

Husbandry Manual for Goliath Stick Insect

Eurycnema goliath (Gray, 1834)
(Insecta: Phasmatidae)



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Occupational Health and Safety

The goliath stick insect *Eurycnema goliath* is an innocuous species. The female goliath stick insect has sharp spines on her hind legs that may draw blood on soft skin, and this would be most likely to happen when they are in a defensive posture (A. Polak, pers. comm.). There is also a possibility of catching a zoonoses such as a bacteria, fungus or virus that the phasmid may be carrying. Always clean the area where phasmids are being kept in a hygienic manner and also wash hands before and after handling the phasmids.

1 Introduction

There are 900 000 documented species of insects in the world, with thousands more described each year. Insects are estimated to make up 99% of animal species in the world and yet there is little emphasis on displaying this diversity in zoos. In fact there is an extreme bias towards the remaining 1% of the world's taxon, especially towards mammals. Phasmids otherwise known as stick / leaf insects are just one type of insect found in the world. They have been kept in private collections for many years. They make educational displays in zoos that can be quite entertaining. They draw a lot of attention due to their larger sizes and colour variations. The goliath stick insect grows to 20cm in length and is a fairly easy species to keep in captivity. They are not endangered, but make great ambassadors for those that are, such as the 'Lord Howe Island Stick Insect.' There is no IUCN listing for the goliath stick insect and their ASMP category is 'Not Evaluated.'

2 Taxonomy

2.1 *Nomenclature*

Class	Insecta
Order	Phasmatodea
Family	Phasmatidae
Sub Family	Phasmatinae
Genus	<i>Eurycnema</i>
Species	<i>goliath</i>

2.2 *Subspecies*

No known sub species.

2.3 *Recent Synonyms*

- *Acrophylla goliath* Gray, 1835
- *Clemacantha regale* Rainbow, 1897
- *Cyphocrana goliath* (Gray); Brullé, 1835
- *Cyphocrania goliath* (Gray); de Haan, 1842
- *Cyphocrania herculeana* Charpentier, 1841
- *Diura goliath* Gray, 1834
- *Diura magnifica* (Kirby); Günther, 1929
- *Eurycnema goliath* (Gray); Kirby, 1904
- *Eurycnema magnifica* Kirby, 1904
- *Eurycnema viridissima* Kirby, 1904a

2.4 *Other Common Names*

- Goliath Stick Insect
- Goliath Walking Stick

3 Natural History

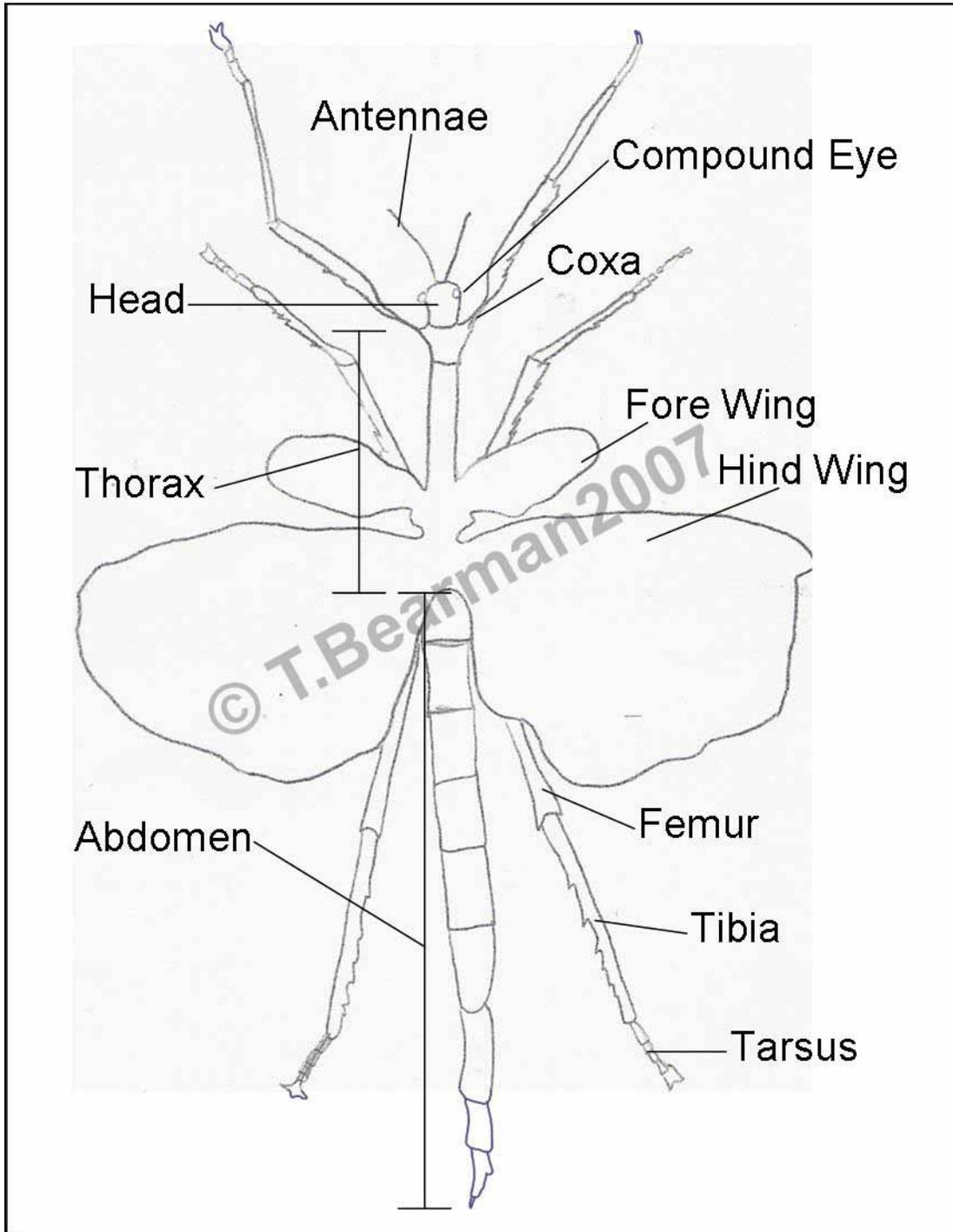


Figure 1. Basic Phasmid Anatomy.

3.1 Morphometrics

3.1.1 Mass and Basic Body Measurements

Mass

Female weighs approximately 40-50 grams, male weighs approximately 30-40 grams.

Body Length (Head to Tip of Abdomen)

Male 121-146 mm, Female 172-204 mm. (Brock, 1998).

Antennae

Female antennae is approximately 32mm; male antennae is approximately 57mm (Brock, 1998).

