HUSBANDRY MANUAL FOR

Image 1 Wolf Spider (Provided by http://www.richard-seaman.com/Wallpaper/Nature/Spiders/index.html)

WOLF SPIDERS

With specific reference to Lycosa godeffroyi

Class: *Arachnida*
Order: *Lycosidae*

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Date of Preparation:
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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 III in Captive Animals, Course number 1068, RUV30204.

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.

OCCUPATIONAL HEALTH AND SAFETY

Every species of spider in the world contains venom in their poison glands, but few react with humans causing a reaction (sometimes deadly). These few spiders are classified by us as 'Venomous'.

All Wolf Spider species are generally classified as venomous to humans, though not lethal. Individual reactions tend towards the subjective, depending upon allergies, the amount of injected venom, size and species of wolf spider, age and health of victim.

This generally non-aggressive spider will only initiate a strike if provoked. The effects range from swelling, itching and some minor pain to serious pain at the sight of the wound, a burning sensation, nausea and a headache that can last up to a couple of days.

Despite the outcome of a bite not resulting in death, medical assistance should always be sought, particularly in the elderly and young.

To date Australian wolf spiders have also been falsely associated with necrotic wounds. Research on this topic has thus far indicated that it is not the spider's venom that causes skin necrosis rather, it is the bacteria on their fangs. This specific bacterium is found in the soil, and if one was to examine the list of spider species that have been accused of causing necrotic reactions over the years, it would be seen that they are all ground dwelling/soil inhabiting species e.g. the white-tailed spider, black house spider and... the Wolf spider! Necrotic wounds are painful and can sometimes be extremely difficult to treat successfully.

Image 2. Wolf Spider Fang (provided by www.microscopy-uk.org.uk)

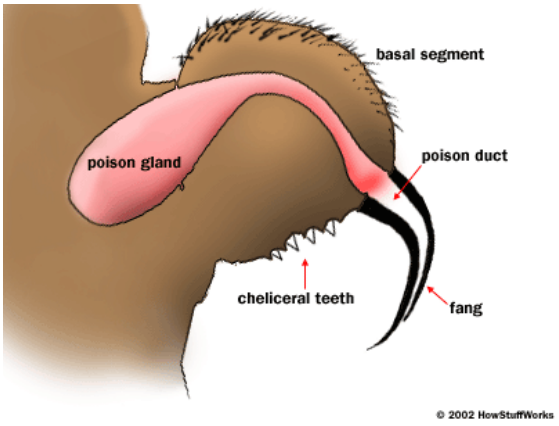

Image 3. Wolf Spider Fang (provided by animals.howstuffworks.com)

Despite being classified a hazardous animal, *Lycosa godeffroyi,* like other wolf spiders, is able to be handled by their keepers with minimal risk, though direct contact should be avoided; particularly with females who are bearing young or an egg sac. Handling at this time can lead to abnormal defensive aggression that will take place during this time.

Image 4. Mother Wolf Spider with babies and disposed egg sack (provided by uglyoverload.blogspot.com)

Handling should be avoided wherever possible, ideally trap or coax the animal into a container when removal is necessary, this avoids undue stress on both the animals and keepers. If handling is required use thick (preferably leather) gloves and have a first aid kit nearby that is easily accessible.

1st Aid Procedure for Bite; (- http://www.termite.com.au/spider-identification.html)

- The patient should be kept calm and rested; all undue movement should be avoided.
- Reassure the patient - their life is not in danger - treatment is available at the hospital.
- A pressure/immobilisation bandage should be firmly applied (but not tight) wrapping the entire limb bitten - similar as for a sprained ankle. This compresses the tissue, thus reducing the flow of venom along the limb. The bandaging should be applied first to the site of the bite before working its way up to the limb joint –

shoulder/groin. Finally work back down to the end of the limb – hand/foot. If the torso has been bitten wrap its entirety.

- A second bandage can be applied to immobilise the affected limb using a splint. This will minimise movement of the muscle of the affected limb in order to reduce the rate of blood flow and venom therein to the vital organs of the body.
- Seek Medical Aid immediately. Call the AMBULANCE phone 000 rather than transport the victim.
- If safe to do so, collect the spider for identification. Often the animal is misidentified and in tern the wrong diagnosis given.

DO NOT
– Elevate the bitten area.
– Give the patient anything to drink.

NOTE: Conditioning of these spiders is also a possibility (to walk into a box or onto a spoon etc for easy and stress free removals and examinations), though it is a time consuming process and will require regularity and patience on the keepers part.

I believe the benefits of conditioning far out way that of any time spent lost in the process. However if there is never, or rarely, any need for a keeper to handle the animal then obviously the benefits of conditioning are minimal to nil. But for those institutes that do handle their animals regularly or wish too do so, conditioning is an extremely helpful and advantageous enterprise.

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1. Introduction

WARNING: As mentioned in the Occupational Health and Safety (OH&S) section at the beginning of this paper Wolf Spiders are classified as Hazardous due to the effects their venom cause in humans. Handling should be done with care and provocation of the spider should be avoided. For First Aid procedures and further information see OH&S section.

