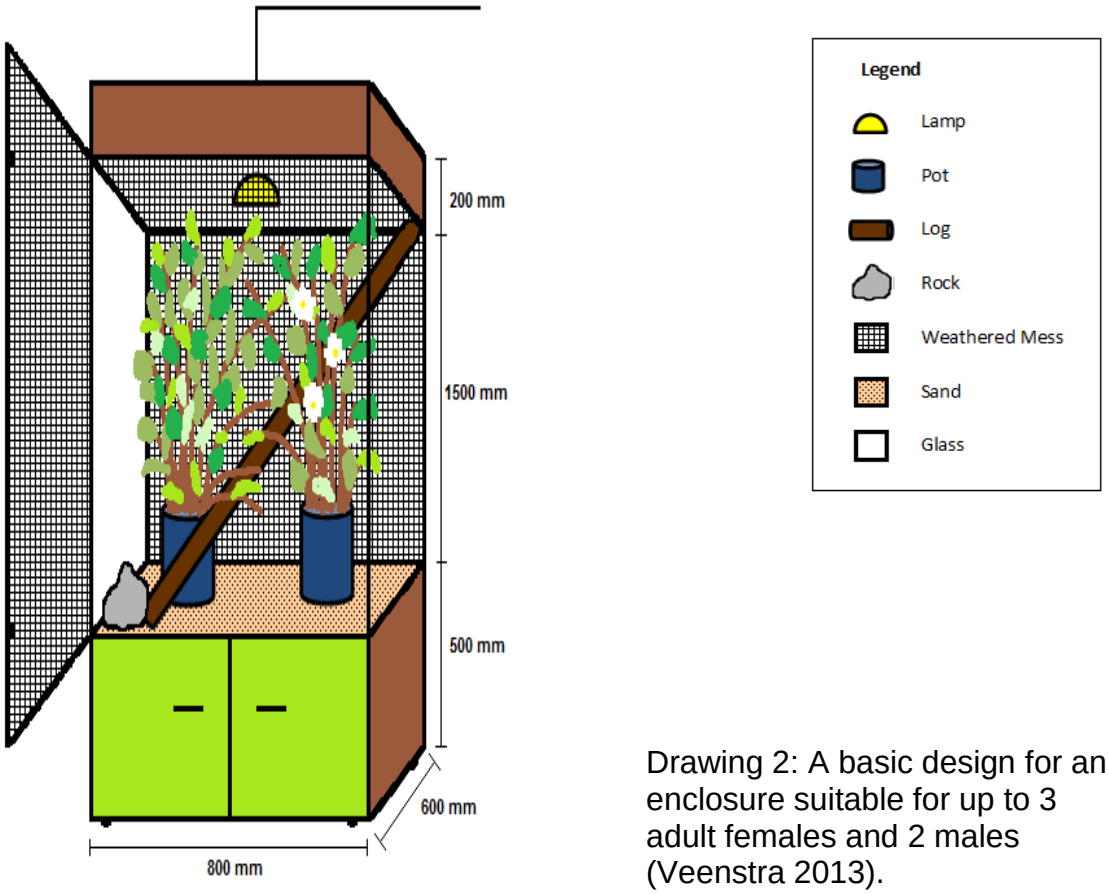
TSIs can be housed in enclosures of any design. The same design can be used for Off Display as well as On Display.
There has to be sufficient space for them to move around, to hang down and for the nymphs it is important that there is enough room to moult. Nymphs and adults can be kept in the same enclosure design. In an enclosure of a certain size you can hold more nymphs than adults, as long as you keep the above requirements in mind.

The enclosure should at least meet the spatial requirements (see Paragraph 4.3), but as that is the minimum standard, there is always room for improvement. It is important to make the enclosure higher than wider or deeper, so the TSI can perform all its natural behaviours. The door must be large enough to transfer cut browse in and out and should open outwards. Sliding doors are not recommended, as the phasmids can get caught in the doors.
The most suitable material for the enclosure are glass, wood and weathered mess. At least one of the walls should be made from weathered mess, to provide suitable ventilation. The base is best made from glass or wood and the same counts for the roof. This way you can avoid direct sunlight coming in.
Make sure that there are no gaps in the enclosure, especially when you have nymphs living in the enclosure. I recommend to check the enclosure daily for gaps and do a full maintenance check every month.

The same enclosure can be used for inside as well as outside. It is important to keep the temperature between 20-28 °C, which might be harder to control outside, especially when you have more than one wall made out of weathered mess. A heat lamp or thermostat is recommended to keep the right temperature.



Drawing 1: An enclosure design with minimum spatial requirements for keeping 2 female adult titan stick insects (Veenstra 2012).



Drawing 2: A basic design for an enclosure suitable for up to 3 adult females and 2 males (Veenstra 2013).

The above design can house up to 3 adult females and 2 adult males.
You can see:

- The measurements of the actual enclosure are: 1500mm high, 600mm deep and 800mm wide. This means you can hold more than two adult female TSIs, but I wouldn't put too many TSIs in this enclosure. They need enough room to hang from the leaves, moult (if they are not mature yet) and they need to be able to move around. Large numbers can also make it difficult to change the plants and if overcrowded it is possible that it reduces the size of the resultant adults. Males are smaller than females (max. 150mm), so you can house more males than females in the enclosure and a large number of nymphs can be kept together provided there is adequate space for them to move around and to moult.
- There is storage room on the bottom of the enclosure that is 50cm high, 60cm deep and 80cm wide. This can be used to store equipment like a spray bottle with water and a spare light bulb.
- The enclosure is made out of (untreated) wood, glass and weathered mess.

- The base and roof are made out of wood. With a wooden roof you can avoid direct sunlight coming in.
- The two sides are made out of glass and the front and back out of weathered mess. The weathered mess makes sure you have enough ventilation, but because of the two glass walls you also keep enough warmth in the enclosure that is suitable for the TSI. I made this design as an indoor enclosure. If you keep the TSI outdoors, I would replace the weathered mess at the back for wood, to minimise the exposure to weather extremes.
- The roof is made out of wood with a space underneath of 20cm high, 60cm deep and 80cm wide. In this space you can hang a light bulb. The underside of the space is covered with weathered mess to protect the TSIs from the light bulb.
- The door is large enough to transfer cut browse in and out and is opening outwards. The door has two locks and by using padlocks you prevent people getting in without permission.
- Most stick insect enclosures are indoors, because it makes it easier to maintain a temperature setting of 20-28 degrees. With an indoor enclosure it doesn't really matter which way the opening is facing. Except maybe when the enclosure stands in a room with a door that opens a lot and causes wind to blow in every time. In that case I recommend to have the glass side towards the door.
- If this enclosure would be outside, the opening of the enclosure should be facing north east, to minimise exposure to weather extremes. The wooden back and roof will protect the phasmids from rain, wind and direct sunlight and because the front is made out of weathered mess, the TSI will still get enough ventilation.
- The substrate is sand, which looks natural and you can add leaf litter to give it a more aesthetic appeal. It does make it harder to clean the enclosure, especially when you have to remove all the eggs first.
- The main furnishing of this enclosure is the food plants of the TSI. I've put two big pots in the enclosure with a lid with holes in it. The lid is to prevent the TSI fall in and drown and the holes in the lid are to put the browse through.
- Other furnishings in this design are a log and a rock. The log stands in the middle of the enclosure. The TSIs can use it to move between the browse and it will make the browse stand up straight. The rock looks natural and it will keep the log in place. You can use more small rocks to make it look natural.

Picture 7: Example of an enclosure with the minimum spatial requirements for keeping 2 female adult titan stick insects (Veenstra 2012).

Picture 8 & 9: Examples of enclosures for stick insects (Images taken at Taronga Zoo, Sydney) (Veenstra 2012).

4.2 Holding Area / Off Exhibit Design

There are many Off Exhibit enclosure designs to house your TSI. The spatial requirements (see Paragraph 4.3) are the same as for the On Exhibit enclosure designs. There has to be sufficient space for them to move around, to hang down and for the nymphs it is important that there is enough room to moult. That means the height of the enclosure must be at least three times the maximum length of the phasmids you are housing.
There has to be enough ventilation and the temperature should be between the 20-28 °C. Nymphs and adults can be kept in the same enclosure design.

Examples of enclosures that can be used as a Off Exhibit housing for the titan stick insect are:

- 'small pet' cages (put on the side) (see Picture 10),
- fish-tanks or aquariums with ventilation holes in the lid,
- vivariums with heating equipment,
- plastic plant propagators with variable ventilation settings (some include a built-in heater pad in the base),
- net cages.

(Brock 2000, p.13)

Make sure you don't overcrowd these cages. The 'small pet' cages can only be used for nymphs, as these cages are not meeting the requirements for an adult female titan stick insect.
You can put more nymphs in the different cages than adults, provided there is sufficient space for them to move around and moult.
You can use these enclosures for quarantine, controlled breeding or newly hatched nymphs.

Picture 10: Example of a 'small pet' cage (Veenstra 2012).

Besides the 'ready to go' enclosures there is also the option to design your own Off Exhibit enclosure. The requirements for these are the same as described in Paragraph 4.1.

4.3 Spatial Requirements (EAPA regulations not applicable)

The height of the exhibit must be at least three times the maximum length of the phasmids (Brock 2000, p.14). For two female TSIs with a body length of 260mm, you will need an enclosure at least 900mm high, 400mm deep and 550mm wide (Miller 2006). This is the same for both on and off display.

Relatively large numbers of nymphs can be kept together provided there is adequate space for them to move around and to moult. Large numbers can make it difficult to change the plants and if overcrowded it is possible that it reduces the size of the resultant adults.

4.4 Position of Enclosures

The TSI is mostly kept indoors as the phasmids need a temperature setting of 20-28 °C, it's easier to maintain a suitable environment indoors.

If the enclosure is outside, it's important to minimise exposure to weather extremes. That's why the open end of the enclosure should face north east.

4.5 Weather (and other) Protection

To be able to keep the TSI outside, the enclosure requires shelter to protect the phasmids from rain, wind and direct sunlight.
It's important that the enclosure is well ventilated, so at least one side needs to be open.

The most suitable construction materials for weather protection is hard woods, as these are untreated and will not deteriorate rapidly with weather exposure. Avoid the use of any plastic materials if possible, as these materials may release toxins into the phasmids enclosure. Never use tin as this will heat up too quickly to an unsuitable temperature for you phasmids (Bearman 2007, p. 14).

4.6 Temperature and microclimate Requirements

A temperature setting between the 20-28 °C is suitable for the TSI. The temperature should be lower at night than during the day to mimic natural conditions.

In warmer climates artificial heating is often unnecessary. If it is, you could consider heat pads in the colder months, usually kept beneath the container. They provide an efficient heat source, except through glass or thick wooden bases. Pads can also be kept inside a cage.
Light bulbs are not recommended, because they have the disadvantage of drying up food plants and can burn the TSI. If you want to use a light bulb, make sure you cover it so the TSI can't reach it.

The TSI requires good ventilation. This will also help against the growth of bacterial and fungal agents in the enclosure.

It is important to avoid direct sunlight. You can provide the TSI with filtered sunlight (especially when it's colder), however part of the enclosure should be protected from any sunlight.

Spraying the leaf daily is not only to provide the TSI with droplets to drink from, but also to help the moulting.

4.7 Substrate

Leaf litter, bark, moss or peat give an aesthetic appeal to the enclosure as it looks natural and they are all suitable ground cover. It can involve a bit more work when you clean the enclosure. You need to make sure that all the faeces are removed and that you don't throw away any eggs. Newspaper doesn't look very appealing to the eye, but it makes it easier to clean the enclosure.

4.8 Nest boxes and/or Bedding Material

Not applicable.

4.9 Enclosure Furnishings

Food plants are required as furnishing for the enclosure of the TSI. Branches with suitable leaf are enough for the TSI, as it lives on the food it eats. Make sure you always have fresh browse in a nice pot (covered with a lid) filled with fresh water to make it look aesthetic. The browse should stand up straight, so TSI has enough space to hang from the leaves, to moult, to move around and is able to climb.
There should be enough leaves for the TSI for hiding and resting.

The TSI doesn't need any more furnishing, but if you want to make it look more pleasing to the eye when it's on display, you can use leaf litter and small rocks on the floor to make it look natural. If it is a big enclosure you can use a small log to allow the TSIs move between the browse and to make the browse stand up straight.

Make sure you only use plants that are safe for the TSI and that it can feed on (see Chapter 6 for more information about suitable food plants). I would not advise to add plants that have not been tried successfully as food plants, without prior testing.

Display board:
A display board can be put outside of the enclosure with information about the TSI. The information may include:

- Common and Scientific name,
- Habitat,
- Diet,
- Longevity,
- Breeding habits,
- How many TSIs there are in the enclosure,
- Funny and interesting facts about the TSI.

(See Appendix 16.3 for an example of a Display Board)

5 General Husbandry

5.1 Hygiene and Cleaning

It is important to maintain a high level of hygiene at all times. Always wash your hands with disinfectant hand soap and rinse them well before and after cleaning an enclosure and handling the phasmids. Make sure you clean the equipment (with F10) after every use.

Daily:

- Spray the leaf so it stays fresh and the TSI can drink from the droplets. They need about 4ml of water sprayed daily. The best time to spray is in the afternoon before the TSIs are active and when it's a warm day a second time around noon.
- Collect the eggs, as they have a bigger chance of hatching when you put them in a special box (see Paragraph 11.1 for more information) and you can control the heating.
- Check the temperature to make sure that it's between the 20-28 °C. A thermometer is a good tool to use for this.
- Remove dead specimens and dispose when found.
- Count the phasmids at the end, so you know none escaped.
- Check the enclosure for gaps. If there are any gaps fix this straight away to prevent TSIs to escape. If this is not possible you will have to transfer the TSIs to another enclosure.

Weekly:

- Clean the enclosure: Make sure you dispose of the faeces when cleaning and you collect all the eggs first. Remove all the dead leaves from the floor. You can clean the enclosure with a dustpan and brush and disinfect it with F10SC.
- Scrub the pot with a scrubbing brush and fill it with fresh water and put fresh browse in the pot. It is likely that this needs to be done more often when it's warm. As soon the leaf looks dry you need to replace it. Normally this is about once a week.

Monthly:

- Replace the substrate. Especially with substrates like leaf litter or moss you need to replace this regularly as it dries out or doesn't look appealing anymore.
- Disinfect the enclosure and pot for water. F10SC is recommended for this. It kills all types of fungi (and spores), bacteria and viruses.

Cleaning chemicals can be dangerous for the TSI, so only use chemical agents that you know are safe for the phasmids, like F10SC. Be careful using insecticides in the same room or area of the enclosure, because it kills the TSI.

DAILY	WEEKLY	MONTHLY
Spray leaf	Clean enclosure	Replace substrate
Collect eggs	Scrub pot	Disinfect enclosure
Check temperature	Fresh browse	Disinfect pot
Remove dead specimens		Full enclosure maintenance check
Count phasmids		
Check enclosure for gaps		

Table 1: Exhibit Maintenance Tasks (Veenstra 2012).

(See Appendix 16.4 for a Weekly Checklist)

Maintenance tasks:

- Fix any gaps in the enclosure.
- Replace the pot for water when needed.
- Replace the logs and rocks in the enclosure monthly.
- Check if the lock is still working properly.
- Make sure the roof is not leaking (when outside).

(See Appendix 16.12 for the Annual Cycle of Maintenance)

Methods to clean the enclosure:

- Take the old browse out with the TSIs still on it and put it in a temporary container/enclosure.
- After you cleaned the pot and put the fresh browse in it try to let the phasmids walk from the old browse onto the new browse without handling them.
- Another way to do it is to let the TSI walk on to your hand (don't pull it off the leaf, as it can easy lose one of its legs) and transfer it to the fresh browse.
- If it's an adult TSI or a large nymph you can gently pick it up by the thorax (avoiding the legs), after you have persuaded it to release a leaf or branch by touching the end of its leg, which will be resting on a surface (Brock 2000, p. 19) (for further information about handling the TSI see Chapter 7).

Pest Control Maintenance:

A pest relating to the the TSI is the Subterranean termite (*Coptotermes acinaciformis*). If you have an enclosure that is made out of wood, this pest can form a problem. It can damage the enclosure and become a safety concern for the phasmids.