Wings

Brock (1998) states the average length of the forewings is 44 mm in the female, 15-20 mm in the male.

3.1.2 Sexual Dimorphism

Body Length

Male 121-146 mm, Female 172-204 mm. (Brock, 1998).

Abdomen

Female: Operculum long, tapering to slightly pointed tip. Anal segment semitruncate, with lamina supraanalis present. Cerci broad, 2-2.5 × longer than wide (Brock, 1998).

Male: Margins at end of anal segment slightly broadened; triangular, when viewed laterally, claspers with several black teeth within. Cerci broad, approximately 4 × as long as wide (Brock, 1998).

Thorax

The mesonotum in the female is slightly shorter than in the male.

Males always have bold, uneven, paired, green spines on the mesonotum; typically, 2 pairs on first half-and a pair towards hind part of segment (Brock, 1998).

3.1.3 Distinguishing Features

Head

Large, longer than wide, with 3 ocelli; slightly glossy. Pale yellow, with longitudinal green bands centrally and from eyes to back of head, with brownish lines in between. Antennae much shorter (approximately 32 mm) than length of forefemur in female, with approximately 29 short segments, of which 3rd segment is much longer than 2nd; antennae much longer in male (approximately 57 mm) than forefemur, with approximately 27 longer segments. (Brock, 1998).

Thorax

Green with some lighter yellowish patches, particularly in male; mesonotum in both sexes often with a bluish green median line. Pronotum smooth, marginally shorter than head, with central indentation. Mesonotum less than 3 × length of pronotum in female (slightly longer in male, which has a glossy appearance), usually either completely smooth or with several bluish green tubercles (as in lectotype) in female; if smooth, several tubercles laterally present. Ventral surface with a series of 4-5 pairs of tubercles surrounded by patches of blue. Metanotum somewhat shorter than mesonotum, with several tubercles on lateral margin. Ventral surface of metanotum with 3-4 transverse bands of blue, each armed with a pair of well spaced tubercles. Occasionally, such as in the holotype of the synonym *Clemacantha regale*, tubercles replaced dorsally, laterally, and ventrally by spines. Male always with bold, uneven, paired, green spines on mesonotum; typically, 2 pairs on first half-and a pair towards hind part of segment. The ventral patterning is as in female. (Brock, 1998).

Abdomen

Yellowish green. Final three segments much shorter than previous segments (Brock, 1998).

Female: Operculum long, tapering to slightly pointed tip. Anal segment semitruncate, with lamina supraanalis present. Cerci broad, 2-2.5 × longer than wide (Brock, 1998).

Male: Margins at end of anal segment slightly broadened; triangular, when viewed laterally, claspers with several black teeth within. Cerci broad, approximately 4 × as long as wide (Brock, 1998).

Wings

Forewings moderately long, ovate, green above with white longitudinal bars and patches, bars suffused with purple. Underside bright red in female, edged with green and sometimes reddish in male. Average length of forewings 44 mm in female, 15-20 mm in male. Pre-anal part of hind

wings green, often with white longitudinal bars suffused with purple. Inner margin bright red. Underside completely bright red. Hind wings transparent, with veins invariably green (Brock, 1998).

Legs

Long and slender with bold denticulated ridges, mottled with green and yellow; with bold apical spines; inner margin of hind tibia usually with 7 brown, well spread spines, of which fourth and fifth spines more than twice as long and broad as others. Forefemur more serrate than mid- and hind femur; in male, spine formation usually more pronounced, with up to 3 bold larger spines subbasally on central ridges of mid- and hind femur and tibia (Brock, 1998).

3.2 Distribution and Habitat

The goliath stick insect occurs in eastern portions of Australia, where it can be found on a wide range of shrubs and trees. It occurs as far south as Singleton NSW and as far north as Stratford QLD (Miller, 2003). The projected distribution (Fig.1) includes a small area in Western Australia as there is a distinct possibility that a feral population may form, due to the improper disposal of goliath stick insect frass by phasmid enthusiasts. This frass may contain viable eggs which hatch under the environmental conditions of Western Australia.

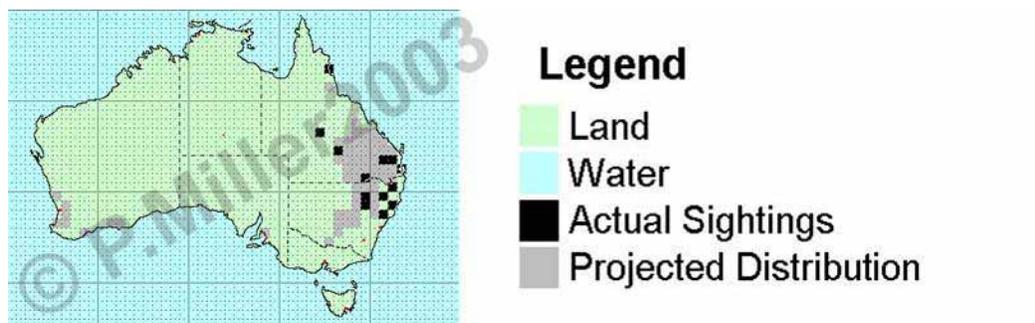


Figure 2. Distribution of *Eurycnema goliath*.

Reproduced from *A Guide to the Stick Insects of Australia* (Miller, 2003), with permission from Peter Miller.

3.3 Conservation Status

- No IUCN listing.
- ASMP category – Not Evaluated – Management level 3. These taxa are censused annually. The census of current and planned holdings for the region is published in the annual ASMP Regional Census and Plan document (Lees & Wilcken, 2002).

3.4 Longevity

3.4.1 In Captivity

The goliath stick insect lives for approximately 5-7 months after hatching. Males will live for 2-3 months once they have reached the adult phase and females will live for 4-5 months once they have reached the adult phase. Eggs require a minimum of 6 months before hatching and will remain viable for up to 2 years (A. Polak, pers. comm.).

3.4.2 Techniques Used to Determine Age in Adults

Future Research

Thorough data on mass especially during the growth and development stages of the goliath stick insect needs to be kept. Sufficient records in this area will allow people to identify an estimated age of individual phasmids.

4 Housing Requirements

4.1 *Exhibit/Enclosure Design*

The goliath stick insect can be kept in many ways successfully the following design is a simple design that can be modified to meet individual institution requirements.