To most the simple idea of spiders causes a negative and sometimes phobic reaction, with visions of bites and the results of such. The simple truth is that the predacious nature and almost reflexive movements of these animals causes a natural response to draw away from them, if however we can learn to look past this fact long enough to observe them most would be surprised and even interested in their existence. Many are drawn into their world, comprised of fascinating behaviours and evolutionary lifestyle developments never before witnessed. Once accepted appreciation and respect can be attributed to the once feared and shunned.

In truth all spiders use venom to subdue their prey but in only a few is this substance actually harmful to humans. In most spiders the fangs are either too small to penetrate our skin or the poison to dilute to effect us. Those species physically capable of inflicting a bite will only do so if threatened, feeding or under duress.

Despite being orthognathic (having downward pointing chelicerae), like the Mygalomorphae, there is no close relationship between those two. It is thought that the common ancestor of all spiders was orthognath, and that in the Opisthothelae, comprising of Mygalomorphae (mostly tarantulas) and Araneomorphae (all other spiders), only the Araneomorphae changed their alignment of chelicerae, while the mygalomorphs retained this symplesiomorph feature.
(http://www.bioone.org/perlserv/?request=get-document&issn=0161-8202&volume=033&issue=01&page=0153&ct=1|Factors&SESSID=36bfd66d6edb450a335364696c29c032)

Although these spiders can be frightening in appearance, mygalomorphs (tarantulas) more so than others; the chances of being bitten by them are small. It is therefore important to note that they have a rightful place in the outdoors, and so should not be needlessly killed or persecuted. If confronted by one and its presence is not desired, it can be easily placed in a container and transported to some area where it can continue, unmolested, to live its useful life. Furthermore, It is important to remember that spiders perform an important and vital function in maintaining the populations of pest which damage crops and grasses.

According to the Queensland Museum, two Wolf spider species are known to be predators of cane toads. *Lycosa lapidosa* will take small toads and frogs while *L. obscuroides* has been noted biting and killing a large toad within one hour.
(http://www.austmus.gov.au/factsheets/wolf_spiders.htm)

There is a need to study the consumption rates and levels of multiple spider populations and species. In the hopes that one day biological control methods can supplement, and may even supersede the harmful results of chemical management of pests.

1.1 ASMP Category

This species is not part of the Australasian Species Management Program.

1.2 IUCN Category – see also 2.3

Results of a Red List taxonomic query for Order Araneae (10/4/00)
(http://www.geocities.com/rainforest/9081/actions.htm)

Rosemary wolf spider, *Lycosa ericeticola*- Data Deficient/-,
Glacier Bay wolf spider, *Pardosa diuturna* - Vulnerable/D2
Lake Placid funnel wolf spider, *Sosippus placidus* - Vulnerable/D2
– all 3 species are found in the USA.

Kauai cave wolf spider (*Adelocosa anops*) was also recently (January, 2000) listed as Endangered in Hawaii.

1.3 EA Category

There are no State protections, Threatened Status's, EA State requirements or permits for movement or transfer in relation to Wolf Spiders in Australia.

1.4 NZ and PNG Categories and Legislation

Unknown.

1.5 Wild Population Management

Not required.

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: Arachnida
Order: Araneae
Family: Lycosoidea
Genus: *Lycosa*
Species: *godeffroyi*

2.2 Subspecies

There are 156 Wolf Spider species in 24 genera that are recognized in Australia today (October 2007):

Genus	*Number of species*
Subfamily Zoicinae	**1**
Zoica	1
Subfamily Venoniinae	**11**
Allotrochosina	2
Anomalosa	2
Venonia	7
Subfamily Artoriinae	**35**
Artoria	20
Artoriopsis	7
Diahogna	4
Tetralycosa	4
Subfamily Lycosinae	**109**
Agalenocosa	1
Allocosa	11
Alopecosa	2
Cynosa	1
Dingosa	4
Geolycosa	3
Hogna	11
Knoelle	1

Lycosa	33
Mainosa	1
Orinocosa	1
Orthocosa	1
Tasmanicosa	1
Trochosa	6
Tuberculosa	4
Venator	2
Venatrix	26

Table 1. Species of Wolf Spider (provided by http://www.lycosidae.info/identification/australia/firstpage.html)

2.3 Recent Synonyms

The etymology of the word Lycosidae can be broken down to see the original meaning, and the origin of spiders the common name 'Wolf Spider'. The greek word '*lýkos'* means 'wolf', while '*idea'* – *id2,* is a suffix occurring in English derivatives of modern Latin taxonomic names, esp. zoological families and classes; such derivatives are usually nouns denoting a single member of the taxon or adjectives with the sense "pertaining to" the taxon: *arachnid; canid.*
-http://dictionary.reference.com/browse/lycosid

2.4 Other Common Names

'Wolf spider' is the only known common name for all *Lycosidae* species (throughout the world). Every wolf spider has its own common name e.g *godeffroyi* – garden wolf spider, as there are 156 species, there is likely to be some variants in the common names.
As a genus Wolf Spiders are more commonly mistaken for Nursery web spiders (family *Pisauridae*), or Sac spiders (genus *Miturga*) due to multiple similarities in appearance and behaviour – see distinguishing features 3.1.3.
The 3 easiest ways to distinguish these animals are eye configurations, mating stances and egg sac construction. If you have a single spider, or male, with no egg sac then look to the eyes and section 3.1.3 for the defining answer.