To prevent this pest regularly inspect places where termites are likely to be. If termites are a problem at your workplace, have a professional inspection done every 6 months. Fix leaking hoses or water taps, as termites are attracted to water.

To eliminate this pest hire a professional termite control service. If the enclosure is infested by termites it might be best to replace it.

Record every pest control measure in the pest control logbook.

A lot of animals that are considered pests to other animals are considered a predator for the TSI. These include ants, spiders and native birds (like the kookaburra). There are also parasites, such as the parasitic flies, wasps and the Tachinidae flies that can be considered as a pest for other animals, but they are a predator to the TSI and they are able to feed on the phasmids (Brock 2003, p.5).

5.2 Record Keeping

It is important to monitor the health, condition and reproductive state of the TSI. That´s why records should be kept of:

- Health problems.
- Movements within and between institutions.
- Reproductive state, condition or behaviour.
- Weight and measurements.
- Veterinary examinations with treatments provided.
- Change in diet.
- Behavioural problems.
- Any observations made.

The following information should be recorded on a daily basis:

ACQ = Acquisition

Any importation from outside the collection, public donation, or capture from grounds or from the wild. Include insect hatching.

D/30 = Death within 30 days

Death/euthanasia within 30 days of birth, hatching or acquisition.

D/E = Death established.

Death/euthanasia of any animal which has been resident in the collection for longer than 30 days.

DIS= Disposition

Includes exports from the collection, releases, sales, escapes

BRD = Breeding

Reproductive details/ observations. Any laying of eggs, mating, courtship, sexing of previously unsexed individuals or any other reproductive matter.

INT = Internal movement/Transfer

Any movement of a phasmid from its residing enclosure, be it within a section or to a different section. Transfers/exports out of the collection NOT included.

TAG = Tagging

Phasmid identification by numbering, naming or any other method of identification (see Paragraph 5.3 Methods of Identification for details).

W/L = Weight/Length

Weight or length measurements.

Rx/Tx = Treatment

Any medical treatment administered to phasmids, either by Vets, or continuing treatments administered by animal care staff. Include observations of anything related to treatment. Flag if veterinary examination is required. Use VET code.

OTH = Other

Any notable observation made in reference to daily routine or phasmids, e.g. behaviour, change to routine etc. Also anything else of interest e.g. animal management procedures, diet change, maintenance etc.

5.3 Methods of Identification

Individually identifying a TSI can be very difficult, because there is very little that can be done without traumatising the insect. There are a few methods that might help to identify the phasmids. Whether these methods will work depends on the institution.

1. **Individual housing.**

Individuals may be kept in individual enclosures with signage on each enclosure allowing you to individually identify each phasmid (Bearman, T 2007, p.17).

2. **Individual markings or patterns.**

Each phasmid will have individual markings or patterns on their exoskeleton. If these markings are notably different between the individual phasmids kept in the collection then a photographic record of the individual phasmids may be kept. This would allow for quick and easy identification of each individual. This method would not be feasible if a large number of phasmids are being housed together, or with phasmids that have not had their final shed (Bearman, T 2007, p.18).

3. **Individual "battle scars".**

Individual phasmids will have their own "battle scars". Some may have lost entire or partial limbs, they may have torn wings, or they may have scars on their exoskeleton. Keeping track of these "battle scars" will allow you to monitor individual phasmids. The negative aspect of this method of identification is that unless the phasmids have had their final shed, many "battle scars" markings will disappear as phasmids have minimal regenerative abilities, especially with regards to their limbs (Bearman, T 2007, p.18).

4. **Marked with number.**

Dash of white paint (water soluble) and a number with a fine tip permanent marker (Bearman, T 2007, p.18).

5.4 Routine Data Collection

At the moment there is not a lot of data collection of the TSI.
I would recommend the following areas that could use further study:

- Data on the incubation of eggs until hatching.
- Data on growth and development across different life stages.
- Data on leg measurements.

6 Feeding Requirements

6.1 Wild diet

The TSI is found on many food plants in eastern Australia including Stiff Bottlebrush (*Callistemon rigidus*) and White Cypress-pine (*Callitris columellaris*) (Brock & Hasenpusch, 2009, p.94).

The TSI will also feed on:

- Hazel (*Corylus*),
- Eucalyptus (*Eucalyptus* sp.),
- St. John's Wort (*Hypericum*),
- Blackberry (*Rubus fruticosus agg*),
- Raspberry (*Rubus idaeus*).

(*Acrophylla titan* (Macleay, 1827) 2008)

The wild diet of the TSI includes the above species, but it is not limited to these species.
Some of these plants are seasonal, including the Blackberry and Raspberry.

6.2 Captive Diet

Suitable food plant species include (Miller, 2006):

- Eucalyptus (*Eucalyptus* sp. Including *E. gunnii*),
- Acacia (*Acacia* sp. Including *A. irrorata*),
- Bramble (*Rubus* sp. Including *Rubus fruticosus agg.* and *Rubus idaeus),*
- Rose (*Rosa*).

The TSI's diet includes the following *Eucalyptus* sp. (*Pers. Obs.*):

- Tallow wood (*Eucalyptus microcorys*),
- Swamp Mahogany (*Eucalyptus robusta*),
- Forest Red Gum (*Eucalyptus tereticornis*),
- Lemon-scented Gum (*Corymbia citriodora*).
- Grey Gum (*Eucalyptus punctata*).

Other species that are suitable for the TSI include:

- Stiff Bottlebrush (*Callistemon rigidus*).
- White Cypress-pine (*Callitris columellaris*).

A diet of the species listed above is suitable for the TSI. They eat most of these species also in the wild.

The diet of the evergreen Eucalyptus and Acacia are suitable species all year round. The diet of the TSI changes in Winter, because food plants like the Bramble and Rose are seasonal plants.

The range of diets offered by different institutions varies based on the ability to produce certain food plants and the quantities that are available from those successfully produced plants.

The diet depends on where the institution is located and what species there are growing in the area to harvest leaf from. If you harvest leaf from the wild, make sure the habitat is free from any chemical spraying or other pollution.
Chemicals can be harmful to the phasmids and fresh and healthy leaf contains more nutrition. Collect branches from several trees instead from only a few trees. This way you prevent harming those few trees and give them a change to restore after harvesting.

Rose and Bramble are not native to Australia, but it's still a good food plant for the TSI. If you collect these plants from nurseries or florists they should be washed thoroughly before offering them to the TSI to remove any possible insecticides.
I advise to remove as many thorns as you can from these food plants (easy to do with a pair of scissors). It's not common, but it is possible for a TSI to get caught up in the thorns and even impale themselves. If it's not possible to remove the thorns, make sure to check the phasmids daily to make sure they are not injured or stuck.
I recommend to wear gloves when handling these thorny plants.

Captive diet at the Koala Hospital Port Macquarie includes:

- Tallow wood (*Eucalyptus microcorys*),
- Swamp Mahogany (*Eucalyptus robusta*),
- Forest Red Gum (*Eucalyptus tereticornis*),
- Lemon-scented Gum (*Corymbia citriodora*).
- Grey Gum (*Eucalyptus punctata*).

Water requirements:
For one or two adult female TSIs in an enclosure with the measurements of 900mm high, 400mm deep and 550mm wide and browse that fits in there (4-5 branches), they require 4ml of water daily, sprayed on the leaves. When it's very warm it is recommended to spray twice a day (*Pers. Obs.*). The best time to spray is in the afternoon before the TSIs are active and when it's hot a second time around noon.
The TSI will drink from the droplets on the leaves. Be careful not to soak the leaves, because this can cause mould to form. This mould can be harmful to the TSI.

It is very important to use a spray bottle that has not been used for chemicals. I would recommend to have a spray bottle only for the use of watering the leaves for the titan stick insect.

Quantity:
Each adult TSI requires one small branch (approximately 10 medium sized leaves) per day.

A small stem of 10 medium sized leaves weighs approximately 100g. For one year you will need approximately 365 small branches for one TSI (or 36.50kg of leaf matter).

Picture 11: Example of a small stem of Tallow wood (*Eucalyptus microcorys*) (Veenstra 2012).

Picture 12: Example of a small stem of Swamp Mahogany (*Eucalyptus robusta*) (Veenstra 2012).

Information and identification of suitable plant species for the TSI:

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Tallow Wood	*Eucalyptus microcorys*	30	20

The **Tallow Wood** occurs naturally in NSW and Qld. It has thick ginger-coloured bark and leaves of an unusual shade of green. It grows well in good, fertile, acid to neutral soils in frost-free districts with a high rainfall (Dark 1986, p.112).

Picture 13: The Tallow wood flower/fruit/leaves, bark and tree (Images sourced from *Maroochy Botanic Gardens*).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Swamp Mahogany	*Eucalyptus robusta*	30	10

The **Swamp Mahogany** occurs naturally in NSW and Qld. A spreading tree with a heavy crown of dark, glossy leaves and coarse, fibrous bark. Its natural occurrence is restricted to swamps and edges of saltwater estuaries and lagoons, generally within 2 kilometres of the sea (Dark 1986, p.122).

Picture 14, 15 & 16: The Swamp Mahogany bark, tree, flower/fruit and leaves (Images sourced from *Noosa's Native Plants* 2013).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Forest Red Gum	*Eucalyptus tereticornis*	50	10

The **Forest Red Gum** occurs naturally in NSW, Qld and Papua New Guinea. This is a moderately large to very large tree extending from coastal areas and occurring at elevations up to 1000 metres. It prefers fairly rich alluvial soils, sandy loams, or gravelly terraces, which are moist but not waterlogged. It does not like acidic soils. In coastal NSW it has proved to be a fairly hardy tree for loams or clay loams in areas of moderately high rainfall (Dark 1986, p.126).

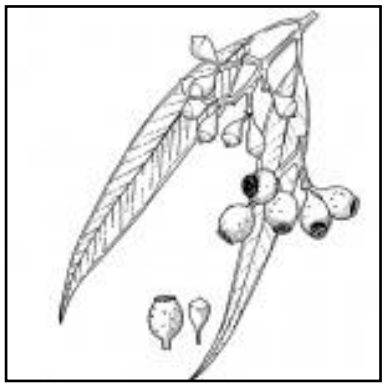


Picture 17, 18 & 19: The Forest Red Gum tree, bark, leaves and flowers/fruit (Images sourced from *Noosa's Native Plants* 2013).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Lemon-Scented Gum	*Corymbia citriodora*	30	20

The **Lemon-Scented Gum** occurs naturally in NSW and Qld. A tall-growing and popular ornamental tree, it has a graceful crown and a smooth, white barked, slender trunk. The long, tapered leaves release a strong, lemon scent when crushed. It is adaptable to a wide range of frost-free soils without excess lime. Well-drained loams are preferred, however (Dark 1986, p.89).





Picture 20, 21 & 22: The Lemon-Scented Gum bark, tree, fruit and leaves (Images sourced from *Noosa's Native Plants* 2013).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Grey Gum	*Eucalyptus punctata*	25	8

The **Grey Gum** occurs naturally in NSW and Qld. This is a medium-sized tree with a spreading crown, and smooth grey and pink bark. It is most common on the transition zone between sandstones and shales. It is suitable for well-drained loamy and clay soils, particularly useful for poor rocky sandstone areas and exposed places, and it will grow on ridge tops (Dark 1986, p.120).



Picture 23, 24 & 25: The Grey Gum tree, bark, fruit and (Images sourced from *Noosa's Native Plants* 2013).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Green Wattle	*Acacia decurrens*	12	6

The **Green Wattle** occurs naturally in Vic., NSW, Qld. A quick-growing, small to medium-sized tree, that is moderately drought-hardy. It has very angular branch lets, a dense crown of dark green feathery leaves, and produces heavy golden blossom commencing in mid-winter. It prefers well-drained, acid to neutral soils (Dark 1986, p.36).


Picture 26 &27: The Green Wattle tree, flowers and leaves (Images sourced from *CarLyn Indigenous Plants* 2013).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Stiff Bottlebrush	*Callistemon rigidus*	4.6	3

The **Stiff Bottlebrush** occurs naturally in NSW. It is a stiff, upright, woody shrub to small tree. The flowers encircle the stem to form the familiar bottlebrush shape, and foliage continues to grow beyond the ends of the flowers. It prefers well-drained soil and full sun (Harrison 2009, p. 23).


Picture 28 & 29: The Stiff Bottlebrush tree, flower and leaves (Images sourced from *Healthy Home Gardening* 2006).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
White Cypress-pine	*Callitris columellaris*	20	6

The **White Cypress-pine** occurs naturally in NSW and Qld. This is the best known cypress in cultivation, with dense, dark green foliage and a columnar habit. It thrives under warm coastal conditions, even in almost pure sand. It is moderately fast-growing in good rainfall (Dark 1986, p.61).


Picture 30 & 31: The White Cypress-pine tree, leaves and fruit (Images sourced from *Plants For a Future* 2012).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Bramble	*Rubus idaeus*	2	1.5

The **Bramble** occurs naturally in Europe and northern Asia. It is suitable for light (sandy), medium (loamy) and heavy (clay) soils and prefers well-drained soil. It can grow in semi-shade (light woodland) or no shade (*Plants For a Future* 2012.).

Picture 32 & 33: The Bramble leaves and fruit (Images sourced from *Plants For a Future* 2012).

Common Name	Botanic Name	Max. Height (m)	Max. Spread (m)
Musk Rose	*Rosa moschata*	3	1.8

There are over 100 species of roses. I'm describing one species, but many others can be used in the TSI its enclosure.
The **Musk Rose** originated for the Himalayas. It grows in fertile, moist, well-drained soil in full sun or partial shade. They can tolerate more shade than most roses (*Rosa 'Prosperity'* 2013).

Picture 34: The Musk Rose leaves and flowers (Image sourced from *The Horticultural Society of Canberra Inc.*).

6.3 Supplements

The TSI doesn't require any supplements.

6.4 Preparation and Presentation of Food

Preparation:
Give your phasmids more than one species to feed on. Ensure that one of the species is the phasmid his favourite and the other one or two species may change. It might be good to record which species the TSI eats. Some TSIs have their personal preferences, so it is important to make sure that they all have leaf that they like. If none of them eat a particular species, remove it from the diet. New species can be introduced as enrichment feeding. Make sure you only introduce one new species at the time. This way the TSI has at least one species that it eats. In the wild the TSI will live mostly in one tree, so it is natural behaviour for them to eat from one species.

Cut the branches to the right size, check the leaves and remove objects such as snails, woodlice and spiders' eggs. Woodlice have been known to attack phasmids (Brock, 2000, p.18). Take care when feeding phasmids with soft, new leaves, which may contain poisons.

Presentation:
Place the branches in a water container or jar. Make sure all the branches touch the water and cover the container with a lid (with holes in it for the branches) or plug the gap with tissues or newspaper to prevent the phasmids or their eggs fall into the water.
Never place the branches flat on the ground. The natural behaviour of a TSI is to hang of the leaves and climb them. Make sure the branches stand up straight (see Picture 35).

Picture 35: Example of two species of fresh leaf in a water container with lid (Veenstra 2012).

Pictures 36 & 37: Examples of the presentation of leaf in an enclosure suitable for one or two adult TSIs (Veenstra 2012).

The leaves should stay fresh for about five or six days, but when you have more phasmids in one enclosure or you see the leaves look dry, you will need to change the branches more often. Check daily if the branches still reach the water in the container and fill the container up when necessary.

The TSIs don't have a water bowl in their enclosure to drink from, because they can drown in it. To meet their water requirements it is important to spray the leaves daily (as described in Paragraph 6.2).

6.5 Dietary Changes

The TSI doesn't have any dietary changes and will eat the same species of food plants all year round.
The only thing that changes is the species of leaf that are seasonal (like bramble and rose) and therefore can only be fed when in season.

6.6 Feeding Regime

Example Dietary Program for One Week.
Each adult TSI requires one small branch (approximately 10 medium sized leaves) per day.