The insects should be given as much space as possible (see spatial requirements) this will allow them to perform all their natural behaviours. For an indoor enclosure the base of the enclosure should be made of a material that is easily cleaned and not porous. The most suitable materials for the base are glass or wood. The walls of the enclosure are best made from glass and the roof should be made from weathered mesh, this will give the enclosure suitable ventilation. For an outdoor enclosure the same materials may be used however it is important to note that keeping the humidity levels up is harder and the insects will require misting more often. For all enclosures the most suitable entry is via a set of doors that opens outwards. Sliding doors are not recommended, as the insects can get caught in the doors. A heat lamp and thermostat is also recommended to keep the temperature just above room temperature.

It is recommended that the phasmid enclosures are checked every 6 months for any necessary maintenance repairs and upgrades.

The use of plastics in enclosure design is an easier and cheaper alternative to glass and wood, however plastics degrade over time and may release toxins while degrading. These toxins may affect your insects by contributing to high mortality rates in nymphs and deformities in adults (L. Jefferys, pers. comm.). Further research needs to be conducted to confirm the extent that these toxins may have on your phasmids. When cleaning plastic enclosures scratches can also be made in the plastic material, this is a suitable place for bacteria and fungi to thrive as they can never be cleaned properly. This increases the risk of bacterial or fungal infections in your phasmids.

4.2 *Holding Area/ Off Exhibit Design*

Use the same design as for the exhibit / enclosure. It should be noted that Sydney Wildlife World use pet packs quite successfully to hold their stick insects when off display providing they remain indoors (A. Polak, pers. comm.).

4.3 *Spatial Requirements*

For a stick insect with body length 204mm, to keep 2 adult females, you will need a cage at least 900mm high, 400mm deep and 450mm wide (Miller, 2003).

4.4 *Position of Enclosures*

Most phasmids in captivity are kept indoors as it is easier to maintain a suitable environment. However for an outdoor enclosure, the open end should face north east, to minimize exposure to weather extremes.

4.5 *Weather (and other) Protection*

For outdoor enclosures shelter is required to protect insects from direct sunlight and from other unfavourable conditions. 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 plastic materials may release toxins into your insect enclosure. Never use tin as this will heat up too quickly to an unsuitable temperature for your insects.

4.6 *Temperature and Other Microclimate Requirements*

Keep your goliath stick insects just above room temperature with moderate humidity. If the eggs are allowed to experience extremes in humidity or temperature, they may die or become dormant (A. Polka, pers. comm.).

They require good ventilation to survive. This will also discourage the growth of fungal and bacterial agents in your phasmid enclosures.

Few people and institutions give their phasmids access to UV light or filtered sunlight, unless they are in outdoor enclosures. This appears to have no affect on the management of the goliath stick insect in captivity, however there is little research or data to show how effective the use of UV or filtered sunlight may be on captive phasmid collections especially with regards to mortality rates in nymphs.

4.7 *Substrate*

The use of a substrate as ground cover has aesthetic purposes and can highlight the natural aspects of your exhibit. Leaf litter is a suitable ground cover as it gives that aesthetic appeal and if sprayed daily will also keep the humidity at suitable levels (A. Polak, pers. comm.).

4.8 *Nestboxes and/or Bedding Material*

Not applicable.

4.9 *Enclosure Furnishings*

The food that is supplied is all that is required in terms of furniture as the goliath stick insect lives on the food it eats. Supplying branches (with suitable leaves) in a small pot with fresh water also has an aesthetic appeal for exhibits.

5 General Husbandry

5.1 *Hygiene and Cleaning*

Ensure that a high level of hygiene is maintained at all times. Simple daily routines including washing hands before, after and between insect enclosures; washing equipment used after every use. Enclosures should be regularly disinfected using F10SC veterinary grade disinfectant. F10SC is a total spectrum disinfectant, it kills all types of fungi (and spores), bacteria and viruses. (For further details see Appendix 3 and Appendix).

It is important to dispose of frass suitably when cleaning. As frass may contain eggs, when disposed it could start feral populations of insects in the local area that they are being kept. Frass should be placed in water, the eggs will then sink and the faeces will rise. This will ensure that nearly all the eggs are collected. Any remaining frass should be incinerated before disposal to avoid accidentally contributing to a feral population.

5.2 *Record Keeping*

Record keeping is an integral part of zoo keeping husbandry for all animal species including insects. Recorded data can be useful for the compilation of workable husbandry manuals and for the use in scientific papers, it is also necessary for good animal management. 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 nesting, laying of eggs, oestrus, menstruations, matings, courtship, pouch checks, sexing of previously unsexed individuals or any other reproductive matter.

- **INT = INTERNAL MOVEMENT/ TRANSFER**

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

- **TAG = TAGGING**

Animal identification by banding, tagging, notching, tattooing, naming or any other method of identification. See 5.3 Methods of Identification for details.

- **W/L = WEIGHT/LENGTH**

Weight or length measurements.

- **Rx/Tx = TREATMENT**

Any medical treatment administered to animals, 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 animals, 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*

This is a fairly non applicable area when it comes to the goliath stick insect as there is very little that can be done without traumatizing your insects. However the following methods are some of the ways that you may be able to individually identify the phasmids. Whether these methods are feasible or not, is up to the individual institution that houses the phasmids.

1. *Individual housing.*

Individuals may be kept in individual enclosures with signage on each enclosure allowing you to individually identify each phasmid.

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.

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 scar" markings will disappear as phasmids have minimal regenerative abilities, especially with regards to their limbs.

4. Wing notching.

This method would not be feasible in many species of phasmid due to the size of their wings being too small, however in the goliath stick insect this could be done with some success. It would not be recommended to wing notch male specimens as it may affect their reproductive status. This method would also not be entirely reliable, as wings can be easily torn and any notches would therefore be lost.

5. Marked with number.

Dash of white paint (water soluble) and a number with a fine tip permanent marker (A. Polak, pers. com.).

5.4 Routine Data Collection

Keeping good records allows for the collection of useful data that may be used a more long term study. Some areas that could use further study include:

- Data on Growth and development across different life stages.
- Data on fecundity through egg collection.
- Data on the incubation of eggs until hatch.
- Data on nymph survival rate especially in relation enclosure design, access to filtered sunlight or UV, temperature and humidity.

6 Feeding Requirements

6.1 Wild Diet

The goliath stick insect will consume most Australian native species of acacia and eucalyptus, however in the wild they travel little and spend most of, if not all of their life in one tree. The goliath stick insect will eat several introduced species including but not limited to (Miller, 2003):

- Evergreen Oak Species (incl. but not limited to *Quercus myrtifolia*, *Q. laurifolia*, *Quercus virginiana*, *Q. chrysolepis*, *Q. wislizenii*, *Q. agrifolia*, *Q. emoryi*, *Q. engelmannii*, *Q. oblongifolia*, *Q. hypoleucoides*.),
- Rose,
- Bramble (Raspberries and Blackberries – *Rubus* sp.),
- Hawthorn (*Crataegus* sp.),
- Pyracantha (*Pyracantha* sp.)