3 Natural History

Wolf spiders are members of the family *Lycosidae*, from the Greek word "λυκος" (http://www.abdn.ac.uk/bestiary/translat/16v.hti) meaning "wolf"; this is due to their nomadic lifestyle in which they actively run down their prey. They were originally believed to hunt in packs like wolves further awarding them their common name. Classed as open range hunters, they are a robust and agile spider, with extremely keen eyesight which aids their nocturnal habits. They live mostly solitary lives and hunt alone. Some are opportunistic hunters, pouncing upon prey as they find it, or chasing it over short distances. Others lie in ambush for passing prey, often from or near the mouth a burrow.

Unlike other spiders *Lycosidae* do not spin webs or nests with their silk. Silk is used for lining a burrow, creating egg sacs or as a trail/drag line and aerial dispersal in spiderlings and smaller wolf spider species.

There are several genera of wolf spider, ranging in size from 1 cm to 8 cm. They have eight eyes arranged in two rows. The bottom row consists of four small eyes in a tight line, the top line of eyes wraps around the front of the animal; consisting of two very large eyes (which distinguish them from the *Pisauridae*) at the front and one eye of a slightly smaller size on either side of the cephalothorax - see 3.1.3 for images and further description.

They depend on their eyesight to hunt. Wolf spider eyesight is superior to many other spider species, this is necessary as they are roving hunters by nature. The eye itself has a highly reflective surface like that of a cats allowing for greater light intake in the darker hours. In addition to this, Wolf Spiders are able to view 'polarised light' (Lindsey 1998) a light invisible to humans but also visible to homing pigeons. This type of light forms patterns in the night sky allowing Wolf Spiders to hunt all evening, but ensuring that they successfully find their way back to their burrows before dawn. Their sense of touch is also quite acute. Wolf Spiders not only are covered in sensory hairs of multiple lengths (see image below), but can also pick up vibrations from the ground, instantly alerting them to the presence of potential food or threats. (Honan, 2008)

Image 5. Sensory hairs of Wolf spider (provided by http://www.cirrusimage.com/spider_wolf.htm)

Wolf spiders are unique in carrying their eggs along with them in a round silken globe, or egg sac, which they attach to the spinnerets at the end of their abdomen. Similarly to scorpions, though unique among spiders is their method of infant care. Immediately after the little spiders hatch and emerge from their protective silken case they clamber up their mother's legs and all crowd onto her abdomen.

Because they depend on camouflage for protection, they do not have the flashy appearance of some other kinds of spiders. In general their colouration is appropriate to their favoured habitat. Most commonly seen are varying shades of browns, greys and blacks often with a 'union jack' pattern on their cephalothorax.

Hogna is the genus with the largest of the wolf spiders. Among the *Hogna* genus in the U.S.; the nearly solid dark brown *H. carolinensis* is believed to be the largest, sometimes reaching more than 26 mm in length. It is sometimes confused with *H. helluo* which is smaller and displays an entirely different pattern and coloration.

Some members of the *Lycosidae* make deep tubular burrows in and around which they lurk much of the time, i.e. *H. carolinensis*. While others, such as *H. helluo*, seek shelter under convenient rocks, bark and other potential shelter that nature provides. *Lycosids* are nomadic and are therefore more likely to be the spiders attracted to human habitation when the temperatures drop during autumn and winter. Most species are commonly found in and around homes and gardens, occasionally wandering right into the house seeking shelter from storms, heavy rain and flooded burrows. Once the weather clears most specimens will wander straight back out in search of more appropriate housing and food.

There are many smaller wolf spiders that patrol pastures and fields and, like all spiders, are important biological controls to harmful and large populations of insects.

3.1 Measurements

Depending on the species size can vary anywhere from 10mm to 80mm across the legs. Body length is approximately 28mm.

3.1.1 Mass and Basic Body Measurements

These are measured by head-body length, total length and height. Adult weights and measurements range and all weights should be measured to 0.01g
Measurements should be taken with calipers where appropriate.

3.1.2 Sexual Dimorphism

Males – Obvious bulbs on the ends of their large pedipalps, small abdomen compared to cephalothorax and long legs. The palps and forelegs of the male are, also, often marked with conspicuous black bands or coloured tufts of hair.

Image 6. Male Wolf Spider (provided by bugguide.net)

Females – Larger abdomen then cephalothorax, more robust then males, pedipalps smaller and more discrete. Only females carry the egg sacks and young.

Image 7. Female Wolf Spider (provided by prometheus.med.utah.edu)

3.1.3 Distinguishing Features

There are many species of Wolf spider, with a leg span ranging in size from about 1-8 cm. Their body colours are typically drab with most having variegated patterns or radiating lines on the carapace, in brown and yellow, grey, black and white (some inland species are ventrally a bright salmon pink). The sides of their jaws may have a small raised orange spot or 'boss'. The exception to the rule is the Desert Wolf Spider – *L. bicolour.* This species is quite brightly coloured; the cephalothorax and forelegs a yellow brown continuing as a stripe along the centre of an otherwise black abdomen.

Image 8. Eye configuration (Provided by bugguide.net)

Eyes are the most unique feature in this species and set in two rows on the carapace. The top row has distinctly large eyes; two in front (set like headlights) with one on either side of the head (like blinkers). The second row has 4 smaller eyes (approximately ¼ the size of the top eyes) and all in one line below the front two eyes (image 8).