Day	Diet: Food	Diet: Water
1	Two or three species from suitable species. This can be eucalyptus, acacia and/or bramble. Fill water container with fresh water.	Spray leaf
2	Check water level of container	Spray leaf
3	Check water level of container	Spray leaf
4	Check water level of container	Spray leaf
5	Replace all leaves. Provide the TSI with fresh leaves from its favourite species and alternate the other two for enrichment. Fill water container with fresh water.	Spray leaf
6	Check water level of container	Spray leaf
7	Check water level of container	Spray leaf

Table 2: Weekly Dietary Program (Veenstra 2012).

6.7 Plant propagation

Acacia species (*Acacia* sp.)

Plant Description:
The leaves of acacias are compound pinnate in general. In some species, however, more especially in the Australian and Pacific Islands species, the leaflets are suppressed and the leaf stalks (petioles) become vertically flattened, and serve the purpose of leaves. The small flowers have five very small petals, almost hidden by the long stamens, and are arranged in dense globular or cylindrical clusters. The plants often bear spines (*Acacia* 2012).

Distribution and Source of Seed / Cutting:
Out of the roughly 1300 species of *Acacia*, approximately 960 are native to Australia. The distribution of the *Acacia* spread around the tropical to warm-temperate regions of both hemispheres.
Seeds and cutting may be sources from a reliable native plant seed service. Seeds and cutting from natural bush areas would require a permit from National Parks or the landowner (Simmons M. 2012).

Growing Season:
Winter and Spring.

Propagation:

- Seeds

The easiest way is to pour boiling water over the seeds and allow them to stand overnight. The next day any seeds which have swollen are ready for wowing and can be removed. The remainder of the seeds can be treated with boiling water again and the process repeated for as long as necessary (*Acacia* 2006).

- Cutting

The best results for this are achieved with cuttings of about 75-100mm in length of mature, current season's growth with the foliage removed from the lower two-thirds of the stem. "Wounding" the lower stem by removing a sliver of bark and treating the lower stem with a "root promoting" hormone both seem to improve the success rate (*Acacia* 2006).

Growing Notes:
It is best to plant saplings in the ground in late Spring or early Autumn.

Acacia seed usually germinates well by conventional sowing methods in seed raising mixes. Pre-germination, by sowing into a closed container containing moist vermiculite or a similar material, is also a useful method. Using this method, germination usually occurs in 1-2 weeks and when the root has reached about a centimetre or so in length, the seedling can be placed into a small pot of seed raising mix (*Acacia* 2006).

Plant Pests and Diseases:

- ***Insect and Mite Pests***

Severe insect attacks generally occur in one of two ways. The pest-predator-plant interaction may become unbalanced so that the pest population explodes and causes extensive damage to the plant. Alternatively the pest attack may have a cyclical nature, causing damage on a seasonal basis. Often plants adapt to this latter form of damage in some way and usually survive with minimal long lasting effects. Cultivated plants may either escape insect attack, or, more commonly, suffer greater damage from both naturally occurring and introduced pests.

Some aspects of some important groups of insect pests are:

- ***Sap sucking insects***

Those insects which suck on plant nutrients in the sap flow are often associated with the most severe damage seen on plants and are often the most difficult to control. The main groups of sap sucking insects are aphids, mealy bug, scale and mite pests.

In many cases these pests arise as the result of external stresses on plants and are common on plants suffering cold stress, nutrient imbalances or some other disturbance. In these cases it is often difficult to control these pests by the use of pesticides and the control achieved in these situations will be transitory. Inappropriate pesticide use may often only enhance the reproductive capabilities of the pest population high by continually removing a proportion of the population. This frequently results in the development of pesticide resistance in an insect population.

It is necessary to have a full understanding of the conditions necessary to grow plant species infested by these insects and to recognise those environmental conditions likely to limit plant growth and increase susceptibility of these plants to these insect pests. Plants grown under suitable conditions are less likely to be affected by these insects and predatory and parasitic insects should provide sufficient control of the pests.

Picture 38: Example of aphids feeding on a leaf (Image sourced from *Aphids* 2012).

- ***Stem and bud boring insects***

These insects, mainly the larvae of *Lepidoptera* and *Coleoptera*, can be particular problems in native plants grow for the cut flower trade where they can effectively ruin a season's productivity. Control of this group is difficult as they are not easy to observe, and systemic pesticides are poorly translocated to the active site. Quite often regular applications of systemic insecticides as a preventative measure are necessary to ensure control (Summerill B. & Steinke E. 1997).

If you have to control these pests with insecticides this might be harmful for the TSI. The chemicals on the leaf can cause serious damage to the phasmids, so I would recommend not using any insecticides and finding a different way to control the pests, as mentioned above.

- ***Foliage Diseases***

Our understanding of the nature of foliar diseases on Australian plants is limited. It is highly likely that for most Australian plant species there will be a suite of fungal pathogens capable of causing leaf spots, cankers or mildews. Most at this stage are still undescribed taxonomically and their biology and pathology unknown. In most cases these diseases do not warrant control but in rare cases can cause economic problems in plants grown for floriculture or other horticultural purposes. Generally many of the broader spectrum fungicides used for control of leaf spots are suitable, however these chemicals may require special registration or exemption for their legal use (Summerill B. & Steinke E. 1997).

- ***Soil borne Fungal Diseases***

These diseases are the most regularly blamed cause of death in native plants. However the symptoms of these diseases are often confused with problems such as nutrient imbalances, water logging or deficiencies, poor root aeration or other problems associated with root growth and development.

The two most successful approaches to the control of these diseases are through the use of hygiene practices and by maintaining ideal growing conditions. The avoidance of these diseases has for many years shown itself to be the best approach to control plant losses. Hygiene or "good housekeeping" needs to work at every stage of the propagation and cultivation of all plants. It is particularly important to maintain strict hygiene at the propagation stage; healthy stock plants are essential if diseases are to be avoided.

The most important aspects of plant hygiene is the use of pathogen free propagation media, the growing of plants on raised benches and the removal of diseased or potentially diseased plant material as soon as it is observed (Summerill B. & Steinke E. 1997).

Again, using chemicals to control these diseases can be harmful for TSI. If there is any fungal disease on the leaves, you cannot feed this to the phasmids. That is why it is very important to check the leaf before you feed it to the TSI.

Weed Potential:
Not native species do have a high weed potential in Australia should they be cultivated.

Eucalyptus species (*Eucalyptus* sp.)

Plant Description:
This is a very large group of approximately 900 species. The genus encompasses small mallees of only 0.5-1m tall and proceeds through a range of sizes, habits and flower colours to height of some 100m. Seed has been recorded as viable for twenty-one years (Dark 1986, p.81). Nearly all Eucalypt species are evergreen.

Distribution and Source of Seed / Cutting:
Eucalypt species are distributed across all of Australia except (or at least reduced in diversity) in rainforests and truly arid environments. Seeds and cutting may be sources from a reliable native plant seed service. Seeds and cutting from natural bush areas would require a permit from National Parks or the landowner.

Growing Season:
Generally, eucalypts can be planted at any time of the year. However, if you live in a climate where your eucalypt is expected to be marginally hardy, it would be advisable to plant it in mid-spring so that it can reach the maximum possible size before the following Winter. Similarly, if you have hot dry summers and anticipate that it will be difficult to keep the eucalypt watered, it may be best to plant it in the Autumn (or the beginning of the rainy season) (Levy A. 1995).

Propagation:

- Seeds

A common method used for germination of Eucalypts is the “bog method” where the pot containing the seeds is placed into a saucer of water until germination occurs. This results in moisture reaching the seeds by capillary action and ensures that the seeds do not dry out (*Eucalyptus, Corymbia and Angophora* 2006).

- Cutting

Cuttings are generally about 75mm long although this will vary depending on the physical size of the stem and leaves of the plant. The lower 15-20mm of the cutting can be ‘wounded’ to encourage root formation over a larger area; this is done by removing a small sliver of bark with a sharp knife out (*Eucalyptus, Corymbia and Angophora* 2006).

Growing Notes:
Eucalypts must not be allowed to dry out when they have just been planted and are small and vulnerable. You may need to water the eucalypts as often as once a week to once a day, depending on the consistency of your soil.

Eucalyptus plants should not be transplanted. That is, if you have planted it in one place in the ground, and it becomes established there, you should not move it. Eucalyptus plants are much more sensitive to root damage than normal trees when young. If you dig it up and fail to get at least 40-80% of the roost (this can vary according to the time of year), then the tree is likely to die outright. Even if it survives transplanting, its vigour will be greatly reduced (Levy A. 1995).

Plant Pests and Diseases:
There are quite a number of pests which can attack eucalypts and which may require control in a garden situation. Leaf chewing insects are probably the main concern but, unless damage is severe, there is little reason to resort to chemical controls. Regular observation will enable removal by hand for trees which are being established and, if a few chewed leaves can be tolerated, birds will often keep the infestations in check on larger specimens (*Eucalyptus, Corymbia and Angophora* 2006).

The TSI is not known to be a pest for the Eucalypt.

- ***Christmas beetles***

These insects can appear in plague proportions and cause severe defoliation which is beyond the ability of the bird populations to control. If access is possible, the beetles can be shaken off, collected and disposed of.

- ***Steel-blue sawfly***

These insects can appear in large numbers. They do most of the damage to a tree's foliage during the night and in daylight hours they gather into groups around small branches. If they are accessible at these times they can be removed by cutting off the branches where they cluster together.

Picture 39: Steel-blue sawfly larvae (Image sourced from *Australian Native Plants Society* 2009).

- ***Psyllids (including lerp-forming species) and scale***

These are sap-sucking insects and can cause a tree to lose vigor. Again, birds will normally keep them under control but often a strong jet of water directed at the pests will also dislodge them. This may need to be carried out several times. If this is not successful, the traditional treatment with white oil is usually effective.

- ***Insects and "galls"***

Some insects lay their eggs into leaves or twigs forming "galls" in which the next generation develop. The galls form as a response by the plant to secretions by the particular insect. To prevent hatching of the adults, galls can be removed by hand and burnt. Often, however, only a few galls occur and are unlikely to damage the tree to any serious extent. They are sometimes attractively coloured and of interesting shapes which can be appreciated as part of the local garden environment. Wasps, flies and thrips are among the gall-forming insects.

Picture 40: Eucalypt gall (Image sourced from *Australian Native Plants Society* 2009).

Once a tree gets to a reasonable size, control of pests by hand removal will be impractical. If serious damage is being caused, it may be necessary to seek advice from the local Agricultural Department. (*Eucalyptus, Corymbia and Angophora* 2006).

If you have to control these pests with insecticides this might be harmful for the TSI. The chemicals on the leaf can cause serious damage to the phasmids, so I would recommend not using any insecticides and finding a different way to control the pests.

Weed Potential:

Within Australia the eucalypts are recognised as having weedy potential, but are generally considered a low weed risk, as they are relatively slow to spread, have non-persistent seed and are easy to control (O'Sullivan W, p.2).

7. Capture, Restraint, Handling and Transport

Work, Health & Safety Risks:

Risk Category:
The TSI is classified as innocuous.

Possible risks:
The female TSI has sharp spines on her legs that may draw blood on soft skin if handled incorrectly.

Methods to reduce risks:
Wear (rubber) gloves when handling the TSI. When changing the leaf, let the phasmids walk onto the fresh leaf so you don't have to handle the phasmids.

Biological:
Zoonoses (diseases that are transmissible from animals to humans) such as a virus, fungus or bacteria are potentially present in TSIs. It is very important to always wash your hands with disinfectant hand soap before and after handling the phasmids. Make sure you rinse your hands thoroughly before you come in contact with them.
To minimise the risk of any diseases it is important to have good hygiene procedures.

7.1 Timing of Capture and Handling

Capture and handling a TSI can be done at any time of the day. Saying that, the TSI is more active during the night, so it might be easier to capture it during the day. To prevent stress it is best to handle the phasmid in a quiet environment.

7.2 Capture Equipment

An adult TSI is quite easily captured by hand.
If this is not possible, equipment you can use include:

- Butterfly net: This can be used when the phasmid is out of reach.
- Beating tray: This is a good way to capture TSIs.
- Egg trap: This can be used to collect eggs.
- Light trap: This can be use to capture winged species.
- "Assembling cage": To attract male phasmids.

(See Paragraph 7.3 for more information about this capture equipment)

7.3 Capture and Restraint Techniques

7.3.1 The best handling method for the safety of the animals as well as the handler

Important note:
Always handle the TSI with care. There is a high risk of the TSI losing any limbs when you handle it incorrectly. Don't try to "pull" it from the leaf, but wait until it walks onto your hand or the fresh leaf. Be patient.

Physical restraint:
Most of the times the easiest way to capture a TSI is by hand. There are two ways of doing this:

1. Place your finger under the body and gently direct the phasmid onto your hand. The TSI will walk onto your hand without you handling it, which reduces the chance of limb injury (see Picture 41). Let the TSI do the handling. You can use this method for adults and nymphs.
2. Pick the phasmids up gently by the thorax (avoiding the legs) (see Picture 42 & 43). Before you pick it up, touch the end of each of its legs so it doesn't hold onto the leaves. You cannot use this method for small nymphs, as they are too fragile to pick up.

Picture 41: Letting the TSI walk from the leaves onto your hand (Veenstra 2011).

Picture 42 & 43: Holding a large nymph TSI by the thorax (Veenstra 2012).

When the TSI is on your hand, hold the other hand above the phasmid (not touching it) to prevent it flying away or close your finger around the body (see Picture 45).

Picture 44: Holding a TSI with a finger above it to prevent it flying away (Veenstra 2011).

Another safe way to capture the TSI when you have to clean the enclosure is to let it walk onto the fresh leaves. This might not work for all phasmids, but is especially good for nymphs, so you don't have to handle them.

When the TSI is out of reach, you can use a butterfly net.
A net can also be used to catch winged phasmids in flight, although it is usually better to follow them and pick them up carefully if within reach, taking care not to damage their legs (Brock & Hasenpusch 2009, p. 26).

Picture 45: Example of a Butterfly net (Image sourced from *Australian Entomological Supplies*).

Chemical restraint:
There is little incentive to research chemical restraint techniques as they are economically not feasible for phasmids (Bearman, 2007, p. 26).

For the best and safest handling method I would recommend letting the TSI walk onto your hand. You have control over the phasmid and if it is used to be handled it won't get stressed. It is important to wash your hands before and after handling the phasmid.
With the use of a butterfly net there is a chance that a limb can get caught in the net and the TSI will lose it.

When the TSI is stressed it might wrap his legs around your hand. Because the adult females have small spines on their legs, they might draw blood. Make sure you know how to read its body language and don't handle it when it is stressed. You can also wear gloves if necessary.

7.3.2 The best method of luring and trapping stray animals

Light traps
A light trap is useful in order to catch winged phasmids attracted to light. It is usually males that are attracted to light, but occasionally females turn up. If collecting from a light sheet, using both a strong mercury vapour light and a fluorescent black light is reported to be the most productive (Brock & Hasenpusch 2009, p. 27).

Picture 46: Example of a light trap
(Image sourced from Brock & Hasenpusch 2009, p. 27).

7.3.3 The best method for collecting in the field

Butterfly net:
To capture TSIs in the wild you can use a butterfly net, if you can find the phasmids amongst the foliage (see Appendix 16.5 for Suppliers Details).

Beating tray:
Beating the foliage is also a good way to collect TSIs. Place a suitable beating tray underneath the branch and beat this branch several times with a strong stick. The phasmids will fall onto the tray (see Picture 47).

Picture 47: Using a beating tray to collect phasmids (Image sourced from *Davis* 2002).

Light trap:
A light trap can be used to capture TSIs in the wild. Be aware that predators such as bats and toads are also out hunting during the night. Also search again early morning (before birds pick up survivors) on and around the light sheet, as well as nearby vegetation. Another option is to collect at lights, for example in isolated areas, by petrol stations (Brock & Hasenpusch 2009, p. 27).

Egg trap:
In order to collect eggs, place a canvas egg trap beneath high-growing vegetation. The trap needs to be checked an emptied daily, before ants and other predators find the eggs (Brock & Hasenpusch 2009, p. 27).

"Assembling" cage:
This is a simple net cage in which you place a female, making sure she is secure from predators. Males will fly to pheromones released by the female so, in early morning, look for males on and around the cage. Later in the day they may fly off or walk away, or birds may find a ready-made meal (Brock & Hasenpusch 2009, p. 27).