6.2 Captive Diet

Care should be taken when collecting plants as they may have been sprayed with insecticides. Plants collected from nurseries or florists should be washed thoroughly first to remove any possible insecticides.

Diets vary from institution to institution based on the ability to produce certain food plants and the quantities that are available from those successfully produced plants.

Suitable food plant species include (Miller, 2003):

- Acacia species
- Eucalyptus (*Eucalyptus* sp.),
- Evergreen Oak Species (incl. but not limited to *Quercus myrtifolia*, *Q. laurifolia*, *Quercus virginiana*, *Q. chrysolepis*, *Q. wislizenii*, *Q. agrifolia*, *Q. emoryi*, *Q. engelmannii*, *Q. oblongifolia*, *Q. hypoleucoides*.),
- Rose,
- Bramble (Raspberries and Blackberries – *Rubus* sp.),
- Hawthorn (*Crataegus* sp.),
- Pyracantha (*Pyracantha* sp.)

Evergreen species of Acacia, Eucalyptus, Oak and Pyracantha are suitable species all year round. Other food plants such as Rose, Brambles, and Hawthorn are more seasonal.

A diet made up of the above food plants is quite apt for goliath stick insects as these are species that they would be found eating in the wild. Some of these species are introduced species, showing that the goliath stick insect has adapted well with a changing environment. The above food plant species can be cultivated (See section 6.7 Plant Propagation) and are sustainable in the Australian climate therefore allowing for captive animal institutions to easily create their own plantations to reduce food competition with wild phasmids and other leaf eating species.

Other plant species that have been eaten in captivity (Stables, 2001) include:

- Beech,
- Cherry,
- Fuchsia,
- Apple,
- Cinnamon,
- Ferns (Bracken),
- Grasses,
- Guava,
- Hazel,
- Ivy,
- Manuka,
- Privet,
- Palms,
- Hypericum,
- Leguma,
- Robinia,
- Willow,
- Sweet Chestnut,
- Rhododendron.

Approximate Cost of Diet per Animal

Estimating that a small stem of 10 medium sized leaves (quantity per day per adult insect) weighs approximately 150g.

The quantity involved in feeding this animal for one year is 365 small branches of approximately 10 medium sized leaves or approximately 54.75Kg of leaf matter.

Estimated cost of feeding per day is **\$5.00 - \$7.00**.

This includes the cost of:

- Staff wages - for personnel who must maintain the plantations; and, for the keeper time required in collecting, preparing, installing and removing any food.
- Maintenance costs (not including personnel) - such as fertilizer, water, mechanical equipment, transport vehicles and the fuel to operate that equipment/vehicles.

Total cost involved in feeding one animal for one year is approximately **\$1800 - \$2500**. For every additional animal the increase in cost per animal would only be small.

6.3 *Presentation of Food*

Erect branches of suitable food plants in a water source such as a vase. Ensure water source is covered to reduce the risk of a phasmid or their eggs from falling into water. A wooden cover with holes drilled in for plants to be placed in will make a suitable cover for water sources. By erecting the plants instead of placing them flat on the ground you will allow for the phasmid to display more natural behaviours.

It also prevents them from defecating where they eat (A. Polak, pers. comm.).

Supply a small variety of suitable food plants to give the phasmids as much choice as possible. When changing the food plants try to ensure that the phasmids favourite is always fed, they will eat alternate species and this may be provided for enrichment purposes however in the wild they spend most of their life in one tree and it is a natural behaviour for them to eat one species of plant. Ensure that when new species of food plants are introduced the phasmids eat a suitable amount of food. Phasmids may have personal preferences and not eat all species offered. If a particular food plant is not being eaten remove it from the diet. Change the food plants every two to three days for nymphs and every three to four days for adults ensuring that the leaves never dry out.

6.4 *Dietary Changes*

The goliath stick insect will eat the same species of food plants all year round. Some of the introduced species are seasonal and therefore can only be fed when in season.

6.5 *Feeding Regime*

Example Dietary Program for One Week

NB Each phasmid will require one small branch (approximately 10 medium sized leaves) per day.

Day	Diet
1	Two-three species from above list i.e. leaves from two species of eucalyptus and leaves from a blackberry plant.
3-4	Replace the favoured food plant and alternate the other two for enrichment.

6.6 Plant propagation

General Maintenance

Every 2 months it is recommended that the plantation is thoroughly weeded of all unwanted plants. Every 2 months prune any necessary trees, choose branches carefully when pruning, and cut in such a way as to promote wanted tree grow to make future harvesting easier.

It is also recommended that every 6 months the irrigation system is checked for efficiency and any leaks or other problems. After which any adjustments or repairs should be made to the irrigation system to ensure it is functioning properly.

Propagation Methods

Vegetative Propagation

This is useful as you can get uniform, high quality plants that grow at the same rate and flower at the same time. Seedlings are much more variable (Roberts, 2001).

Seed Propagation

This is useful where propagation of species by other methods is impossible, very difficult or too expensive (Roberts, 2001).

Eucalyptus Species (*Eucalyptus* sp.)

Description

Nearly all eucalypts are evergreen and vary in range of height from low shrubs to high trees and have a high amount of variability in structure from species to species.

Distribution and Source of Seeds/ Cutting

Eucalypt species are distributed across all of Australia and seeds may be sources from nurseries or wild trees except those found in the national parks of Australia. Cuttings may also be obtained the same way.

Propagation

Seed - A common method used for germination of eucalypts and related plants 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 (ASGAP, 2006a).

Semi Hard-Wood - Cuttings are generally about 75 mm long although this will vary depending on the physical size of the stem and leaves of the plant. The lower 15 to 20 mm 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 (ASGAP, 2006a).

Growing Season

Seed Propagation – Anytime.

Semi Hard-Wood Propagation – Summer.

Growing Care Notes

It is recommended to plant saplings in the ground during autumn, at this time the environmental conditions are optimal for ensuring your saplings get the best chance after being replanted.

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 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 roots (this can vary according to the time of year), then the tree is likely to die outright. Even if it survives transplanting, its vigor will be greatly reduced (Barclay, 2004).

Plant Pests and Diseases

Many Australian insects will eat eucalyptus species; however they should not cause sufficient damage to the trees to affect the quality of the food that you can collect for the goliath stick insects.

Weed Potential

In countries outside of Australia there is a high weed potential of eucalyptus species.

Acacia Species (*Acacia* sp.)

Description

Also known as wattles, they also grow to a variety of sizes and have a high amount of variability in structure from species to species. Many species have thorns.