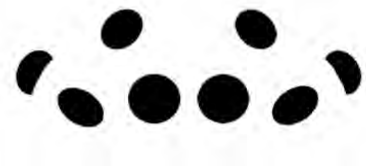
Mistaken Identities

Due to the similarities in their shape and colouration, Wolf spiders as a whole are often mistaken for Nursery web or Sac spiders. The only truly distinguishing features between the three are the configuration of their eyes (see pictures below) and the way that they carry their egg sacs. *Lycosidae* carry their egg sacks by attaching them to their spinnerets at the end of the abdomen. *Pisauridae* (Nursery Webs) carry their egg sacs with their chelicerae and pedipalps holding them bellow their cephalothorax, while Sac spiders (*Miturgid*) construct egg sacs on foliage guarding them til hatched.

Eye Configuration

Sac Spider

Images 9. Eye configuration of Sac spiders (provided by http://www.ehow.com/how_4558972_identify-spiders-utah.html)



Images 10. Eye configuration of Sac spiders (provided by http://www.ehow.com/how_4558972_identify-spiders-utah.html, and http://bugguide.net/node/view/160753/bgimage)

Nursery Web Spider

Image 11. Eye configuration of Nursery web spider (provided by www.eurospiders.com/Pisaura_mirabilis.htm)

Image 12. Nursery Web egg sac positioning (provided by http://www.cirrusimage.com/spider_nursery_web.htm)

3.2 Distribution and Habitat

The family *Lycosidae* are found throughout the world, Australian species being distributed across the expanse of the continent, adapting to an array of climates and habitats.

Image 13. Distribution Map (provided by http://en.wikipedia.org/wiki/Wolf_spider)

Wolf spiders species are found in habitats ranging from dry inland shrub lands and woodlands to wet coastal forests and alpine meadows. Some species, such as the *Lycosa furcillata and L. godeffroyi* are common in suburban areas and gardens. Two of the most common Australian species are *L. godeffroyi* and *L. leuckartii*, have wide spread ranges covering most of the temperate parts of the continent. (http://www.austmus.gov.au/factsheets/wolf_spiders.htm)

Many Wolf Spiders have wide distributions, especially across inland regions. This distribution is aided by their ability to disperse aerially as spiderlings or small juveniles over large distances. Many also have very specific microhabitat preferences such as stream-side gravel beds, montane herb-fields or coastal sand-dunes. Most are wanderers but some build burrows, either open or with a trapdoor, while others may make temporary retreats in vegetation. Arid zone species build turrets to deflect floodwaters during rainy periods, while others use pebbles to plug their burrows. In woodlands, twigs may be used to form a palisade around the top of the burrow. One species of Wolf Spider (commonly known as

the Shuttlecock Spider) collects and binds twigs with silk to form such a palisade around the entrance of its burrow. This barrier can reach up to 8cm in height, a construction which from a distance closely resembles a badminton shuttlecock half berried in the soil. (Lindsey, T. 1998)

The shape and materials used to form burrows and trapdoors may be diagnostic in distinguishing similar-looking species.

3.3 Conservation Status

Wolf Spider species such as *Lycosa godeffroyi* are common and widespread, though the order *Lycosidae* as a whole is far from scarce being found throughout the globe. There are only 4 Wolf Spider species red listed by the IUCN all of which are found in the USA, see section 1.2.

3.4 Predators

Gordian Worms; these are a long thin worm that rely on intermediary hosts to complete their breeding cycle. Living in freshwater, they lay thousands of eggs. Once the young worms hatch they are consumed by freshwater insect larvae. These larvae eventually mature with the dormant worms inside them and are in turn consumed by spiders. Once consumed by the spider the worms break its dormancy, burrowing out through the spiders stomach and feeding upon its internal organs. The spider inevitably dies triggering the worm to leave the dead body, making its way back to freshwater where the cycle starts once again. (Honan, T. 2008)

Sand, Potter, Ichneumon and other Wasps species; these are perhaps the most relentless and persistent of spider predators hunting spiders as food generally for their offspring. Typically, the wasp anaesthetises its victim by stinging it with its long ovipositor before drags its lifeless body back to its burrow where it lays an egg upon the spider's body and seals it in. Paralysed, but still alive and conscious, the helpless spider is eaten by the wasp grub when it hatches.

Other species neither paralyse nor drag their victims to their fate; instead they simply stun their prey. Taking care, when this occurs, to lay an egg upon the victim's body, the location is chosen so that it does not become dislodged once the spider recovers and resumed hunting and foraging. Once this occurs the animal continues its life oblivious to its impending doom. The egg eventually hatches then proceeds to eat the spider alive. Furthermore some tiny wasp species even lay their eggs with in the spiders' eggs, the spiderling embryo providing food for the minute wasp grub as it grows. The sac itself is continuously carried unbeknownst to the mother in question. (Honan, T. 2008 & Lindsey, T 1998)

See image 14 below.