Specialist climbing equipment:
To catch TSIs up trees, specialist climbing equipment can be used, but only by experienced climbers (and not for night work) because of the obvious dangers. Alternatively, it may be possible to work with scientific groups that have access to a canopy lift or crane. It is also worth checking vegetation on recently felled trees (Brock & Hasenpusch 2009, p. 27).

7.4 Weighing and Examination

Weighing:
Place a container with a small branch with leaves on the scales and record the weight of the container and branch. Put the TSI on the leaves and record the total weight. Take the weight from the container and branch off the total weight. This is the weight of the TSI.

Examination:
No other health checks are required other than general observation. To prevent stress when you do a general health check, try and leave the TSI on its leaves during the examination. If you have to restrain the phasmids during examination, hold it by the thorax as explained in Paragraph 7.3.1.

7.5 Release

To release a TSI place it on fresh leaves. The best way to do this is to let the TSI walk from your hand onto the leaves (see Picture 48).

Picture 48: Releasing a TSI by letting it walk from your hand onto the fresh leaves (Veenstra 2011).

7.6 Transport Requirements

General Welfare:

- Animals should have priority over merchandise.
- Only animals in good health should be transported.
- Animals should not be sedated.
- Animals should be left undisturbed during transport.
- No feeding should be necessary during transport.
- To avoid cross-infection, and for health and hygiene reasons, human contact with animals should be avoided. Should it be necessary, in an emergency, to handle them, then the hands should be thoroughly washed before and after handling the phasmids.
- Animals should not be housed near foodstuff.
- No animal should be transported with radioactive material or other substances dangerous to health.
- Containers should be secured to the aircraft, rail wagon, lorry or ship to avoid any possible movement, and should at all times be maintained in a horizontal position.

(*CITES*)

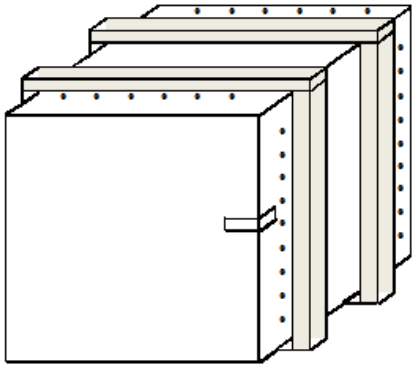
7.6.1 Box Design

The *International Air Transport Association (IATA)* (1998) states that before construction of transport container commences, contact transport facility i.e. airline etc. and ascertain whether they use insecticides routinely in the air circulation systems. If the transport facility uses insecticides then the phasmids must travel in an air tight container. If no insecticides are used in the ventilation system of the transport facilities then a well ventilated container may be used.

Ventilated box:
IATA standards are: ventilation holes must be lined with a fine mesh to prevent any phasmid escaping. The outer container must be constructed of fibreboard, wood, wood products or any plastic material of adequate strength. This will stop the container from being crushed during transport. It must have solid sides, top and base. An inner container such as a smaller plastic container may be used. When using a smaller plastic container (with plastic lid) place ventilation holes in the sides and top but ensure they are covered with a fine mesh to prevent escape. Ensure the plastic container is packed into outer box securely so they are not thrown about during handling or transport (*International Air Transport Association* 1998).

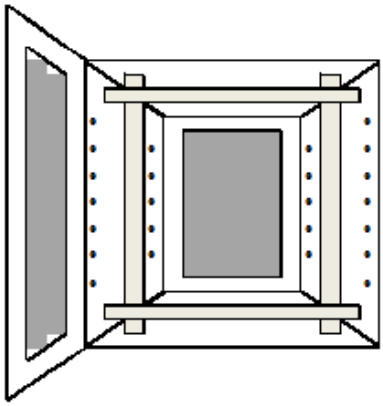
Airtight box:
IATA standards are: outside box should be constructed of fibreboard, wood, wood products or any plastic material of adequate strength. It must have solid sides, top and base and have no ventilation holes. A ventilated inner box can still be used (as mentioned previously) (*International Air Transport Association* 1998).

Transport box for an adult Titan Stick Insect.



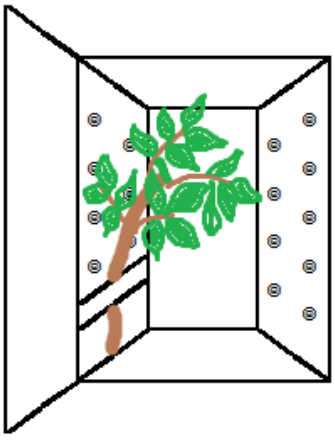
- Constructed of untreated fibreboard and wood.
- Wooden bars for extra support and used as handling bars.
- Ventilation holes are covered with a fine mesh.
- Door at the front is locked with a padlock.
- Height: 550mm, Width: 400mm, Depth: 230mm.

Drawing 3: Example of the outside of an outer transport container (Veenstra 2012).



- Wooden bars in the outer container, where the inner container fits exactly between the bars.
- Foam on door at the front and at the back (grey areas) to secure the inner container and make sure it can't move during transport.

Drawing 4: Example of the inside of an outer transport container (Veenstra 2012).



- Constructed of untreated fibreboard.
- This inner container fits exactly in the outer container.
- Ventilation holes are covered with a fine mesh and are not blocked by the bars from the outer container.
- The wooden bar is used to put the branch in between as furnishing and food.
- Door at the front is locked with a padlock.
- Height: 400mm, Width: 250mm, Depth: 225mm.

Drawing 5: Example of an inner transport container (Veenstra 2012).

All transport boxes must be constructed of non-toxic materials. Chemically impregnated wood may be poisonous and must not be used.

Short term transportation box:
For short term transportation you can use different types of boxes. If you have to transport the TSI from one enclosure to another for example, you can us a plastic container with ventilation holes, a small pet cage (see Picture 49), a plastic container with ventilation holes or a carton box. Make sure you keep the container in upright position. This might mean you have to hold the container during transport to prevent the TSI to be thrown around. Always provide them with a branch with leaves from a suitable food plant which can be fixed in a way so it doesn't fall over.

- Small pet cage on the side.
- Provide TSI with a small container with leaves to hold on to.
- Hold the container upright during transport, to prevent the TSI to be thrown around.

Picture 49: Example of a small pet cage (Veenstra 2012).

Transport of an adult TSI:
The transport time should be as short as possible and the TSI should be provided with branches to hang onto and feed from.
The temperature should not drop below 15 °C and not exceed 30 °C during transport.

Transport of nymphs:
Nymphs can be transported through the mail or with couriers. The transport time should be as short as possible, as longer transport times may have a detrimental impact on their health. The temperature should not drop below 20 °C and not exceed 30 °C during transport.
The nymphs can be transported in a box of any size with branches to hang on to and feed from. The branches should be fixed to the inside of the box to provide stability. The box should be made out of a strong material, such as hard plastic or wood, to prevent it getting damaged during transport and injuring the nymphs. The box has to have some type of ventilation. You can transport more than one nymph per box, provided there is enough food and room.

Transport of eggs:
The eggs can be packed into a Petri dish or film canister and the empty space filled with tissues. Small air holes should be punched in the lid of the container. The lid should be taped to prevent the container opening.
I don't recommend sending eggs older than 6 months, to prevent eggs hatching during transport

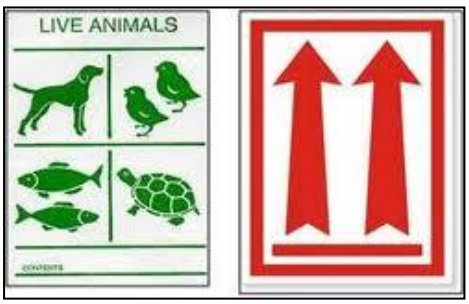
For all transports you will need to fill in an Animal Data Transfer Form (see Appendix 16.6). On this form you can fill in or read (depending if you are sending or receiving) the phasmids health, diet, behaviour, identification and history.

All transport boxes for eggs, nymphs and adult TSIs should have appropriate signage.

Durable, waterproof labels should be provided as follows:
- "LIVE ANIMALS – DO NOT TIP", on all sided and top.
- "THIS WAY UP", with arrows indicating the top, on all sides.
- Consignor's and consignee's name, address and telephone number. Box numbers should not be used as the sole address.
- Detailed list of contents: number of animals; scientific name and common names used in the exporting and importing countries.
- Temperature range required.
- Date on which the phasmids were packed for transport.
- Official stamp of carrier showing date of his receipt of consignment.

Durable, waterproof means of containing the following documents and other essential information should be firmly attached to the container:
- Duplicate of consignor's and consignee's name, address and telephone number.
- Duplicate list of contents: number of animals; scientific name and common names used in the exporting and importing countries.
- Copies of relevant export and import licenses.
- Copy of valid health certificate issued in accordance with the requirements of the importing country.
- Duplicate information regarding temperature range required.

(*CITES*)
These labels must not block any of the ventilation.



Picture 50: Labels that can be used on the transport box (Images sourced from *ANA Aviation* 2013).

7.6.2 Furnishings

A small branch with leaves from a food tree should be attached to the inner container. The TSI can rest on this during transport.

7.6.3 Water and Food

The branch used as furnishing should have approximately 20-25 leaves of a suitable food plant. This will feed one TSI for up to two days. The leaves should be misted just before transport. The leaves won't stay fresh for too long without misting, so the travel time should be kept to a minimal period of time.

7.6.4 Animals per Box

Adult TSIs should be transported individually to avoid damage to one another.

7.6.5 Timing of Transportation

It is best to avoid extreme highs or lows in temperature during travelling, so the best travel time for the TSI is late afternoon or early morning.

7.6.6 Release from Box

Before you release the TSI from the transport box, you have to make sure that its new enclosure is provided with branches with fresh leaves of suitable food plants, a suitable substrate and that the enclosure is clean and doesn't have any holes. Spray the leaves before you release the TSI in the enclosure. It is best to release the TSI late afternoon, so it can get used to its surroundings. It is likely that the TSI is stressed after being transported. This is why I wouldn't recommend handling it by hand. Try to let the phasmid walk from the old leaf onto the fresh leaf to prevent more stress. Another option is to put the branch, where the TSI is sitting on, in the new enclosure with the fresh leaf. After a few hours you can probably remove the old branch, because the TSI has moved onto the fresh leaf.

The TSI will probably not move a lot for the first few hours, because it has to adapt to its new environment. Check his general health after this time by observing its condition. I would recommend to observe the TSI in the first few days after transport, to see if it is adapting to the new environment.

8. Health Requirements

8.1 Daily Health Checks

It's important to observe the TSI daily to make sure it is healthy and stays healthy. These observations, or daily health checks, are best to be done when you clean the enclosure and give the TSI fresh leaf.

Daily health checks that you need to do:

- Is the TSI alive.
- Is it caught in its shed.
- Are all limbs present and moving freely.
- How do the faeces look; normal colour, sloppy.
- Has it been feeding well.
- How is the phasmids overall appearance; colour of the phasmid, is its body bent or abnormally shaped, does it appear sluggish?
- Any other abnormality.

TSIs can be easily weighed to monitor their progress through the various nymphal stages and to record their life history. Weights should be measured to 0.01g.

8.2 Detailed Physical Examination

8.2.1 Chemical Restraint

Not applicable.

8.2.2 Physical Examination

If possible I would recommend to do a physical examination with the TSI still on its leaves in the enclosure. This way the phasmid doesn't get stressed. If you need to handle the phasmid to examine it you can keep the TSI on a small branch with some leaves and pick the branch up to have a closer look. If you put the phasmid on a treatment table without leaves it will often walk away and it will get stressed.
Another way to examine it, when you really need to, is to have the TSI on your hand. This can only be done if the phasmid is used to being handled and doesn't get stressed. Make sure the TSI can't fly away.

Picture 51: Holding the TSI on your hand is one way to examine the phasmid up close (Veenstra 2011).

Physical examination:

- Check if limbs, head, abdomen, wings are present and in good condition.
- Check the colour of the phasmid.
- Check if the body is not bent or abnormally shaped.
- Check if the TSI is not tangled in its shed.
- Check if the adult/nymph appears sluggish.
- Check if the nymph doesn't have an egg shell stuck to the leg.

8.3 Routine Treatments

Spray with water at least once a day. If the environment is quite dry then it may be necessary to spray more than once. Be careful not to spray too much, because this can cause mould to form. This mould can be harmful to the TSI.

8.4 Known Health Problems

Health Problem	Cause	Signs	Treatment	Prevention
Legs drop off	The TSI may lose legs on prickly food plants when moulting, or shed them as a defence mechanism (the discarded leg may twitch for several seconds which might distract a potential predator).	Missing one or more legs.	There is no treatment for losing legs. Most nymphs will re-grow their lost legs, but these legs will be smaller than the other legs (see Picture 52). Adults can survive with 3-4 legs, but not when the 3 legs are on the same side of the body.	Ensure the TSI doesn't feel stressed or threatened and avoid prickly food plants, especially for phasmids that are still in the stage of moulting.
Adults considerably smaller than in previous generations	Possibly the effects of inbreeding (not introducing fresh stock), although in some cases such eggs might not hatch at all (Brock 2000, p. 28). It can also be a result of overcrowding.	Adults are smaller than a normal TSI should be. Normal: Male:135 – 150mm. Female: 200 – 260mm.	There is no treatment for this health problem.	Introduce fresh stock if possible and select the largest specimens for breeding (Brock 2000, p. 28). Ensure the enclosure is not overcrowded.
Improper Shed and Dehydration	Insufficient access to moisture.	Entanglement in old shed and death.	Assist shed with care and spray with water.	Ensure that the phasmids are sprayed once a day. If the environment is quite dry it may be necessary to spray twice a day.

Health Problem	Cause	Signs	Treatment	Prevention
Fungal or Bacterial Infection, or Viral Disease	Inappropriate cleaning regime, use of plastic enclosures, introduction of infected individual phasmid.	Visible fungal growth, bad odour, deformities and death.	Thoroughly clean the enclosure and monitor the phasmids condition. Quarantine any sick phasmids.	Do not use plastic materials in enclosure construction, ensure enclosure is cleaned thoroughly daily and quarantine new individuals before introduction to the main collection (Bearman 2007, p. 30).
Chemical exposure/ Ingestion	Use of plastic enclosures, use of food, furniture and substrate sprayed with insecticides or chemicals used in the same room as the TSI.	Deformities and death.	Remove food, furniture, substrate and replace with new items that have been washed before installation into the enclosure.	Ensure that food, furniture and substrate are collected from reliable sources and wash before installation into the enclosure. Do not use plastic materials in enclosure construction (Bearman 2007, p. 30).
Deformities	Overcrowding conditions or the enclosure is not tall enough.	Bent or/and abnormally shaped bodies.	If it looks like the TSI has difficulty feeding, it is possible to arrange a splint for adults with bent bodies (and perhaps nymphs). Pin the phasmid down under gauze (but not so that it is damaged – the pins should be crossed over legs and not enter any part of the body) and glue a matchstick, or similar, to the thorax (use Araldite) to straighten it. Leave for several hours and then release the TSI. The matchstick should drop off after a few days. If used for nymphs, the support must be removed carefully; otherwise they will not be able to moult (Brock 2000, p. 28).	Ensure that you don't overcrowded the enclosure and that the enclosure is tall enough (at least 3 times the length of the phasmid).

Health Problem	Cause	Signs	Treatment	Prevention
Nematode Worms	Nematodes are found in nearly every ecosystem from marine to fresh water, to soils, and from the polar regions to the tropics, as well as the highest to the lowest of elevations (*Nematode* 2012). The worm, such as the Horsehair Worm, lives inside the phasmid, feeding on its body fluids and reproductive organs (Brock & Hasenpusch 2009, p. 20).	They appear sluggish. It can slow the phasmids growth and kill it, although usually as an adult (Brock & Hasenpusch 2009, p. 20).	There is no treatment for Nematode worms.	Taking the right precautions and procedures.
Mites	Incorrect cleaning of the enclosure and not enough ventilation.	A mite attached to the TSI (see Picture 53) or in with the container with eggs.	There is no treatment against mites on the TSI, except to try and prevent it. If there are mites on the eggs of a TSI than you can remove the eggs from the container and clean them carefully with a paintbrush. Thoroughly clean the container or use a new one.	Keep enclosures and containers clean and well ventilated.
Adult or nymphs appear weak and/or die for no apparent reason; not 'squashy'	Incorrect conditions; Too dry, too cold, too hot, incorrect diet (Brock 2000, p. 27).	Weak or die.	If you notice the TSI appears to be weak, remove it from the enclosure, thoroughly clean the enclosure and make sure the temperature and humidity levels are correct. Try and give the phasmid different species of food plants.	The correct temperature and humidity levels and feed the correct food plants.