Distribution and Source of Seeds/ Cutting

Distributed across the world where there are dry and warm regions. Out of the approximate 1300 species of acacia in the world there are approximately 950 species found in Australia. Seeds may be sources from nurseries or wild trees except those found in the national parks of Australia. Cuttings may also be obtained the same way.

Growing Season

Spring.

Propagation

Seed - the easiest 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 sowing 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 (ASGAP, 2006b).

Softwood cutting - 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 (ASGAP, 2006b).

Growing Care Notes

It is recommended to plant saplings in the ground during autumn, at this time the environmental conditions are optimal for ensuring your saplings get the best chance after being replanted.

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.

Plant Pests and Diseases

Many Australian insects will eat acacia species; however they should not cause sufficient damage to the trees to affect the quality of the food that you can collect for the goliath stick insects.

Weed Potential

Species not native to Australia do have a high weed potential in Australia should they be cultivated and vice versa if Australian acacia species are cultivated internationally.

7 Handling and Transport

7.1 *Timing of Capture and Handling*

Basic capture and handling of the insects for short periods can be successfully done at any time of the day.

7.2 *Capture Equipment*

Generally adult phasmids are fairly easily captured by hand if you can find them. Butterfly nets may be necessary for capturing adult males because they have some flight capability. They are very hard to see amongst the foliage in the wild. If collecting live phasmids in the wild you may wish to beat the foliage (A. Polak, pers. comm.). Before beating the foliage place a suitable tray or cloth on the ground or hold under the branch and beat the foliage with a stick to cause the stick insects to fall on the tray.

7.3 *Capture and Restraint Techniques*

Place one finger under the body of the insect and gently direct insect onto your finger. Allowing the insect to walk onto your finger reduces the risk of limb injury.

Fresh leaves may be used to try and lure a stray insect especially nymphs; however there is no guarantee that they will be lured.

There is little incentive to research chemical restraint techniques as they are economically not feasible for phasmids.

7.4 *Weighing and Examination*

Easiest method is to tare a small stem of leaves in a suitable container on the scales. Place insect onto leaves and record weight.

7.5 *Release*

Place insect on new leaves to release, mist phasmids with water after release.

7.6 *Transport Requirements*

7.6.1 *Box Design*

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 (International Air transport Association, 1998).

Ventilated Box

Ventilation holes must be lined with a fine mesh to prevent any phasmid escapes. 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

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).

Appropriate live animals signage is necessary (International Air transport Association, 1998).

7.6.2 *Furnishings*

A small stem of approximately 15-20 leaves of a suitable food plant should be fixed to the base of the transport box. This will give the insect a suitable amount of food for a maximum of two days travel. It will also allow the insect a suitable amount of space for any required locomotion (International Air transport Association, 1998).

7.6.3 *Water and Food*

A small stem of approximately 15-20 leaves of a suitable food plant should be fixed to the base of the transport box. This will give the insect a suitable amount of food for a maximum of two days travel. Insects should be misted well just before transport. Misting is a daily requirement; and, as they may become too dry during transport, trips should be kept to a minimal time period.

7.6.4 *Animals per Box*

Only one insect per box / compartment (International Air transport Association, 1998).

7.6.5 *Timing of Transportation*

The goliath stick insect is fairly adaptable and as they would be placed on their food when introduced to a new enclosure they will not have any trouble finding it. The main issue to consider when choosing a suitable time to capture, handle and transport them is temperature. If an animal is to be transported they will travel much better if temperatures do not reach extreme highs or lows, therefore choose the travel period to be in the late afternoon or early morning.

7.6.6 *Release from Box*

Ensure new enclosure is fully set up with food and substrate. Spray leaves with water before releasing phasmids into new enclosure. Attempt to release phasmids in the early hours of the evening to give them a reasonable amount of time to adapt to their new environment. Recapture phasmid using previously mentioned capture and restraint techniques (section 7.3). Place phasmid in new enclosure on food source and leave so that they may acclimatize to new environment. Phasmids may as a defense stay still for several hours after being disturbed; therefore they may not investigate the new enclosure for some time. Leave phasmids for 2-3 hours and check on them afterwards to observe their condition and whether they are adapting to the new environment.

8 Health Requirements

8.1 *Daily Health Checks*

- Check they are alive.
- Check they are not caught in a shed.
- Check that they have the required amount of moisture to shed.
- Check phasmids limbs are present.
- Check for any other abnormality.

8.2 *Detailed Physical Examination*

8.2.1 Chemical Restraint

Not applicable.

8.2.2 Physical Examination

- Check head, limbs, wings and abdomen are present and in good condition.
- Check not tangled in shed.
- Check colour of insect. If colour has dulled ensure good misting.

8.3 *Routine Treatments*

Spray with water at least once daily. If the environment is quite dry then it may be necessary to spray more than once.

8.4 *Known Health Problems*

Improper Shed and Dehydration

Signs: entanglement in old shed, and death.

Cause: insufficient access to moisture.

Treatment: assist shed with care and spray with water.

Prevention: ensure that the phasmids are sprayed once a day minimum. If the environment is quite dry it may be necessary to spray more than once.

Fungal or Bacterial Infection, or Viral Disease

Signs: visible fungal growth, bad odour, deformities and death.

Cause: inappropriate cleaning regime, use of plastic enclosures, introduction of infected individual phasmid.

Treatment: thoroughly clean the enclosure and monitor the insect's condition.

Prevention: do not use plastic materials in enclosure construction, ensure enclosure is cleaned thoroughly daily and quarantine new individuals before introduction to the main collection.

Chemical Exposure/ Ingestion

Signs: deformities and death.

Cause: use of plastic enclosures, use of food, furniture, and substrate sprayed with insecticides

Treatment: remove food, furniture, substrate and replace with new items that have been washed before being installed, thoroughly clean the enclosure free from possible chemicals.

Prevention: 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.

8.5 Quarantine Requirements

Newly acquired goliath stick insects should be quarantined for 30 days before introduction into the collection. During this time they should be observed for any arising conditions.

8.6 Vet Procedures

Euthanasia can be carried out via the use of ethyl acetate in a insect killing jar. See appendix 4 for details.

9 Behaviour

9.1 *Activity*

If disturbed, a stick insect may slightly sway as if in a breeze; or, they may stay perfectly still for hours, camouflaging well with their leafy background. When left undisturbed they can be quite active (especially in warmer temperatures). Care must be taken when housing phasmids, not to house too many in the one enclosure. As when the enclosure is opened, the many, very active phasmids, will without a doubt all walk in completely different directions.

9.2 *Social Behaviour*

Little social behaviour between individuals occurs with the exception of fertilised reproduction. Where the male phasmids are in need of being mobile to find their respective females and therefore have some flight capabilities, which in some form will inevitably lead the male to socialise with a female.