Image 14. Wasp killing and burying an adult Wolf Spider (provided by Lindsey, T 1998)

Praying Mantids; these are known as being a serious threat to any insect or roving spider, snatching the victim and consuming them before they are detected themselves. This happens so quickly giving the spider little, if any, time to react.
Mites; these simply attach themselves to the spiders. One or two can be fixed to the spider without any consequence. If an infestation occurs the spider can starve to death as the sheer amount of numbers interfere with the animals' ability to hunt. (Lindsey, T 1998)

3.5 Longevity

3.5.1 In the Wild

If factors such as weather, predators, health and food supply are not a factor in its early demise, a Wolf Spider can live to an average of 2years in the wild.

3.5.2 In Captivity

In captivity, where all external factors can be controlled, a Wolf Spiders life span is only increased to an average of 2–3years.

3.6 Techniques Used to Determine Age in Adults

To be regarded as an adult, an animal must have a fully developed reproductive system. In the case of Arachnids (and reptiles) this is for the most part, related to size. Size and age are not synonymous with one another. The more food a spider consumes, the faster it will reach its ultimate instar, resulting in adulthood. In many species, the last one or two instars before the penultimate and ultimate instars – the animal is roughly "adult" size. Again, size does not account for individual growth rates, and the reproductive organs of a spider can be very difficult to examine. Heat is also a factor and will be relayed in more detail in later segments. If you receive a spider no matter what the size there are no defining features to distinguish anything more than an approximate age.

4 Housing Requirements

4.1 Exhibit/Enclosure Design

Majority of principles made below refer to a public displayed enclosure not your pet at home.

Enclosure design should allow for both a naturalistic setting for the inhabitant and easily visible display for the public. If the public are unable to see the animal the point of exhibit is defeated, but likewise if the animals is in an unnatural and incompatible environment its health and behaviour are likely to suffer.

To reconcile these issues and any others that arise; a little time, effort and thought will go a long way creating a functional and aesthetic spider exhibit.
The theme, furniture and style of the exhibit are limited only by your imagination. The best practice is to first work out your target demographic adults may spend a little longer hunting for an animal in an exhibit than children, and/or are you going for a natural setting or a themed exhibit etc - followed by, what is your particular species and its natural habitat.

A longer exhibit is more desirable as this allows the animal to roam as it would naturally but also enables the public to view the spider without it wandering too far or deeply into the exhibit itself and becoming lost to the viewing eye.

For species such as *L. godeffroyi* who like to burrow, a pre made burrow placed at the front of the exhibit against the glass allows the spider to be easily located even when it's underground and hiding. An LED red light can also be placed down the burrow to illuminate the spider without disturbing it. This method allows you to have your animal successfully viewable in either a natural day or reverse cycle lit room, such as a nocturnal house.

Substrates should be natural soil and sand blends (thoroughly cleaned and free of chemicals), as found in the bush, this allows the animal to dig should it wish to. To avoid escapes and undesired burrows occurring in your exhibit, a solid inner mould and pre made burrow are perfect with a thin layer (2-3cm) of substrate over the top, if the animal burrows down they will hit the solid layer and be guided to the area in which you would prefer it to burrow (this can also be easily covered over by keepers). To make it all visually flow, the mould can either be made with non-toxic paint in the mix before drying (this is ideal as any scratches or chips later on don't show), or simply painted the appropriate colour when dried. This is shown in below examples.

Exhibit A

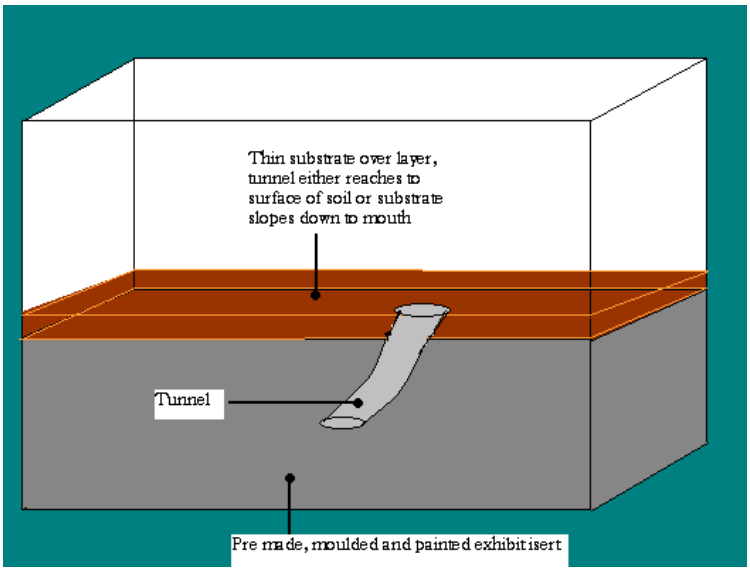


Exhibit B

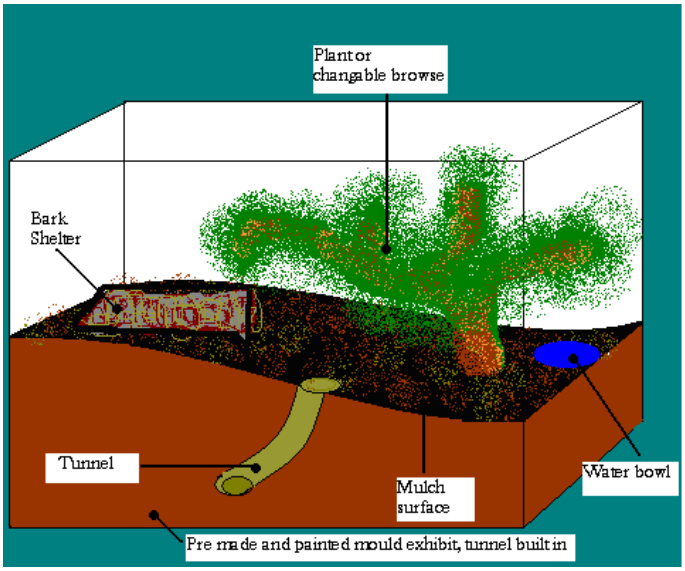


Image 15. Exhibit A, Showing burrow construction (Author 2008)
Image 16. Exhibit B, Showing Exhibit design/set up (Author 2008)