Health Problem	Cause	Signs	Treatment	Prevention
Nymphs or adults suddenly die (not of old age in the case of adults) and are 'squashy'	Incorrect conditions; too humid, affected by mould, overcrowding. Some breeders find tiny egg-like objects in droppings, which appear to be a mould and is often harmless, but following the earlier advice should eradicate infection (Brock 2000, p. 27).	Weak and they die suddenly.	If you notice the TSI appears to be weak, remove it from the enclosure, thoroughly clean the enclosure and keep it in drier conditions. If overcrowding is the reason for the phasmids to appear weak, move part of the phasmids to another enclosure.	Keep in drier conditions and thoroughly clean enclosure. Don't overcrowd the enclosure.
Nymphs fail to moult or failed to moult	If the nymphs fail to moult it means that they are kept too dry. If they are found dead (failed to moult) the cause may be overcrowding (nymph may have been knocked to the ground by another insect) or the temperature and humidity levels are incorrect (not warm enough) (Brock 2000, p. 27).	Nymph is caught in old skin or is found dead on the bottom of the enclosure.	It may be possible to remove skin carefully, using a wetted paintbrush, a delicate operation which is not very often successful (Brock 2000, p. 27).	Spray regularly when the nymphs fail to moult and consider transferring to a different enclosure, where you can have the correct temperature and humidity levels that the nymphs need. Place nymphs close to moulting in separate cage to give them enough room to moult (Brock 2000, p. 27).

Picture 52: Here you can see that the left front leg of the large TSI nymph is smaller than the right front leg. The TSI lost his leg before his last moult, but it grew back after moulting (Veenstra 2012).

Picture 53: A mite attached to a Richmond Stick insect (*Candovia strumose*) (Image sourced from Brock & Hasenpusch 2009, p. 20).

8.5 Quarantine Requirements

Every institution should have a written Quarantine Policy for newly arrived TSIs.
Quarantine for adult TSIs:

- ***A newly acquired TSI should be quarantined for 30 days***.
- Follow the Quarantine Policy and I recommend using a 'Quarantine Care Sheet Titan Stick Insect' (see Appendix 16.7).
- Weigh the phasmid on arrival and at the end of the quarantine period.
- Measure the phasmid on arrival.
- Keep in a separate enclosure away from the other phasmids.
- Use news paper as substrate, because it is easy to clean and to check the faeces.
- The equipment should only be used for the quarantine phasmid and is not to be used for the other phasmids. If this is unavoidable, then all equipment must be thoroughly disinfected before used in other areas.
- Only experienced keepers are allowed to handle the phasmids, feed and clean the enclosures.

- Wear gloves and wash hands thoroughly before and after handling the phasmid or cleaning its enclosure.
- If possible, let one keeper clean its enclosure and somebody else the other enclosure(s) of the TSIs.
- One species of leaf should be its favourite from where it comes from, two other species can be leaf the institution uses for the other TSIs, to give the new TSI time to get used to it.
- Keep quarantine food plants separate from the other food plants and prepare separately.
- Observe what species of leaf it eats and how much and record this.
- Ensure the temperature is between the 20-28 °C. If the TSI comes from a warm climate into a colder climate (or the other way around), ensure you acclimatise the TSI slowly. Start the temperature and humidity level the same as where it comes from and slowly adjust this to the temperature and humidity level from the institution (no lower than 20 °C or higher than 28 °C).
- Observe the TSI daily during the quarantine period for any unusual conditions, including:
    - How do faeces look?
    - Does it feed well?
    - Does it look stressed?
    - Colour of his skin?
    - Did it lose any limbs?
    - Look out for mites?
    - Any other abnormal behaviour.
- Keep observing the phasmid for at least another 30 days after the quarantine period is finished and it is introduced to the other phasmids.
- Record every observation made.
- Dispose waste off-site and separate from the other waste (this includes food plants).

Quarantine for Nymphs:

- I recommend to keep nymphs in quarantine until after their first moult. Newly hatched nymphs are very fragile and they have the highest death rate in phasmids. After the first moult they should be alright to be moved to an enclosure with bigger TSIs.
- It takes them about 2-4 weeks until they reach their maximum size and have to moult for the first time.
- You can keep healthy newly hatched nymphs together in one enclosure during the quarantine period, but avoid overcrowding. They need enough room to moult.
- If there is something wrong with a nymph, such as a fungal infection, they should be quarantined individually.

Other quarantine requirements are the same for nymphs as for the adult TSI, with the exceptions being:

- Weighing and measuring shouldn't be done before the first moulting, as they are very fragile.
- They can be housed with other nymphs of the same stage.
- Try and handle them as less as possible (let them walk onto the fresh leaf, instead of you handling them).
- Give them 3 species of leaf. When they have difficulty feeding; snip the edges of the leaves.
- The temperature should be close to the 28 °C with the humidity level a bit higher than for adults, to help them moult.

Picture 54: Here you can see an adult female TSI feeding on a eucalyptus leaf. To give the phasmid the best care possible it is important to know and record how much the TSI eats and what species it likes (Veenstra 2011).

8.6 Vet Procedures

Ringer's solution.
Ringer's solution is used generally by vets for therapeutic support of dehydrated or distressed vertebrates. Several attempts have been made over the years by a number of breeders to modify this solution for invertebrates, particularly tarantulas. Some studies have also been done on the physiology of stick insects, particularly comparisons between the mineral (and other) components of their food plants, and the components of the stick insects' bodies. The vets at Melbourne Zoo have attempted to modify Ringer's solution to cater for the differences between vertebrates and stick insects, but there is so little research available, and the results that have been published vary so dramatically, that it is difficult to know where to start. Particularly when, for example, papers published on the quantities of magnesium found in the bodies of stick insects vary by orders of magnitude between different species. There have been attempts to administer a version of Ringer's solution intravenously (intracoelomically) to unwell specimens through membranes between tergites in the abdomen, but so far without success (Honan 2007, p.7).

8.7 Euthanasia

Euthanasia can be carried out via the use of ethyl acetate in an insect killing jar (see Appendix 16.8).

Reasons for euthanasia may include:

- The TSI only has 1 or 2 legs left. A TSI with 3 legs is able to move around, but not when the legs are on the same side of the body. Euthanasia will be the kindest thing to do in this situation.
- The TSI has deformities which prevent it to move around and feed. The TSI will slowly die of starvation, so euthanasia will be the kindest thing to do in this situation to prevent more suffering for the phasmid.
- The TSI is tangled in its shed and it can't be removed. The TSI will slowly die of starvation because it won't be able to move around freely, so euthanasia will be the kindest thing to do in this situation to prevent more suffering for the phasmid.

8.8 Post Mortem results

Not applicable.

9. Behaviour

9.1 General Behaviour

The TSI is not territorial and it can live in one enclosure with other stick insects. It is not aggressive by nature and spends most of its days camouflaged between the leaves.

9.2 Activity

The TSI is a nocturnal animal and is mostly active at night. During the night it moves around on the browse and feeds on the leaves. On warm days the TSI can also be quite active during the day. Other than that it stays perfectly still and well camouflaged between the leaves. If disturbed, the phasmid will start to sway with its body, mimicking the vegetation moving in the wind, in the hope the predator won't see it.

Picture 55: The TSI is most active during the night when it moves around and feeds on the leaves (Veenstra 2011).

9.3 Social Behaviour

There is little social behaviour between individual TSIs, except for fertilised reproduction. The male will go and search for the female, which in some form you can call social behaviour.

9.4 Reproductive Behaviour

Male TSIs don't play a big role in the lives of females, because parthenogenesis (egg development without fertilisation) is a common feature. Usually those eggs hatch only into females, so males are necessary for genetic diversity.
In captivity TSIs are able to breed all year round. Males can smell the presence of an adult female because she will produce pheromones when receptive.

The male connects his abdomen to the lower part of the female's egg compartment. Mating can take up to 40min and is repeated several times. The female will end up with a fat abdomen and will produce a lot of eggs in her lifetime (*Acrophylla titan* 2012).

The female flicks her eggs to the ground. In the wild ants will often pick up the egg and eat the 'knob' on top of the egg. They will leave the egg in the ants nest, where they will stay until they hatch. Soon after hatching the nymph will find its way upwards and starts eating the leaves.

9.5 Misting

Misting is an essential health requirement for the TSI. It has to be done at least once a day, but I would recommend twice a day in warm weather. It also simulates the morning dew and rain that the TSI would encounter in a natural wild environment.

9.6 Behavioural Problems

Because of the simple nature of the TSI it has no known behavioural problems.

9.7 Signs of Stress

When the TSI is disturbed or stressed it can show different types of behaviour:

- **Swaying**:

The TSI sways its body, mimicking the vegetation moving in the wind; in the hope the predator won't see it.

- **Dropping onto the ground**:

When disturbed, the TSI will drop to the ground and walk away rapidly to find cover.

- **Defensive posture**:

When threatened the TSI will lift its front legs and front segment of the thorax and make a sort of a boxing movement. It can also flash its wings. This is a clear sign that the TSI is stressed (see Picture 56).

- **Wrapping legs around hand**:

If the phasmid is stressed or feels threatened when you are handling it, it can wrap its legs around your hand and/or fingers. The sharp pines on the legs of the female can be a bit painful.

Picture 56: A female TSI showing her wings and lifting her front legs is a clear sign of stress (Veenstra 2011).

9.8 Behavioural Enrichment

Enrichment is important in a captive life of the TSI to stimulate their natural behaviour. To be able to provide the TSI with suitable enrichment it is important to research the natural behaviour of the phasmid first.
To find out if the enrichment 'works' you can observe the behaviour before, during and after the enrichment of the TSI, using a Data Recording Sheet (see Appendix 16.9).

- **Different species of food plants**.

This gives the TSI variation and a choice in food. You can have 2 or 3 species of food plants in one enclosure. One of those can be its favourite and the others can be different species every time, as long as they are suitable food plants.

- **Daily misting**.

To stimulate morning dew and rain.

- **Indirect sunlight**.

If the enclosure is inside, you can put it outside on sunny days, when it's not too hot. The TSI enjoys the warmth of the Sun as long as it is not too hot or has direct sunlight. If you can't move the enclosure you can put the phasmid outside in a temporary enclosure during the day.

- **Gradual variations in temperature and light**.

To simulate day and night (Bearman 2007, p.32).

- **Slight breeze**.

To simulate wind or moving air currents (Bearman 2007, p.32).

(See Appendix 16.10 for a Monthly Enrichment Calender)

9.9 Introductions and Removals

There are currently no set quarantine guidelines for phasmids.
I recommend to quarantine a TSI for a period of 30 days if newly arrived.
The TSI is indifferent about whom it is housed with, so no introduction or removal periods are necessary. However, as the TSI is most active during the night I would introduce the phasmid late afternoon, so it can get used to its surroundings.

If a TSI is transferred to another facility you can fill in an Enrichment Data Transfer Form (see Appendix 16.11) devised by the AAZK (American Association of Zoo Keepers). This form provides information on the phasmids behavioural history, general background information and what kind of enrichment is a success for the phasmid.

9.10 Intraspecific Compatibility

TSIs are compatible with other phasmids.

9.11 Interspecific Compatibility

Many other species are predators to the TSI, such as birds, small reptiles and rodents. Therefore it is not recommended that the TSI is housed with other species.

Many different species of stick insects are compatible with the TSI, provided that they are not overcrowded.
Bulky, spiny species such as Macleay's Spectre (*Extatosoma tiaratum*), Jungle Nymph (*Heteropteryx dilatata*) and Giant Spiny Stick Insects (*Eurycantha calcarata*) shouldn't be living together with the TSI, as they may cause damage to each other (Brock 2000, p. 12).
The TSI and the Wuelfingi Stick Insect (*Acrophylla wuelfingi*) are quite simular. It has been said that some experts think the *Acrophylla titan* and *Acrophylla wuelfingi* cross-breed, but there is no research to confirm this and it's very unlikely. To be sure they won't cross-breed, I wouldn't house these two species together.

9.12 Suitability to Captivity

The TSI is easy to care for and adjusts almost immediately to captivity. The requirements they need can be easily provided with suitable food plants and a suitable enclosure.
There is a high mortality rate in hatchlings, but after the first mould this mortality rate decreases and, if correct husbandry is followed, they become an easy species to care for.

10. Breeding

10.1 Mating System

The TSI is able to reproduce both sexually and asexually. If males are not available, reproduction can take place by means of parthenogenesis, which is the development of unfertilised eggs (Brock & Hasenpusch 2009, p.12). Only a small percent of these eggs will hatch, and they will often be all female.
The TSI is polygamous; if there are males present, both the male and female will have multiple partners.

10.2 Ease of Breeding

If correct husbandry conditions are maintained, the TSI is quite easy to breed in captivity. Suitable food plants and the correct environment (see Chapter 4 & 5) are important to be successful in breeding. There is a high mortality rate for nymphs, but because the TSI can lay around 400 eggs in her lifetime, it shouldn't be a problem to breed this species successfully.

10.3 Reproductive Condition

10.3.1 Females

The female TSI comes into reproductive condition when she is fully mature, this is after the final moult.
They don't need to be able to fly, as they are parthenogenetic and don't need to search for a male. For this reason their wings are shortened and they can't fly very well.
It is believed that females attract males by releasing pheromones (chemicals, rather like a perfume) (Brock & Hasenpusch 2009, p.13).

10.3.2 Males

The male TSI is coming into reproductive condition when he is fully mature, this is after the final moult. At this stage they have fully developed wings, which they need to fly from tree to tree to search for females.

10.4 Techniques Used to Control Breeding

To promote breeding you will need the correct temperature (between the 20-28 °C) and humidity, a suitable enclosure (at least 3 times the size of the TSI) and fresh, suitable leaf daily.

To prevent breeding I would recommend removing the unwanted eggs and dispose of them by freezing or incineration. I recommend freezing the eggs for a week or so, to make sure no eggs survive.
Because they are parthenogenetic, separation of the sexes is not a possibility to prevent breeding.

Contraception's and surgical breeding restrictions are also unavailable due to the size of the phasmids and the extreme lack of surgical knowledge on insects (Bearman 2007, p. 33).

10.5 Occurrence of Hybrids

Unknown. It has been said that some experts think the *Acrophylla titan* and *Acrophylla wuelfingi* cross-breed, but there is no research to confirm this and it's very unlikely.

In theory the different distribution range of these two species should block any likelihood in the wild (although it is unlikely they would cross-breed even if in the same area). In captivity, possible (i.e. pheromones released by females might confuse), but unlikely. There could be attempted mating but would they produce fertile offspring? (P.D. Brock, pers. comm.).

10.6 Timing of Breeding

In the wild the TSI will breed all year round. This is the same in captivity, if provided with the correct husbandry requirements.

10.7 Age at First Breeding and Last Breeding

The TSI is sexually mature after its final moult and will be approximately 3-4 months of age by then. It can breed for the rest of its adult life, which is for approximately 5-8 months after it reached maturity.

10.8 Ability to Breed Every Year

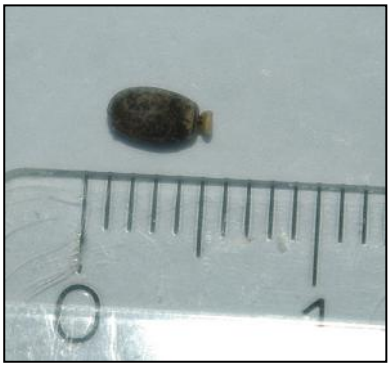
The TSI can breed consistently throughout its adult life.

10.9 Ability to Breed More than Once Per Year

The TSI lays eggs on a consistent base throughout the year. It can lay one egg per day up to around 6 eggs per day (pers. obs.).