9.3 *Reproductive Behaviour*

As parthenogenesis is a common feature of phasmid reproduction males play a little role in the lives of females however fertilized breeding can occur and is necessary for genetic diversity.

Phasmids lay eggs while in the tree where they can fall to the ground. The eggs generally simulate seeds and may either be picked up by ants, birds or other animals, or be left on the ground unnoticed. Upon hatching the phasmids will instantly take to the trees in search of food.

9.4 *Misting*

Daily misting (if not more often) is an essential health requirement for phasmids. It is also a simulation of rain and morning dew; both environmental conditions that a phasmid would encounter in the wild.

9.5 *Behavioural Problems*

The goliath stick insect has fairly simple needs and simple behaviour; and therefore has no known behavioural problems (A. Polak, pers. comm.).

9.6 *Signs of Stress*

When disturbed phasmids will often sway, mimicking the movement of leaves and sticks in a breeze. There is also a defensive posture / display that particularly females will show when threatened. The wings are spread displaying bright colour at the base and they will display a rhythmic jerky movement with sharp contractions of the hind legs. This is when staff should be particularly careful as the sharp spines on the female's hind legs are capable of tearing soft skin.

9.7 *Behavioural Enrichment*

- Daily misting to simulate rain and morning dew.
- Slight breeze to simulate wind or moving air currents.
- Variety of edible foliage to provide food choice.
- Gradual variations in temperature and light to simulation day and night.

9.8 *Introductions and Removals*

There are currently no set quarantine guidelines for phasmids however as a precaution it is recommended that at least a minimum period of 30 days is achieved. This will allow a chance to visually observe the health of the phasmid before it enters the collection.

9.9 *Intraspecific Compatibility*

Stick insects are compatible with other phasmids.

9.10 *Interspecific Compatibility*

Phasmids fall prey to many other species; therefore, it is not recommended that they be housed with any other taxa.

9.11 *Suitability to Captivity*

Phasmids are an easily cared for and manageable group of insects very suitable for captivity. It should be noted that there are some species of phasmid that do have specific requirements such as the Lord Howe Island Phasmid (A. Polak, pers. comm.). Although there is a higher mortality rate in hatchlings as they mature this mortality rate decreases rapidly, providing that correct husbandry is followed. There is a responsibility of the caretaker to safely dispose of excessive phasmid eggs preferably by incineration to prevent releasing them into the wild.

10 Breeding

10.1 Mating System

The goliath stick insect is partially incineration parthenogenetic where females can produce fertile eggs without a male. All of these offspring will be female. If males are present then the goliath stick insect is polygamous where both the females and the males will have multiple partners. These partnerships will result in an even ratio of male to female offspring.

10.2 Ease of Breeding

The goliath stick insect is fairly easy to breed in captivity so long as it is provided with a suitable environment and adequate food is available. There has been much success with breeding this species in captivity, however there is a high mortality rate for nymphs.

10.3 Reproductive Condition

10.3.1 Females

Females must be fully mature, that is in their final stage (or just after last shedding). Females have regressed wing development which has probably evolved because they are partially parthenogenetic and therefore no longer need to look for a mate.

10.3.2 Males

Males must be fully mature, that is in their final stage (or just after last shedding). Males have fully developed wings to ensure that they can fly to a tree with females specifically for mating purposes.

10.4 Techniques Used to Control Breeding

As the goliath stick insect is partially parthenogenetic, separation of the sexes does not control breeding. Contraception's and surgical breeding restrictions are also unavailable due to the size of the phasmid; and, the extreme lack of surgical knowledge on insects.

The only economically feasible methods of control include:

- Culling of excess stock; and,
- Removal and destruction of unnecessary eggs.

Disposal of unnecessary eggs can be carried out via incineration.

10.5 Occurrence of Hybrids

Unknown.

10.6 Timing of Breeding

The goliath stick insects can breed all year round given optimum conditions. Their environment should be kept warm, just above room temperature, approximately 27°C (A. Polak, pers. comm.).

10.7 Age at First Breeding and Last Breeding

After the final moult the goliath stick insect has reached sexual maturity. This is at approximately 3 months and will vary according to quality / species of leaves provided. Temperature will also play a major role in the time it takes for them to reach maturity (A. Polak, pers. comm.).

10.8 Ability to Breed Every Year

The goliath stick insect breeds consistently throughout its adult life.

10.9 Ability to Breed More than Once Per Year

The goliath stick insect can lay throughout the year, laying eggs on a consistent basis.

10.10 Nesting, Hollow or Other Requirements

The goliath stick insect lays their eggs in the tree, where they drop to the ground for their incubation period.

10.11 Breeding Diet

Unchanged from natural diet, this mainly consists of eucalyptus leaves.

10.12 Gestation, Laying Period or Incubation

The goliath stick insect eggs will hatch within 10 -12 months depending on environmental conditions. They will hatch faster in warm, humid conditions.

10.13 *Fecundity*

The goliath stick insect will produce an average of 198 eggs per female during their lifespan (Bedford, 1978).

10.14 *Age at Weaning*

Nymphs are born self sufficient; there is no parental care.

10.15 *Age of Removal from Parents*

Phasmids are strictly herbivorous; nymphs can remain with adults indefinitely if they are all female, if there are males these will have to be removed upon sexual maturity to reduce 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.

10.16 *Growth and Development*

Phasmids are surrounded by an exoskeleton which can not be expanded. In order to grow they must moult (or shed) their old exoskeleton after which they inflate their new exoskeleton with air until it has hardened. Once the new exoskeleton has hardened the insect can continue on, as normal. The goliath stick insect will go through 5 instars (or moults) during its lifetime.

11 Artificial Rearing

11.1 Incubator Type

There are laboratory incubators available that encompass all the features necessary to successfully incubate most insect eggs as well as extra features to make incubation as easy as possible. See appendix 2 for more information. The majority of these incubators are rather expensive however if you are breeding insects on a large scale or have limited time to spend checking your eggs then these incubators are an excellent choice.

A more cost effective approach is to create your own incubator, see section 11.2 incubation temperatures and humidity for a suitable design. Alternatively eggs may be placed on a layer of damp cotton wool in an enclosure with a temperature slightly warmer than room temperature, approximately 27°C. The damp cotton wool will provide suitable humidity for hatching (A. Polak, pers. comm.).



Figure 3. Eggs of *Eurycnema goliath* on damp cotton wool at Sydney Wildlife World.

11.2 Incubation Temperature and Humidity

The eggs seem to hatch in warm weather after wet weather. This may be a monsoonal trigger (Miller, 2003).