Once the exhibit is made, furnishing is simple; dried leaves and plant matter, a few pieces of bark, branches, a small buried bowl of water (with cotton wool etc. to prevent drowning) and an optional plant or two if desired. Modifications can be made along the way according to your tastes or the animals requirements whilst on exhibit (as shown in Exhibit B).

Warning NOTES: Ensure that you thoroughly clean entire exhibit and furniture, thus removing any substances or chemicals used during construction. The last thing you want to have occurred is to produce a beautiful exhibit only to have your specimen die from residual poisoning.
Another thing to be cautious of is over misting the exhibit. Despite living in a variety of habitats, too much moisture or humidity is not good for them. If a water source is present, only infrequent misting is required.
Cage cards and record sheets on exhibit doors eliminate any doubt or confusion in husbandry matters when more than one keeper is servicing the animal. It may seem to be a waste of time for an invertebrate, but when used properly, I find it to be indispensable.

4.2 Holding Area/ Off Exhibit Design

Temporary and off exhibit housing for both adult and juvenile spiders is relatively cheap and simple, it's a pet pack! Just as simple though are any plastic or glass containers; provided it's sealable with air holes (these can be added with a hot soldering iron) it will suite the purpose.

Pet packs are available in a range of sizes and colours tailored to the keepers' preference. Provided the spider has enough room to roam and hunt when required, size and colour are not particularly relevant.

Image 17. Pet Pack set up for Mother Wolf Spider and young (Author 2008)

Substrate and furnishings are simple and easy to create. If you wish for a more natural environment: have a large pet pack with landscaped substrate (soil, sand, mulch or a mixture), furniture in the form of bark/leaves for cover, a burrow and a small Petri dish etc. as a water supply (infrequent misting will do nicely also). Misting is particularly important in off exhibit housing to keep humidity levels up. One technique to maintain humidity levels is to place a piece of bin liner over the container before clipping down the lid. By placing a limited number of holes in the liner you will reduce the amount of moisture that will escape.

Housing for Spiderlings – The only modification that needs to be made to a pet pack with young is the sealing of the roof; this can be done by simply placing an appropriate length of paper towel on the lid or between the lid and container. If you wish for a more secure, reusable and long term solution a mesh layer can be attached permanently to the underside of the lid with sealant.
Once juveniles they begin to disperse from their mother's abdomen, they can be individually housed in smaller pet packs or similar sealable containers with appropriate sized ventilation hole and substrate.

4.3 Spatial Requirements

Wolf spiders are naturally a solitary, roaming species and should be kept as thus in captivity. More room than less and no accompanying species in their exhibit that they can eat or fight with is ideal. Though if two siblings have been raised together, or a desired mating pair, are housed in the one enclosure with a constant food supply coupled with familiarity towards one another should avoid any complications. Anymore than two adult spiders housed together could present a problem. It should be noted that care should be taken even when housing an adult pair. They should be together only for a period long enough to enable copulation (see Breeding 10.1).

4.4 Position of Enclosures

Enclosures should be kept indoors, so provided it is not placed in direct sunlight, position is not an issue. As this animal is nocturnal and found in a number of locations and conditions; provided it is able to construct a burrow or has access to some form of shelter (bark, logs, piece of cardboard) during daylight hours it will do fine.

Keeping your wolf spider outside is ill advised and will lead to problems such as dehydration and desiccation, over exposure to light and inclement weather.

Warning NOTES: If you are intending to keep this animal outdoors be sure that no aerosol pesticides are being used in your area as this will be a major hazard to you spider.

4.5 Weather (and other) Protection

Again as spider enclosures are mostly kept indoors this will not be a deciding factor in the design. Though should you decide to keep them out doors well draining soil and adequate shelters (that will not become water logged) are musts.

4.6 Temperature and microclimate Requirements

Wolf spiders are extremely versatile and hardy. It is true that they survive with UV lighting and humidity in temperature controlled rooms, but it is also true that they endure well without them. I've kept wolf spiders (*Lycosa godeffroyi)* without lighting, heating and humidity and they have survived with great success, though in some cases they did have access to natural UV.
This hardy spider can be kept quite successfully in a pet pack in the middle of your house or a professional enclosure fully equipped with humidity, lighting and heating; it's entirely up to you. I have achieved best success in determining the specimens' provenance and tailoring my exhibit to those particular needs.
NOTE: despite these spiders being able to grow and survive in any climate should you wish for optimal conditions then heat is a definite factor. If housed in a warm, 24°C is ideal and humid environment your spiders will grow faster and thrive for longer.