10.10 Nesting, Hollow or Other Requirements

The TSI lays its eggs in the tree. The eggs are laid singly and will drop to the ground. They will stay there for their incubation period (which can take over a year) or they are carried away by ants. The capitulum (knob) on the top of the eggs is attractive to ants, which carry the eggs away by this structure and bury them. This may improve their chances of survival, as the ants eat the capitulum, protecting the egg capsules from some predators (Brock & Hasenpusch 2009, p.8).



Picture 57: Example of a TSI egg, with on the right side the capitulum, which attracts ants (Veenstra 2012).

In captivity you can try to hatch the eggs naturally, by having leaf litter, bark, soil/sand, moss or peat as a substrate and leave the eggs in there. But this makes it almost impossible to clean the enclosure without disturbing the eggs or having the risk that you throw away a lot of the eggs.
I would recommend removing the eggs from the enclosure daily and try to hatch them in an incubator (see Chapter 11). This makes it also easier to control breeding and to record all details.

(See Appendix 16.12 for the Annual Cycle of Maintenance)

10.11 Breeding Diet

The diet of the TSI is the same throughout the year. It doesn't have a special breeding diet. Its diet consists of Eucalyptus (*Eucalyptus* sp. Including *E. gunnii*), Acacia (*Acacia* sp. Including *A. irrorata*), Bramble (*Rubus* sp. Including *Rubus fruticosus agg.* and *Rubus idaeus)* and Rose (*Rosa*). For more information about the diet of the TSI see Chapter 6.

10.12 Incubation Period

The incubation period for the TSI eggs varies from 10 to 12 months, but can even take longer depending on the environmental conditions. The eggs will hatch faster in a warm and humid environment. If it is too humid, the eggs can become mouldy.

10.13 Clutch Size

On average the TSI will lay 400 to 500 eggs in its adult life. It can lay 1 egg per day up to around 6 eggs per day (pers. obs.).
The TSI has been recorded depositing a huge total of around 2050 eggs while in captivity.

10.14 Age at Weaning

There is no parental care after the nymphs are born. The nymphs are born self sufficient.

10.15 Age of Removal from Parents

The TSI is strictly herbivorous. There is no problem for the female nymphs to stay with the female adults for their whole life. If there are males, these should be removed before their final moult to prevent inbreeding.

For ease of cleaning enclosures it is recommended that phasmids be housed with other phasmids of similar size as tiny nymphs can easily get lost (Bearman 2007, p. 35).

10.16 Growth and Development

Nymphs mostly resemble adults except in their lack of wing and genitalia development, the absence of ocelli, and the fewer antennal segments (Gullan & Cranston, p. 473). Most nymphs are green when they are young.

It will take several months before the nymph reached adulthood. The TSI will moult 5 times before it reaches its final stage and is sexual mature (*Pers. Obs.*). While hanging from the food plant, the skin splits dorsally along a median line and the nymph emerges head-first, thorax and legs next and abdomen last. If a nymph is dislodged from its moulting position and falls to the ground before its legs are free, it will often not survive, as the nymph is seldom able to free itself from its exoskeleton (Bedford G.O. 2007, p. 133). In the newly-moulted position the nymph is soft and it will take a few hours for the exoskeleton to harden. I recommend not to handle the nymph after moulting. If possible, wait at least 12 hours before handling, to make sure you don't harm the phasmid.

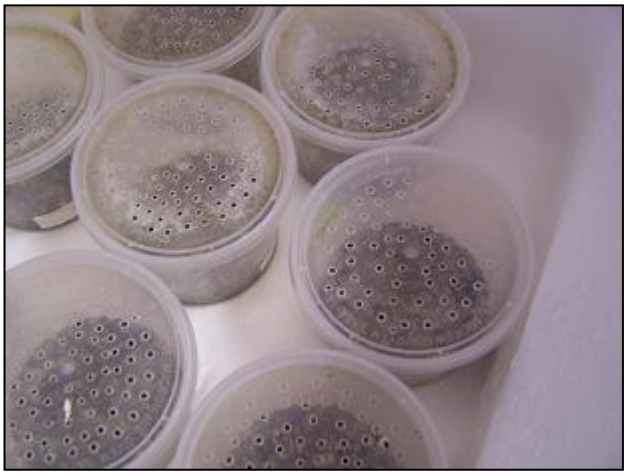
Picture 58: An adult female phasmid who just moulted for the last time with her shed hanging above her (Veenstra 2012).

11. Artificial Rearing

11.1 Incubator Type

There are different types of incubators where you can try to hatch the eggs of the TSI in. You can easily make your own incubator.

A small or medium plastic box is an ideal container. I would recommend to use a container with a lid, so you can maintain a humid atmosphere and prevent escape of newly hatched nymphs. They will need some ventilation, which you can provide by cutting small holes in the lid or one bigger hole and use netting to cover the hole to prevent escaping nymphs.
The advantage of having smaller incubators is that you can easily separate eggs and keep exact records of which TSI laid the eggs and when.



Picture 59: Example of a homemade incubator (Fellenberg).

The base of the container can be lined with 1 cm of;

- sand,
- peat or,
- tissue paper.

It is important to keep all type of bases damp, but ensure that there an no puddles of water.

The eggs can be left at the bottom of the enclosure with the faeces of the adults, which can keep the eggs moist. However, this makes cleaning out difficult and means that newly hatched nymphs hatch into a large enclosure (Brock 2000, p. 16). It makes it harder to keep records of how many nymphs hatch and when they hatch.

If you are breeding phasmids on a large scale or you have limited time to spend checking the eggs, there are also laboratory incubators available. They have all the features necessary to successfully incubate the eggs, but most of these incubators are quite expensive. See Appendix 16.13 for more information.

11.2 Incubation Temperature and Humidity

The eggs of the TSI should be kept warm. Between the 21-27 °C is ideal.
The eggs should be laying on a moist base and sprayed once a week, without soaking them.

They need a medium humidity. If the eggs are kept too dry, they may die or produce crippled nymphs. These may have the egg shell attached to their hind-legs, but this can be carefully removed with the aid of a damp camel-hair paint-brush (Brock 2003, p. 10).

When it's too humid there is a chance of mould developing on the eggs. A mould inhibitor, such as Methyl 4-Hydroxybenzoate (Appendix 16.1 MSDS), can be sprinkled on the base of the container. You can also clean the eggs carefully by hand, using a camel-hair paint-brush. The eggs are particularly fragile, so care must be taken not to damage them (Brock 2003, p. 10).

I recommend to check the container daily to see:

- if there is any mould developing,
- if the eggs are to dry, or
- if there are any newly hatched nymphs that need to be transferred to a small enclosure with a food supply.

11.3 Desired % Egg Mass Loss

There is no information about the desired % egg mass loss in TSIs. Further research in this area needs to be conducted.

11.4 Hatching Temperature and Humidity

It can take up to a year or longer for the eggs to hatch (Pers. Obs.). If the eggs are kept cooler they will invariably take longer to hatch.

The hatching temperature and humidity are the same as described in 11.2: *Incubation Temperature and Humidity*.

11.5 Normal Pip to Hatch Interval

When hatching, the nymph pushes the operculum from the egg capsule with its head and prothorax (Bedford G.O. 2007, p. 132).
There is no research done on how long the hatching of a TSI takes, but other phasmids take about 2 to 4.5min to hatch. One would assume that the TSI won't take much longer to hatch.

11.6 Diet and Feeding Routine

The diet for nymphs is the same as the adult diet (see Chapter 6 for more information).
Many nymphs readily start to feed but if you experience difficulties, you can try placing them in a container with another TSI which is already feeding well. The edges of the leaves are eaten by the latter and this may encourage the others to start to feed (Brock 2003, p. 12). You can also snip the edges of the leaves yourself before feeding them to the nymphs.

Suitable food plant species include (Miller, 2006):

- Eucalyptus (*Eucalyptus* sp. Including *E. gunnii*),
- Acacia (*Acacia* sp. Including *A. irrorata*),
- Bramble (*Rubus* sp. Including *Rubus fruticosus agg.* and *Rubus idaeus),*
- Rose (*Rosa*).

The nymph's diet may include the following *Eucalyptus* sp. (*Pers. Obs.*):

- Tallow wood (*Eucalyptus microcorys*),
- Forest Red Gum (*Eucalyptus tereticornis*),
- Lemon-scented Gum (*Corymbia citriodora*).
- Grey Gum (*Eucalyptus punctata*).

The diet of the evergreen Eucalyptus and Acacia are suitable species all year round. The diet of the TSI nymphs changes in Winter, because food plants like the Bramble and Rose are seasonal plants.

The nymphs don't have any dietary changes and will eat the same species of food plants all year round.
The only thing that changes is the species of leaf that are seasonal (like bramble and rose) and therefore can only be fed when in season.

The preparation and presentation of the food is the same as described in 6.4.

Water requirements:
The nymphs will drink from the droplets on the leaves. Depending on the size of the enclosure I would recommend to daily spray 4ml of water on the leaves. In a small enclosure this would be only 2ml of water. Be careful not to soak the leaves, because this can cause mould to form. This mould can be harmful to nymphs. Nymphs also need this water to make it easier for them to moult.
It is very important to use a spray bottle that has not been used for chemicals. I would recommend to have a spray bottle only for the use of watering the leaves for the TSI.

Feeding regime:
When there are more nymphs in one enclosure I advise to change the branches every 2 or 3 days. Check every day if the branches still reach the water in the container and fill the container up when necessary.

The nymphs don't have a water container in their enclosure to drink from, because they can drown in it. To meet their water requirements it is important to spray the leaves daily (as described in *Water requirements*).

Example Dietary Program for One Week.
The dietary program for a nymph is almost the same as for an adult, except for the changing of the leaf. This will have to be done more often.
Each nymph will require one small branch with about 5 leaves per day.

Day	Diet: Food	Diet: Water
1	Two or three species from suitable species. This can be eucalyptus, acacia and/or bramble. Fill water container with fresh water.	Spray leaf
2	Check water level of container	Spray leaf
3	Replace all leaves. Provide the nymphs with fresh leaves from their favourite species and alternate the other two for enrichment. Fill water container with fresh water.	Spray leaf
4	Check water level of container	Spray leaf
5	Replace all leaves. Provide the nymphs with fresh leaves from their favourite species and alternate the other two for enrichment. Fill water container with fresh water.	Spray leaf
6	Check water level of container	Spray leaf
7	Replace all leaves. Provide the nymphs with fresh leaves from their favourite species and alternate the other two for enrichment. Fill water container with fresh water.	Spray leaf

Table 3: Weekly Dietary Program (Veenstra 2013).

11.7 Specific Requirements

Smaller enclosures are usually most suitable for small nymphs. It makes it easier to find all nymphs when cleaning. As nymphs grow a larger enclosure will be necessary.

Nymphs often hatch at night, so make sure you put a small branch with leaves in the incubator. You can transfer the nymphs to an enclosure in the morning. Newly hatched nymphs require a humid atmosphere and they often drink water droplets. That is why it is important to spray them once a day (see Section 11.6 Diet and Feeding Routine). The risk of developing bacteria and fungi is higher because of the humidity. I would recommend to clean the enclosure every other day with a non-toxic disinfectant to prevent bacteria and fungi. F10SC veterinary grade disinfectant is recommended for this.

Cleaning chemicals can be dangerous for the TSI, so only use chemical agents that you know are safe for the nymphs. Be careful using insecticides in the same room or area of the enclosure, because it kills the TSI.

Don't pick nymphs up with your fingers, as they are easily squashed, and the legs may be shed if nymphs believe they are in danger. You can gently coax nymphs towards their food plant with a paintbrush, or let them walk on your hand and then transfer them (Brock 2000, p. 22).

11.8 Data Recording

There is a large gap in research on egg weights during incubation. There is little incentive to carry out such research which is why there is extremely limited data available (Bearman 2007, p. 39).
Areas that can use further research include:

- Pip to hatching.
- Egg weights and weight loss during incubation.
- Weight of nymphs during different stages of their life.

It is important to keep records. It allows you to learn more about the TSI and the history of each individual phasmid.

Make sure to write on the incubators:

- The date when the eggs are laid.
- Number of eggs in the container.
- Which TSI laid the eggs (only possible if there is only one female TSI in the enclosure).

Include on your records:
EGGS:

- Lay and collection date and ID number of the mother and father (if known).
- Egg weight loss (weigh the eggs when they have been laid and record this weekly).
- Size and volume (measure the length and width of the eggs when they have been laid and record this weekly).
- Changes in the egg.
- Incubating temperature and humidity levels.
- Which substrate you use.

NYMPHS:

- The date.
- Type of entry (e.g. observation).
- Date of birth of nymph.
- Individual identification (if known).
- Weight and measurements.
- Feeding: which species given and which species eaten, change in diet.
- Faecal output.
- Behavioural problems.

11.9 Identification Methods

Individually identifying a TSI can be very difficult, because there is very little that can be done without traumatising the phasmid. There are a few methods that might help to identify nymphs. Whether these methods will work depends on the institution.

- **Housing the nymphs in separate enclosures.**
  - You can identify each nymph if you house them individually.
- **Unique markings.**
  - Each nymph has its own unique marking or pattern on their exoskeleton. If you photograph and record this marking you can indentify each nymph individually.
  - This method will be hard to do with nymphs, because their markings or patterns will change after every moult.
  - You will have to record their markings after every moult until they reached adulthood.
- **Missing legs.**
  - Some nymphs will lose one or more legs, which makes it possible to individually identify them.
  - Even when the leg grows back after a moult, it will often be shorter than the other legs.

11.10 Hygiene

It is important to maintain a high level of hygiene at all times. Always wash your hands before and after cleaning an enclosure and handling the nymphs. Make sure you clean and disinfect (with F10) the equipment after every use.
To maintain a high level of hygiene, cleaning the enclosure regularly is very important.

Methods to clean the enclosure:

- Take the old browse out with the nymphs still on it and put it in a temporary container/enclosure. After you cleaned the enclosure and put fresh browse in a pot with fresh water you can put the old browse with the nymphs back in the enclosure. Most of the time they will move from the old to the new browse themselves in a short period of time.
- Let the nymph walk on to your hand (don't pull it off the leaf, as it can easy lose one of its legs) and transfer it to the fresh browse.

I would recommend the first method, because nymphs are very fragile.

Daily:

- Spray the leaf so it stays fresh and the nymphs can drink from the droplets.
- Check the temperature and humidity to make sure the temperature is between the 20-28°C (when it's too humid, bacteria and fungi might develop).
- Remove dead specimens and dispose when found.

Weekly:

- Disinfect the enclosure (every other day).
- Replace the substrate. Especially with substrates like leaf litter or moss you need to replace this regularly as it will dry out or doesn't look appealing anymore.
- Scrub the pot and fill it with fresh water and put fresh browse in the pot. It is likely that this needs to be done more than once a week. As soon the leaf looks dry you need to replace it. With nymphs this will be every 2-3 days.

DAILY	WEEKLY	MONTHLY
Spray leaf	Disinfect enclosure (every other day)	Full enclosure maintenance check
Remove dead specimens	Scrub pot (when changing browse)	
Check temperature & Humidity	Fresh browse (every 2-3 days)	
Count phasmids	Replace substrate	
Check enclosure for gaps		

Table 4: Exhibit Maintenance Tasks for nymphs.

11.11 Behavioural Considerations

Nymphs will need to be able to reach a food plant immediately after hatching. Their natural instinct is to climb up, so make sure the food plant is the highest point for them to climb on.

This is why it is very important to have at least one small branch in the incubator and check the incubator daily, so you can transfer newly-hatched nymphs to an enclosure with a food plant as soon as possible. Because TSI eggs take at least one year to hatch, I would start putting food in the incubator from around 10 months after laying.

11.12 Weaning

There is no parental care after the nymphs are born. The nymphs are born self sufficient.

12. Acknowledgements

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15. Glossary

Abdomen – The third, rear part of an insect.

Abdominal segments – Subdivisions of the insect abdomen – in phasmids range from 1st (median segment) to 10th segment (anal segment).

Adult – The final (mature) stage of an insect, during which reproduction occurs (often by way of parthenogenesis in phasmids).

Capitulum – Structure attached to the operculum in some phasmid eggs.

Cerci – A pair of appendages at the posterior end of the abdomen.