To encourage a monsoonal trigger place the eggs in a strainer and rinse for about 15 seconds. This will wash off any fungus growing on the eggs and contribute to the monsoonal trigger needed for hatching. Allow the rinsed eggs to drip dry and then spread out on paper towel to fully dry. Once dry, place the eggs in a dry container with no substrate. Place container on a damp peat moss substrate within another container. Ensure outer container has ventilation holes. This setup will reduce fungal growth on eggs but keep the high humidity needed to simulate the monsoonal season.

Ensure that eggs are checked daily and that nymphs are moved to a food source immediately after hatch.

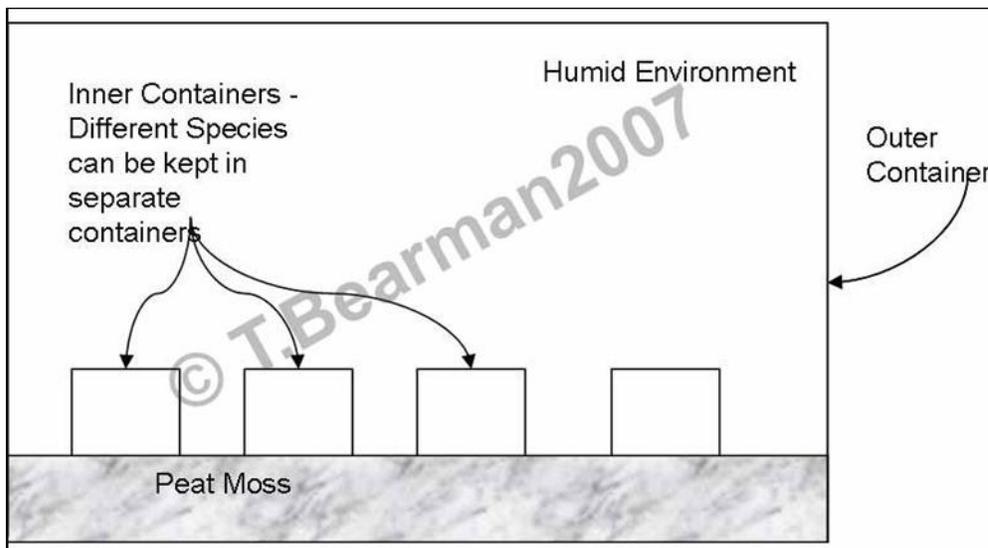


Figure 4. Incubator Design for Phasmid Eggs.

To remove any growth of fungi or bacteria on the eggs and hence prevent fungi or bacteria from inhibiting the development of the eggs it is suggested that goliath stick insect eggs be washed every six months.

Areas of Further Research

1. Research into the most suitable incubation temperatures and humidity levels that would yield the highest hatch rate with the most viable young needs to be conducted. This would allow for maximum efficiency when breeding insects and would have the potential to make captive management plans of highly endangered insects more successful.
2. There may be the ability to control sex determination of individuals during the incubation period. If controlled research was conducted in incubating fertilised goliath stick insect eggs it would allow an understanding of the effects of temperature on sex determination of their eggs. If it was possible to determine the sex of the eggs before hatching then controlling the population of the insects could be more successful and it may even contribute to the effective captive management plans of highly endangered phasmids such as the Lord Howe Island Phasmid (*Dryococelus australis*).

11.3 Hatching Temperature and Humidity

See Section 11.2 Incubation Temperature and Humidity.

11.4 Diet and Feeding Routine

Diets vary from institution to institution based on the ability to produce certain food plants and the quantities that are available from those successfully produced plants.

Suitable food plant species include (Miller, 2003):

- Acacia species
- Eucalyptus (*Eucalyptus* sp.),
- Evergreen Oak Species (incl. but not limited to *Quercus myrtifolia*, *Q. laurifolia*, *Quercus virginiana*, *Q. chrysolepis*, *Q. wislizenii*, *Q. agrifolia*, *Q. emoryi*, *Q. engelmannii*, *Q. oblongifolia*, *Q. hypoleucooides*.),
- Rose,
- Bramble (Raspberries and Blackberries – *Rubus* sp.),
- Hawthorn (*Crataegus* sp.),
- Pyracantha (*Pyracantha* sp.)

Nymphs require younger leaves as they are easier to chew.

NB Each phasmid nymph will require one small branch with a couple of leaves per day.

Day	Diet
1	Two-three species from above list i.e. leaves from two species of eucalyptus and leaves from a blackberry plant.
2-3	Replace the favoured food plant and alternate the other two for enrichment.

11.5 Specific Requirements

Nymphs need to be kept hydrated. It is critical that they are sprayed with water once a day minimum. Higher humidity means that the enclosure, that the nymphs are kept in, will be predisposed to bacteria and fungi. This is suspected to be a large factor in the high mortality rates of nymphs. It is recommended that a non-toxic disinfectant, such as F10, be used to clean the enclosure daily. It is also recommended that the enclosure the nymphs reside in is made primarily of glass. If this is unavailable an enclosure constructed from wood would be the next best option. Only use plastic enclosures as a last resort, plastic is easily scratched during daily cleaning and within the scratches it can harbour bacteria and fungi, increasing the risk of high mortality rates.

11.6 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. However keeping as many records as possible allows you to keep a good eye on the history of your insects. When making records ensure to include the date, the type of entry (i.e. observation), any comments and the individual identification of the insect.

11.7 Identification Methods

This is a fairly non applicable area when it comes to the goliath stick insect as there is very little that can be done without traumatizing your insect. However the following methods are some of the ways that you may, be able to individually identify the phasmids. Whether these methods are feasible or not, is up to the individual institution that house the phasmids. See Section 5.3 Methods of Identification, for further information.

1. Individual housing.
2. Individual markings or patterns.
3. Individual "battle scars".
4. Wing notching.
5. Marked with number.

11.8 Hygiene

See section 5.1 Hygiene and Cleaning.

11.9 Any behavioural Considerations

Immediately after hatch the nymphs should be placed in an enclosure with a food source. Ensure that the food source is the highest climbing point as it is an instinct for nymphs to climb up as high as they can. If the nymphs can climb higher than the food they will.

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15 Glossary

Antennae – One of the paired, flexible sensory organs on the head of an insect, myriapod, or crustacean.

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

Denticulated - Having fine tooth-like projections.

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

Frass - Solid fecal material produced by insects.

Holotype - A single specimen designated as the name-bearing type of a species or subspecies when it was established, or the single specimen on which such a taxon was based when no type was specified.

Incineration – To consume by fire; burn to ashes.

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).

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

Ocelli – (plural) Are simple eyes of many (not all) adult insects which consists of a single bead like lens. Insects may have a single ocellus or they may have a small group of ocelli (up to three).