Warning NOTES: Which ever conditions you decide to keep your spiders in be aware that sudden and extreme climate fluctuation will kill your animals. It is true that they survive well in all conditions but should you be planning on transferring them from one extreme to another (e.g. natural environment to a temperature controlled room) ensure that there is a sufficient acclimation period, such as a slow increase to the desired. Early on I lost several young spiders and learned the hard way.

4.7 Substrate

Again, I find whatever is closest to their natural environments is best; a soil/sand mix works nicely for presentation and drainage. The sand component decreases the amount or shrinkage you encounter over time from water absorption and evaporation.

Image 18. Substrate and Furniture in Pet Pack (Author 2008)

I find that 3:1, soil to sand ratio works best. Lightly cover the substrate in a sprinkling of mulch or dead and dry leaf matter for aesthetics and as a practical, more natural environment for you animal. Sphagnum or peat moss can also be added to the mix as a method of retaining moisture in your enclosure.

4.8 Nest boxes and/or Bedding Material

Nest boxes are not necessary in this species at it is one of the few spider species who mother their young (see 9.4). Bedding material also is irrelevant in addition to surface mulch and furnishings, if your species does burrow then it will line its own burrow with silk and silk alone, there is no need for you to assist this process at all. Leaves and/or pebbles can be scattered as some species of wolf spider will use these to cover or drag into the opening of their burrow for added protection.

4.9 Enclosure Furnishings

These items are again entirely up to you and whether or not you wish for a natural exhibit design. Rocks, bark, ponds, streams, branches and stumps are all usable, appropriate and can be tailored to your exhibit and preferences. Plants such as grasses, small shrubs or changeable browse are all aesthetically pleasing but of no concern to the spider itself. Though if they give your animal a place to hide and climb upon they are superior to other items for reasons of enrichment. Keep in mind also that any live plants you have in the exhibit will have maintenance aspects and requirements of their own.

Provided there is plenty of open ground for the spider to roam, chase and hunt few problems will arise.

Do not over crowd your exhibit with furnishings as you will lose sight of the occupant and hinder its ability to feed. A form of shelter is ideal particularly in non tunnel building species of wolf spider, a piece of bark, cardboard, shaped mould or engineered tunnel is ideal.

I like the visual effect a water source provides in an exhibit, for a spider it shouldn't be too deep and could simply be created from a curved rock surface, however regular misting will also provide you spider with the amount of moisture it requires.

Display boards and signage are again entirely up to you, your facility may have a set design and depending on your facilities purpose the information you wish to display will vary.

5 General Husbandry

5.1 Hygiene and Cleaning

Cleaning regimes are fairly relaxed when it comes to invertebrate enclosures as little mess is made by the occupants.
Any dead insects that have been fed upon and discarded by the spider should be removed once they have been discovered by you.
Substrate changes are down to your own discretion. They very rarely need to be changed but may need to be topped up on occasions as watering and cleaning will thin out your substrate over time.
Furniture and mulch should be changed or refreshed whenever it starts to smell or mould appears. If you wish to change it on a more regular basis to improve the visual appearance, there is no reason not to.
I find that the silken drag line from your spider may need to be removed every 2-3 months or it can become constricting to your spider and an eyesore. The smaller you're housing space the more regularly this will need to be done.

5.2 Record Keeping

This is an especially important aspect to keeping animals and should not be over looked, even with invertebrates particularly when breeding or raising young. Without records (particularly if multiple people are involved in the care of the spider) no consistency or faults can be found with your procedures and methods. By reviewing your records when a symptom or incidents occurs you are able and better likely to trace the source or reason for the occurrence. This allows you to learn from your mistakes and ever improve upon you methods.
When it comes to working with others if one of you has nothing to do with the animals for a period of time (illness, injury, holiday etc.) you are not out of the loop on changes in procedures or past events to do with the animals in your care. You can immediately pick up from where others have left of, providing consistent and specialised care for you animals.
There are many different forms that your records can take, its really up to you and what best suits you daily lifestyle or what may already be in place in your facility. Below is but one form to be used as a guideline if necessary.

Species – *Lycosa godeffroyi* **Acquisition –** 02.09.2008 – Wild Collect
Common Name – Garden Wolf Spider **Food Type –** Lrg Crickets or Med Woodies
Identification – LGOD 005 **Distinctive Markings –** Lrg dot above eyes
Notes – Mist daily

Date	Feed	Water/Mist	Observations/Medications/Events	Initials
6.3.09	2xLrgCrickets		Fed immediately	AG
7.3.09		Mist	Dead food removed	AG
10.3.09		Mist, H2O top up	Egg sac with female	TC
11.3.09		Mist		AG

Table 2. Example of a daily record keeping sheet (Author 2009)

5.3 Methods of Identification

Unless you are familiar with your individual specimen and their markings or have multiple species with individual and unique patterns, colours and markings it is extremely hard to use visual keys as an identification method. Photos can be used but as most of your specimen should be housed separately, the best method is to keep in individual containers and exhibits with ID numbers, photos (if any) and record sheets attached together, i.e on a clip board, to the door of the exhibit or directly near the off exhibit housing. This will allow you to quickly and efficiently find and identify your spiders when need be.