Coxa – The first or basal segment of the leg of an insect.

Cross-infection – The transfer of infection between different species of animal or plant.

Deformity – A deformed part of the body; a malformation.

Enrichment – Act of making fuller or more meaningful or rewarding.

Exoskeleton – A hard outer structure, such as the shell of an insect of crustacean, that provides protection or support for an organism.

Femur – The third segment and longest part of the insect leg, attached to the base of the body by the trochanter and coxa.

Frass – The fine powdery material plant eating insects pass as waste after digesting plant parts.

Genus – An assemblage of species agreeing in one or more character(s) (the first scientific name of two for each species e.g. *Acrophylla* in *Acrophylla titan*).

Innocuous – Having no adverse effect; harmless.

Mesonotum – The upper surface of the second (middle) thoracic segment (mesothorax) of the insect body.

Metanotum – The upper surface of the third (posterior) thoracic segment (metathorax) of the insect body.

Moult – Periodic shedding of the outer skin.

Nocturnal – Active at night.

Nymph – The larval form of certain insects, usually resembling the adult form but small and lacking fully developed wings.

Ocelli – (ocellus) simple eye: an eye having a single lens.

Operculum – The subgenital plate at the end of the abdomen in female phasmids.

Parasite – An organism that lives in or on another (the host), from which it obtains food, shelter, or other requirements.

Parthenogenesis – Egg development without fertilisation (usually into females only).

Pathogens – A bacterium, virus, or other microorganism that can cause disease.

Phasmid – Large cylindrical of flattened mostly tropical insects with long strong legs that feed on plants. Walking sticks and leaf insects.

Pheromones – A chemical substance produced and released into the environment by an animal, esp. a mammal or an insect, affecting the behaviour or development of other of the same species.

Polygamous – Having more than one mate at a time.

Pronotum – The upper surface body plate of the first section of the thorax, frequently enlarged in many insects.

Prothorax – The first segment of the thorax.

Quarantine – A period, or place of isolation in which animals are placed.

Receptive – Able or willing to receive something, esp. signals or stimuli.

Reproduction – The production of offspring by a sexual or asexual process.

Species – Form; kind; individuals alike in appearance and structure, mating freely (if bisexual) and bear fertile offspring resembling each other and their parents, including all varieties and races.

Sub genital plate – The terminal ventral plate underlying the genitalia.

Tarsus – The segmented foot of insects.

Thorax – The corresponding part of the insect.

Tibia – The fourth segment of the leg in insects and some other arthropods.

Trochanter – The small second segment of the leg of an insect, between the coxa and the femur.

Turbercle – A small knob (in phasmids often on the thorax, sometimes on the head and abdomen).

Zoonoses – A disease that can be transmitted to humans from animals.

16. Appendix

Appendix 16.1

Methyl 4-hydrosybenzoate.
http://www.gfschemicals.com/msds/2555MSDS.pdf

GFS CHEMICALS, INC.
P.O. Box 245 Powell, OH 43065
740-881-5501(Tel.) 740-881-5989(Fax)
1-800-424-9300(Chemtrec 24Hr. Info.)

MATERIAL SAFETY DATA SHEET
2555
METHYL 4-HYDROXYBENZOATE
CHEMICAL NAME & SYNONYMS DOT CLASS SARA TITLE 313
Methyl 4-hydroxybenzoate; Methyl paraben NR No
TSCA listed - Yes
FORMULA REPORTABLE QUANTITY F.W. CAS#
6 4 2 3 HOC H CO CH N/A 152.15 99-76-3
PHYSICAL DATA
Melting point 131°C; Very soluble in alcohol; Slightly soluble in water; Density 1.36; Boiling
point 270-280°C.
APPEARANCE & ODOR
White powder. Odorless.
REACTIVITY & CONDITIONS TO AVOID
Stable. No hazardous reactivity. Incompatible with strong oxidizing materials.
FIRE HAZARDS
2 Will be consumed in general fire with evolution of fumes of CO and CO . Fire fighters wear SCBA. NFPA #1-1-0.
EXTINGUISHER FLASHPOINT LEL UEL
Fight surrounding fire N/A N/A N/A
HEALTH HAZARDS
May be irritating to skin, eyes and mucous membranes. Paraben sensitization may occur especially when it comes in contact with broken skin. Not considered toxic orally, but large
50 doses may cause gastric upset. LD (oral-mouse) >8000 mg/kg. OSHA TLV/ACGIH PEL not established. No evidence of carcinogenicity.
SPECIAL PRECAUTIONS
Wear goggles and rubber gloves while handling. If dust is present, use adequate ventilation
or suitable respirator to avoid inhalation.

Appendix 16.2

F10 Super Concentrate Disinfectant.

http://www.lomb.com.au/images/products/F10SC_MSDS_Dec_2003.pdf

MATERIAL SAFETY DATA SHEET

COMPANY DETAILS MANUFACTURER:
AUSTRALIAN DISTRIBUTOR: Health and Hygiene (Pty) Ltd
COMPANY: Chemical Essentials (Pty) Ltd P O Box 347. Sunninghill 2157,
Address: 13 Abelia Str, Doncaster East, South Africa.
Victoria 3111 Tel:+27 11 474-1668
Emergency Telephone number:+03 9841 9901 Fax: +27 11 474-1670
Fax: +03 9841 9909 e-mail: info@healthandhygiene.co.za

IDENTIFICATION
PRODUCT NAME: F10 SUPER CONCENTRATE DISINFECTANT
UN Number: None
D G Class: None
Hazchem code: None
Poisons Schedule: 5

HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA IN THE PACK CONCENTRATE ONLY
(eyes and skin irritant)
USE: Biodegradable multi purpose Disinfectant for all hard surfaces, equipment and airspaces

PHYSICAL DESCRIPTION/PROPERTIES
Appearance: Clear, colourless liquid, with a slight natural odour.
Boiling Point: 110 ^{0}C
Vapour Pressure: Not known
Specific Gravity: 1.00
Flash Point: Not flammable
Flammability Limits: Not flammable
Solubility in water: Soluble

INGREDIENTS
CAS Number Quantity (w/w)
Benzalkonium Chloride 68424-85-1 5.4%
Biguanide 27083-27-8 0.4%
Ingredients not determined to be hazardous to 100%

HEALTH HAZARD INFORMATION
HEALTH EFFECTS:
Acute
SWALLOWED: Low. Substantial ingestion may cause irritation to mouth, throat and digestive tract.
EYE: Low. Will cause irritation but not serious damage.
SKIN: Low. Concentrate may act as mild degreasant to sensitive skin.
INHALED: Low. No significant hazard.
Chronic
INHALED: Low. No significant hazard

FIRST AID
SWALLOWED: DO NOT induce vomiting. Give milk or water to drink. Seek medical advice where necessary.
EYE: Rinse eyes with water. Seek medical advice where necessary.
SKIN: Wash affected area with soap and water.
INHALED: Non-toxic. Avoid long term inhalation of neat liquid. Remove to fresh air.
FIRST AID FACILITIES: Contact a doctor or Poison Information Centre (phone 131126)
ADVICE TO DOCTOR: Treat symptomatically
F10 SUPER CONCENTRATE DISINFECTANT

PRECAUTIONS FOR USE
EXPOSURE LIMITS: No data found
Engineering controls: None required
PERSONAL PROTECTION: Not required
FLAMMABILITY: Not Flammable

SAFE HANDLING INFORMATION
Storage and Transport: Store below 30^{0}C in dry conditions
SPILLS AND DISPOSAL: Soak up on an inert material e.g. dry earth and dispose of in an area approved by local authority by-laws. Flush small spills with copious amounts of water
FIRE/EXPLOSION HAZARD: The product is not flammable or explosive.
OTHER INFORMATION: Ensure good industrial hygiene.
DO NOT mix with soaps or other chemicals.
CONTACT POINT: Managing Director, +03 9841 9901
Chemical Essentials Pty Ltd
KEEP OUT OF THE REACH OF CHILDREN

Issue number: 2
Issue Date: August 2004

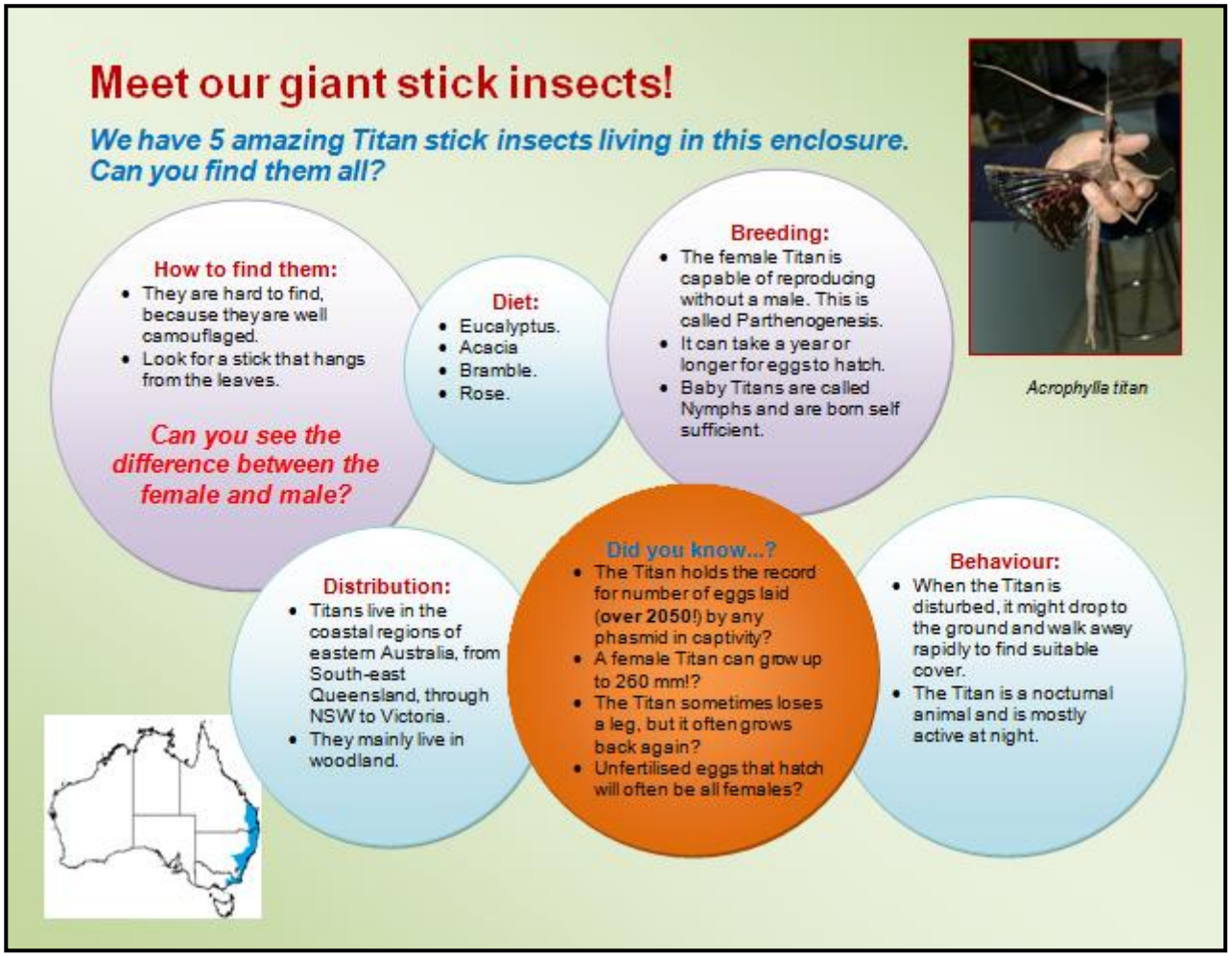
FIRST AID
Wash skin and eyes thoroughly with water after contact. If irritation persists, see a physician. If swallowed, give water or milk to drink. If large quantity swallowed, get medical
advice and attention.

SPILLS & LEAKS
Wash up with water. Dispose to incinerator or (for small amounts only) to sanitary drain if allowed by local, state and federal regulations.

CATALOG # PREPARED BY DATE
2555 MDM November 21, 2006
Full Warranty and Limitations Statement should be reviewed at
www.gfschemicals.com/terms.asp.

Appendix 16.3

Example Display Board.
J. Veenstra 2012



Appendix 16.4 Weekly Checklist.

Day/Date	Task	Sign
Monday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
	Clean the enclosure	
	Scrub the water container and fill with fresh water	
	Fresh browse	
Tuesday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
Wednesday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
Thursday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
	Clean the enclosure	
	Scrub the water container and fill with fresh water	
	Fresh browse	
Friday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
Saturday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	
Sunday **Date:** _____	Spray the leaf	
	Collect eggs	
	Check temperature (20-28°C)	
	Remove dead specimens	
	Count the phasmids	
	Check enclosure for gaps	

Appendix 16.5

Suppliers Details Butterfly net.

- ***Butterfly net***

Company: Australian Entomological Supplies Pty. Ltd.
Office Postal Address: PO Box 250, Bangalow, NSW 2479, Australia
Web address: http://www.entosupplies.com.au/
Telephone Number: (61) 2 8205 7002
Fax: (61) 2 8011 1270

Appendix 16.6

Example of an Animal Data Transfer Form from the American Association of Zoo Keepers.

ANIMAL DATA TRANSFER FORM

AMERICAN ASSOCIATION of ZOO KEEPERS

1. Curator's copy of information on new arrival.
2. Keeper's copy of information on new arrival.
3. Copy for zoo files and/or veterinarian.

DATE: _____
day/month/year

_____
Receiving Institution Name

Common Name_____ Scientific Name_____

Zoo ID #	House Name	Sex	Hatch/Birth Date*	Tattoo Band/Tag #	Weight*	Transponder	Studbook # (Regional/International)

* note if it is actual or estimated

DIET: Present diet and supplements, favored items, problem foods, feeding procedures.

REPRODUCTIVE HISTORY: Relative data, introduction techniques, behavior towards young, specific concerns.

MEDICAL OR PHYSICAL HUSBANDRY: Medication techniques, immobilization techniques, chronic medical problems, Vet Contact.

HUSBANDRY DATA: Exhibit dimensions and description, # of cagemates, disinfection/cleaning needs, temperature and climate control needs.

Please send a copy of this form to shipping institution and state condition of animal(s).

Previous Institution_____

Current Institution_____

Form Completed by_____ **Title**_____

E-Mail_____ **Phone/Fax**_____

Copy of AAZK Enrichment Data Transfer Form attached?
YES **NO**

Copy of AAZK Operant Conditioning Form attached?
YES **NO**

Appendix 16.7

Quarantine Care Sheet Titan Stick Insect.

J. Veenstra 2012 Version 1

Species	
Arrival Date	
Identification	
Age - Sex	

Quarantine Start Date	
Quarantine End Date	

Diet (species)	
Other Comments (e.g. care notes, behaviour, special needs)	

Weight on Arrival	Date	
	Weight	
Weight at the end of Quarantine Period	Date	
	Weight	

Measurements	Date	
	Measurements	

Day:	Date:	Faeces:	Species Leaf:	Comments/Observations
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Day:	Date:	Faeces:	Species Leaf:	Comments/Observations
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17				
18.				
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29.				
30.				

Appendix 16.8

Construction of an Ethyl Acetate Insect Killing Jar.

- Make sure the jar is clean and dry.
- Pour about 1 inch of wet plaster of Paris into the jar. Plaster of Paris is used to absorb ethyl acetate. You may also use paper towel or cotton wool.
- Allow time to set.
- Add ethyl acetate to the jar with an eye dropper until the plaster of Paris appears saturated. No pools of ethyl acetate should remain on the surface.
- Place several crumpled pieces of tissue paper into the jar to keep the insect from getting damaged and to absorb moisture.
- Label the jar with the word “poison”.
- For safety, wrap the bottom of the jar with masking tape or other suitable tape to absorb shocks and prevent the jar from breaking.

(Bearman 2007, p.52).