Operculum - A lid or covering to a chamber-like structure.

Parthenogenesis - The production of living organisms from unimpregnated eggs or seeds.

Parthenogenetic - Not involving the fusion of male and female gametes in reproduction.

Phasmid - Large cylindrical or flattened mostly tropical insects with long strong legs that feed on plants; walking sticks and leaf insects.

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

Propagation – To reproduce or cause to reproduce.

Zoonoses – Diseases which can be transferred from animals to people.

16 Appendices

Appendix 1

Yearly Calendar of Activities

Table 1. Yearly Calendar of Activities

	Task	J	F	M	A	M	J	J	A	S	O	N	D
1	Plant New Saplings in Plantation												
2	Weed Plantation and Prune Trees												
3	Check Plantation Irrigation System												
4	Exhibit Maintenance Check												
5	Wash eggs												

1. **Plant New Saplings in Plantation** (Section 6.6 Plant Propagation)
2. **Weed Plantation and Prune Trees** (Section 6.6 Plant Propagation) Give the entire plantation a thorough weeding where all unwanted plants are removed; at this time also prune necessary trees.
3. **Check Plantation Irrigation System** (Section 6.6 Plant Propagation) Check the entire irrigation system for any leaks/ problems and make any repairs/ adjustments.
4. **Exhibit Maintenance Check** (Section 4.1 Exhibit/ Enclosure Design) Check the entire exhibit for any necessary maintenance repairs/ adjustments.
5. **Wash Eggs** (Section 11.2 Incubation Temperature and Humidity) Every six months wash eggs to remove any fungal or bacterial growth.

Appendix 2 – Commercial Incubators

H24 Incubator - \$4290

<http://www.darwinchambers.com> Phone: 314-771-3111

SPECS:

<i>Temperature Range</i>	Ambient +5°- 60°C
<i>Temperature Control</i>	+0.2°C
<i>Uniformity Temperature</i>	+1.0°C
<i>Ambient Temperature Tolerance</i>	17°C – 30°C
<i>Control Sensitivity</i>	0.1°C
<i>Control Read Out</i>	Actual and Set-Point Values
<i>Sensor</i>	NIST-Traceable Platinum RTD
<i>Controller</i>	Microprocessor based PID
<i>Calibration Capability</i>	Yes, actual and set values
<i>Incubator Alarm</i>	Audible and visible
<i>Alarm Type</i>	Absolute Hi/Lo in 0.1°C increments
<i>Remote Monitoring</i>	Available
<i>Electrical Requirements</i>	115v, 60 Hz, 10 amps
<i>Interior Cubic Feet</i>	24
<i>Required Clearance</i>	1" all sides

CABINET CONSTRUCTION:

- 300 series stainless steel front grill, shroud and doors. Anodized quality aluminum exterior ends and back.
- Interior – INSF approved, white vinyl coated aluminum and 300 series stainless floor with coved corners.
- Barrel lock standard for each door. Locks keyed alike.
- Cabinet mounted on a welded, galvanized frame rail, painted for additional corrosion protection.
- Frame rail fitted with 4" diameter casters, front casters include brakes.

DOORS:

- 300 series stainless steel exterior with white aluminum interior to match cabinet liner. Doors extend full width of cabinet shell.

- Door gaskets of one piece construction.
- Glass doors available.
- Lifetime guaranteed adjustable torsion type closure system with aluminum block supports.
- The face of each door fitted with a 12" long recessed handle with sheetmetal interlock. Handles are foamed-in-place to insure permanent attachment.

INSULATION:

- Entire cabinet structure and doors insulated using foamed-in-place CFC free polyurethane foam.

SHELVING:

- Adjustable vinyl coated wire shelves (3 per door). Shelves capable of supporting up to 250 lbs.
- Full height shelf support pilasters, with double oblong holes on 1/2" centers. Pilasters made of the same material as cabinet interior. Four (4) chrome plated, stainless steel shelf clips to be included for each shelf.

LIGHTING:

- Incandescent interior lighting. Light(s) activated by rocker switch mounted above door(s).

ELECTRICAL CHARACTERISTICS:

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

Appendix 3

F10SC Veterinary Disinfectant

<http://www.f10biocare.co.uk/products1.html>

We believe F10SC to be by far the most effective, safest and economical disinfectant on the market. A total spectrum disinfectant, it is highly effective against avian diseases including Psittacine Beak and Feather Disease and Psittacosis, killing all types of bacteria, viruses, fungi and spores.

It is non-corrosive, non-toxic, non-irritating and aldehyde free so has no adverse effects on people, animals, equipment or surfaces.

F10SC Veterinary Disinfectant (dilution 1:250-500 i.e. 2-4ml in 1 litre) can be used for just about anything - disinfecting floors, cages, perches and toys, food preparation areas, inside incubators, washing eggs and decontaminating hands. F10SC can also be applied as a fog or fine spray to mist rooms to eradicate airborne microbes and to stop cross contamination.

F10 - 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: **F10SC VETERINARY DISINFECTANT** UN Number: None
 OTHER NAMES: **F10 SUPER CONCENTRATE DISINFECTANT** 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^o 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

F10SC VETERINARY DISINFECTANT 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 °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

Appendix 4

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.

Ethyl Acetate MATERIAL SAFETY DATA SHEET

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, E124RS200, E145-1, E145-20, E145-200, E145-4, E145-500, E1454LC, E145FB115, E145FB19, E145FB200, E145FB50, E145POP50, E145POPB50, E145RB115, E145RB19, E145RB200, E145RB50, E145RS115, E145RS28, E145RS50, E145S-4, E145SK-4, E145SS115, E145SS1350, E145SS200, E145SS28, E145SS50, E189-4, E191-4, E195-1, E195-4, E195N119, E195N219, E195RS115, E195RS200, E195RS50, E195SK-1, E195SK-4, E195SS115, E195SS19, E195SS50, E196-4, E196RS115, E196RS28, 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/m ³ TWA 2000 ppm IDLH	400 ppm TWA; 1400 mg/m ³ 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 #9 Date: 5/16/2006

Appendix 5

Suppliers Details:

- F10

AUSTRALIAN DISTRIBUTOR:

COMPANY: Chemical Essentials (Pty) Ltd

Address: 13 Abelia Str, Doncaster East, Victoria 3111

Emergency Telephone number: +03 9841 9901

Fax: +03 9841 9909

- Ethyl Acetate

New Bombay Acid and Chemical Co.

U-2, Behind Sridhar Hospital, Sector-4, Airoli, Navi Mumbai – 4007008, Maharashtra, India.

Email: response@acidsandchemicals.com / manojpanda@acidsandchemicals.com