Material Safety Data Sheet Ethyl Acetate:

ACC# 08750

Section 1 - Chemical Product and Company Identification

MSDS Name: Ethyl acetate
Catalog Numbers: AC149470000, AC149470010, AC149470025, AC149470050, AC149470100, AC149470250, AC167810000, AC167810010, AC167810025, AC167815000, AC232110000, AC232110010, AC232110025, AC232110050, AC232110051, AC232110250, AC232110251, AC268350000, AC268350010, AC268350025, AC268350040, AC296790000, AC326610000, AC326610010, AC326610025, AC326900000, AC326901000, AC326902500, AC327880000, AC327880010, AC364240000, AC364350000, AC364350010, AC364350025, AC364351000, AC423170000, AC423175000, AC423680000, AC423680010, AC423680040, AC423685000, AC610060040, AC610170040, AC610341000, S75118, S80003, S80004, S93229, S93229A, S93230, S93230A, BP1125-1, BP1125-4, E124-20, E124-4, E124RS-200, E124RS200, E145-1, E145-20, E145-200, E145-4, E145-500, E1454LC, E145FB115, E145FB19, E145FB200, E145FB50, E145POP-50, E145POP50, E145POPB-50, E145POPB50, E145RB-200, E145RB-50, E145RB115, E145RB19, E145RB200, E145RB50, E145RS-115, E145RS-50, E145RS115, E145RS28, E145RS50, E145S-4, E145SK-4, E145SS-200, E145SS115, E145SS1350, E145SS200, E145SS28, E145SS50, E189-4, E191-4, E195-1, E195-4, E195N1-19, E195N119, E195N2-19, E195N219, E195RS-200, E195RS115, E195RS200, E195RS50, E195SK-1, E195SK-4, E195SS-50, E195SS115, E195SS19, E195SS50, E196-4, E196-4LC, E196RS115, E196RS28, E196SK-4, E196SS-200, E196SS115, E196SS200, E196SS28, E196SS50, E1984LC, E95NB219, E95SS19, NC9173149, NC9234722, NC9406405, NC9728400, 23-005-51, 23-005-68
Synonyms: Acetic acid, ethyl ester; Acetic ether; Acetidin; Acetoxyethane; Ethyl acetic ester; Ethyl ethanoate; Vinegar naphtha.
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
141-78-6	Ethyl acetate	>99	205-500-4

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear, colorless liquid. Flash Point: -4 deg C.
Warning! Flammable liquid and vapor. Causes eye irritation. Breathing vapors may cause drowsiness and dizziness. May cause respiratory tract irritation. Prolonged or repeated contact causes defatting of the skin with irritation, dryness, and cracking.
Target Organs: Central nervous system, respiratory system, eyes, skin.
Potential Health Effects
Eye: Causes eye irritation. Vapors may cause eye irritation.
Skin: May cause skin irritation. Repeated or prolonged exposure may cause drying and cracking of the skin. The majority of human studies have demonstrated that ethyl acetate does not cause an allergic response on human skin. However, there is one case report of a woman developing a skin allergy to ethyl acetate.
Ingestion: May cause irritation of the digestive tract. Ingestion of large amounts may cause central nervous depression. May cause headache, nausea, fatigue, and dizziness. These effects may be caused in part by ethanol which is released when ethyl acetate is broken down in the body.
Inhalation: May cause respiratory tract irritation. Inhalation of high concentrations may cause narcotic effects. May be harmful if inhaled.
Chronic: Chronic inhalation may cause effects similar to those of acute inhalation. Animals exposed to 4300 ppm (mice) and 2000 ppm (guinea pig), 6 hours/day for 7 days developed minor blood changes & loss of appetite. There was no indication of liver or kidney injury. Rabbits exposed to 16000 mg/m3 (4440 ppm), 1 hour/day for 40 days developed secondary anemia (decreased number of red blood cells), decreased hemoglobin levels, increased numbers of macrophages, congestion and fatty degeneration of various organs, and enlargement of the spleen. A reviewer suggested that the organ damage may have been due to impurities present in the ethyl

Section 4 - First Aid Measures

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid.

Skin: In case of contact, flush skin with plenty of water. Remove contaminated clothing and shoes. Get medical aid if irritation develops and persists. Wash clothing before reuse.
Ingestion: If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Vapors may form an explosive mixture with air. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Flammable liquid and vapor. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.
Extinguishing Media: Water may be ineffective. Use water spray, alcohol foam, CO2, dry chemical.
Flash Point: -4 deg C (24.80 deg F)
Autoignition Temperature: 426 deg C (798.80 deg F)
Explosion Limits, Lower:2.0
Upper: 11.5
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Remove all sources of ignition. Provide ventilation. Use only non-sparking tools and equipment.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid breathing vapor or mist.
Storage: Keep away from sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local explosion-proof ventilation to keep airborne levels to acceptable levels.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Ethyl acetate	400 ppm TWA	400 ppm TWA; 1400 mg/m3 TWA 2000 ppm IDLH	400 ppm TWA; 1400 mg/m3 TWA

OSHA Vacated PELs: Ethyl acetate: 400 ppm TWA; 1400 mg/m3 TWA
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear, colorless
Odor: sweet, fruity odor
pH: Not available.
Vapor Pressure: 73 mm Hg @ 20 deg C
Vapor Density: 3.04 (Air=1)
Evaporation Rate:6.2 (Butyl acetate=1)
Viscosity: 0.44 cps @ 25 deg C
Boiling Point: 77 deg C
Freezing/Melting Point:-83 deg C
Decomposition Temperature: Not available.
Solubility: Slightly soluble.
Specific Gravity/Density:0.9 (Water=1)
Molecular Formula:C4H8O2
Molecular Weight:88.11

Section 10 - Stability and Reactivity

Chemical Stability: Stable at room temperature in closed containers under normal storage and handling conditions.
Conditions to Avoid: Ignition sources, moisture, excess heat, attacks some plastics, rubber, and coatings, confined spaces.
Incompatibilities with Other Materials: Strong oxidizing agents, strong acids, strong bases.
Hazardous Decomposition Products: Carbon monoxide, carbon dioxide, ethyl alcohol, acetic acid.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 141-78-6: AH5425000
LD50/LC50:
CAS# 141-78-6:
Inhalation, mouse: LC50 = 45 gm/m3/2H;
Inhalation, rat: LC50 = 200 gm/m3;
Oral, mouse: LD50 = 4100 mg/kg;
Oral, rabbit: LD50 = 4935 mg/kg;
Oral, rat: LD50 = 5620 mg/kg;
Skin, rabbit: LD50 = >20 mL/kg;
Carcinogenicity:
CAS# 141-78-6: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
Epidemiology: No information available.
Teratogenicity: No information available.
Reproductive Effects: No information available.
Mutagenicity: Cytogenetic Analysis: hamster fibroblast 9g/L Sex Chromosome Loss/Non-disjunction: S. cerevisiae 24400 ppm.
Neurotoxicity: No information available.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: Fish: Fathead Minnow: 230mg/L; 96H; Daphnid LC50=2500 mg/L/96H Golden orfe LC50=270 mg/L/48H
Environmental: Terrestrial: Expected to have high mobility in soil. Volatilization of ethyl acetate from moist soil surfaces is expected to be important. Aquatic: Not expected to adsorb to suspended solids and sediment in water. Atmospheric: Expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase ethyl acetate is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 10 days.
Physical: Substance biodegrades at a high rate with little bioconcentration.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 141-78-6: waste number U112 (Ignitable waste).

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	ETHYL ACETATE	ETHYL ACETATE
Hazard Class:	3	3
UN Number:	UN1173	UN1173
Packing Group:	II	II

Section 15 - Regulatory Information

US FEDERAL
TSCA
CAS# 141-78-6 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
CAS# 141-78-6: 40 CFR 799.5000
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
CAS# 141-78-6: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 141-78-6: fire.
Section 313 No chemicals are reportable under Section 313.
Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 141-78-6 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

XI F

Risk Phrases:

R 11 Highly flammable.
R 36 Irritating to eyes.
R 66 Repeated exposure may cause skin dryness or cracking.
R 67 Vapours may cause drowsiness and dizziness.

Safety Phrases:

S 16 Keep away from sources of ignition - No smoking.
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 33 Take precautionary measures against static discharges.

WGK (Water Danger/Protection)

CAS# 141-78-6: 1

Canada - DSL/NDSL

CAS# 141-78-6 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of B2.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 141-78-6 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 12/12/1997
Revision #10 Date: 6/29/2007

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

Appendix 16.9

Data Recording Sheet.

DATA SHEET INSTANANTANEOUS RECORDING TITAN STICK INSECT

J. Veenstra 2012 Version 1

Date	
Time observed	
Observer	
Weather	

Time	Animal 1	Animal 2	Animal 3	Animal 4	Animal 5	Comments
ID* ->						
0						
.30						
1:0						
1:30						
2:0						
2:30						
3:0						
3:30						
4:0						
4:30						
5:0						
5:30						
6:0						
6:30						
7:0						
7:30						
8:0						
8:30						
9:0						
9:30						
10:0						

* When the TSI is not individually housed, you can ID the phasmid by looking at their individual patterns and markings or their 'battle scars'.

Codes to use:

CODE	MEANING	DESCRIPTION
F	Feeding	Feeding on browse
MB	Moving Browse	Moving from leaf / branch to leaf / branch
MO	Moving Other	Moving to or from ceiling and or walls
R	Resting	Hanging from browse
MOU	Moulting	Shedding
MA	Mating	TSI mating with another TSI
O	Other	Any other behaviour, not what
OS	Out of Sight	Not visible

Appendix 16.10

Monthly Enrichment Calender.

1	2	3	4	5	6	7	8	9	10
- Variation Food Plants - Misting	- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Variation Food Plants - Misting	- Simulate slight breeze (Not on cold days) - Misting	- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Variation Food Plants - Misting
11	12	13	14	15	16	17	18	19	20
- Simulate slight breeze (Not on cold days) - Misting	- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Variation Food Plants - Misting	- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Simulate slight breeze (Not on cold days) - Misting	- Variation Food Plants - Misting
21	22	23	24	25	26	27	28	29	30
- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Simulate slight breeze (Not on cold days) - Misting	- Variation Food Plants - Misting	- Misting	- Indirect Sunlight (Not on hot days) - Misting	- Misting	- Misting	- Variation Food Plants - Misting

Appendix 16.11

Enrichment Data Transfer Form.

ENRICHMENT DATA TRANSFER FORM

1. Quarantine keeper staff
2. Copy for keepers caring for this animal
3. Copy for zoo files and/or veterinarian

Date: _____

Institution _____ Telephone_____

Contact person _____ Fax/Email _____

Common Name_____ Scientific Name _____

House Name_____ Sex_____ Age _____ I.D. # _____

Behavioral History: Behavioral and medical problems, general behavior _____

_____

_____

Reactions to Keepers (shy, likes males vs. females) _____

Stereotypic behavior: List _____ How Frequent _____

How severe _____ Duration _____ Triggers _____ What helps _____

Other relevant information _____

_____

Trained Behaviors _____

How often_____ squeeze cage/chute _____

General Background Information: (Check or list all that apply)

Social- Housed alone_____ Housed w/same species (#) _____ Housed mixed species _____
species housed with_____

Housed on exhibit_____ off-exhibit_____ access to both_____

Rearing type- mother _____ hand-reared _____ peer_____ family/social _____

Preferred enrichment for this animal_____

Enrichment offered: daily _____ weekly _____ monthly_____ scheduled_____ other_____

Naturalistic/Exhibit Enrichment: (When offered or provided, please list or check where applicable)
Static:
Substrates sand_____ gunite_____ mulch_____ leaf litter_____ soil_____ other_____

Plants/rotten logs/termite mounds/trees in enclosure_____

Streams/Ponds_____ Perches-artificial/natural _____

Is indoor area .holding ____ exhibit ____ natural looking ____concrete/chain-link ____ has plants____ No indoors ____

Rotating:
Substrates sand_____ mulch_____ leaf litter _____ soil _____ other _____ How often enrich given _____

Perches-artificial/natural_____ Plants/rotten logs _____

Olfactory _____ Auditory _____

Other (snake sheds, hot rocks/cooling/misting, etc.) _____

_____

Food Enrichment: (variety, presentation, style, please list or check, includes diet and food enrichment)

# of feedings per day_____varied times _____when_____ food scattered _____ hidden _____

Carcass foods (roadkill, hides, parts, feeder animals, bones) _____

Live foods_____ Diet varied - highly _____ moderate _____slightly _____ not at all _____

Preferred foods_____ Diet - blended _____dried _____diced ____whole ____cut _____

Browse (list types) _____

Browse offered: daily _____ weekly _____ monthly_____ frozen_____ fresh_____

Other (rawhide, popsicles, blood trails, etc.)_____

_____

_____

Artificial Enrichment: (Check and list)

PVC feeders_____ Tires_____ Burlap/towels_____ Plastic containers_____

Puzzle feeder_____ Cardboard boxes/tubes/bags _____ Ropes/vines _____

Balls/kegs/barrels _____ Toys (Kong®, dog chews, etc.) _____

Attachments used (chain, rope, bungee) _____ How often enrichment given _____

Other _____

_____

_____

Safety Concerns: (eats plastic or cardboard, items animals shouldn't have, bad experiences, failed items) _____

_____

_____

Comments: _____

_____

_____

_____

_____

_____

Appendix 16.12

Annual Cycle of Maintenance.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding Season												
Full Enclosure Clean & Disinfect (See Paragraph 5.1)												
Full enclosure Maintenance Check (Minor)												
Full Enclosure Renovations/Repairs (Major)												
Routine Health Check (Physical Examination, see Paragraph 8.2.2)												
Heating (Depending on Climate. See Paragraph 4.6)					?					?		
Weighing (See Paragraph 8.1)												

Appendix 16.13

Commercial Incubators.

www.darwinchambers.com
Call for pricing: 314-534-3111

Heated Only Laboratory Incubators:

The H series incubators utilise heat to maintain temperature from as low as 5 °C C. above ambient conditions to 69 °C. If you set point is within this range, you should look at these models for maximum efficiency and cost. Running these models will save you up to 80 % in electricity costs vs. a compressor unit from competitors. Additionally, parts are easily replaced since there is no compressor – should you need repairs past the warranty period.

Most (not the portables) H series incubators can be bought with an optional humidification system.

- **Portable Incubators** – Run on 12 V, battery or 120 V power.
- **HT09 Laboratory Incubator** *– Is our smallest standard incubator. This unit can fit most laboratory benches. Units can be stacked with optional racking set-up.
- **HT030 Laboratory Incubator** – Is a full size incubator with single door.
- **TH055 Laboratory Incubator** – Is a full size, two door chamber.
- **TH085 laboratory Incubator** – Is a full size, three door chamber.

HT09 Laboratory:

Cabinet Construction:

- Standard model features powder-coated galvanised steel door, front, and sides. Interior has 304 stainless steel on door liner, top, bottom, back and sides.

Racking:

- Racking available to stack units.

Door:

- Positive magnetic seal. Reversible.

Insulation:

- Entire cabinet structure and doors insulated using 2” urethane foam.

Shelving:

- 2 stainless steel shelves are standard.
- Full height shelf support pilasters, with double oblong holes on 1” centres. Pilasters mad of stainless steel. 4 chrome plated, stainless steel shelf clips to be included for each shelf.

Electrical characteristics:

- Unit completely pre-wired at factory, and ready for final connection to a 115/60/1 phase – 15 Amp dedicated (recommended) outlet.
- A cord and plug set is included.
- A sole use circuit is recommended.

Popular options:

- Include chart recorder, timed lighting, Watlow controller, and TraceLock electronic/audit capable locks.

Standard Specs:

Temperature Range	Ambient +5 °C to 60 °C
Temperature Control	+/- 0.2 °C
Temperature Uniformity	+/- 0.8 °C
Ambient Temp. Recommendation	21 °C +/- 3 °C
Control Sensitivity	0.1 °C
Control Readout	Actual and Set-Point Values
Sensor	NIST – Traceable Platinum RTD
Controller	Microprocessor based PID
Calibration Capability	Yes, actual and Set Values
Alarm	Audible and Visible
Alarm Type	Deviation in 0.1 °C
Remote Monitoring	Available
Electrical	115 V, 60 Hz, 2 RLA
Interior Cubic Feet	9 net
Required Clearance	1” all sides
Number of Shelves	2
Cord Length	7’
Crated Weight	400 lb