Images 20, 21 and 22 are of varying patterns from different species of Wolf Spider (Provided, respectively, by http://www.brisbaneinsects.com/brisbane_spiders/LittleStripedWolfSpider.htm, http://en.wikivisual.com/index.php/Wolf_spider, http://insects.tamu.edu/extension/youth/bug/bug164.html)

5.4 Routine Data Collection

This refers to any data you will collect on a daily basis along with any information, behaviours or events that are necessary to records e.g moults, gender, mating, movements, upgrades, mulch/substrate changes, feeds etc.

For simple day to day events such as misting and feeding codes can be set up, provided everyone involved is in agreement and informed, while infrequent or peculiar events (such as unusual or never before seen/recorded behaviours, unknown injuries etc) should be logged with as much detail as possible to assist further down the tract when all memory of the event has been forgotten.

Don't forget to always have a date of the event or information recorded otherwise you shouldn't bother recording information at all. If you don't know when it occurred what use is the information to you!

6 Feeding Requirements

6.1 Wild diet

ADULT: Wolf spiders will eat any live insect or arachnid of an appropriate and relevant size (their size or smaller) they come across, provided it doesn't have a solid outer shell they are unable to pierce. Theses include beetles, moths, flies and their larvae as well as grasshoppers, crickets, plant suckers and the like.
Their diet also includes other spiders and even conspecifics (see 9.3 and Juvenile diet below).

JUVENILE: When the immature young first emerge from their egg sac they are of a size to small to successfully capture any food of a similar size, this means the only animal the same size as them, is them!
Wolf spiderlings will crawl onto their mothers back and live cannibalistically until a select few remain of a large enough size that they are able to leave their mothers safety to hunt and feed for themselves. At this stage the diet is much the same as an adult spider.

6.2 Captive Diet

Keep in mind that wolf spider are some of the few spiders who in fact chase and hunt down their prey rather then lie in wait or capture using silk, as a result you will only receive positive results with live food. The best way to feed is with a small scatter feed in the exhibit allowing them to catch the food themselves. This is acceptable practice as invertebrates are the only animals legally able to be fed live.
Tong feeding live and dead food can be implemented if necessary but know that it is often unsuccessful, if however your spider is not feeding of its own accord you may have no choice. See 6.4 for further readings on subject.

BREEDING: Your diet need not change due to different seasons throughout the year, unless you intend to attempt breeding. The only change necessary is the amount of food you present to your female spider. (See Breeding 10.11 for further information).

ADULT: Any small insects are able to be fed; provided they are no bigger than your specimen and living they will most likely be accepted.
I've had wonderful success with crickets and wood cockroaches, though flies and even other spiders are all adequate choices.
Both crickets and cockroaches can be bought from pet shops and pet suppliers or even directly from the breeders themselves, if a large and regular amount is required.

JUVENILE: Best practice with newly hatched spiderlings is to leave them on their mothers back for 3-4 weeks before separating the entire lot (or as many as possible) into a temporary enclosure of their own. Allow them to feed on one another until they reach a size by which they can be fed pinheads – scatter in enclosure, young are able to hunt for themselves immediately. From then on size appropriate insects can be added as the young grow, fruit flies are an obvious and adequate choice, before small crickets, large flies and other insects are used. To attract fruit flies simply place old fruit such as bananas into the enclosure the flies will make their own way in through the ventilation. Be sure not to leave the fruit in so long that it begins to grow mould, regular changes are advisable and any cleans that may be necessary as a result.

6.3 Supplements

I haven't found any used in institutes nor a need for them. If you feed your food a healthy and nutritious diet there should be no need for supplements.
Due to the method of feeding in a spider all nutrients and vitamins are consumed from within the feed insects' body. If your feed insect is healthy so will your spider be.
If you breed or house your own insects' constant access to fresh greens and vegetables is a great idea, for example; spinach, carrot, apple, sweet potato, broccoli etc.
Adding orange slices to the water is also a great way to introduce vitamin C and all its benefits to your animals' diet.

Images 23, 24 and 25 are of multiple cricket set ups as used in Sydney Wildlife World (provided by Auther 2009)

At Sydney Wildlife World all crickets are ordered through Pisces Enterprises - from Brisbane, Queensland. Contact details can be view in Appendix section 15.

6.4 Preparation and Presentation of Food

As mentioned continuously throughout this section, live insects are the way to go.
If your spider is not feeding, creative methods are going to have to implemented by yourself, force feeding or assisted feeding of spiders are not something I have as yet witnessed or encountered.
Use you initiative, there is no harm in being creative; if one method doesn't work try another. Something as crazy as tying a dead insect to a piece of string and dangling it or simulating movement of some kind might just work!

NOTE: if you are going to try and feed out already deceased food, it should be freshly killed. The longer your food has been dead the less benefit it's going to be to your spider and all the effort put into getting it to feed may be futile.

6.5 Dietary changes

These can be initiated without to much hassle, if you wish to wean the spider between changes you can but I find there is no need for this process to occur. Should the diet change mealy scatter the new food, if your spider doesn't accept it, it may not be hungry. If however your spider refuses to eat the new insect introduced after a few weeks and several attempts you may need to switch back to your previous food type or offer it yet another new species. If the animal still continues not to feed you may need to look at its housing arrangements or records to determine a cause.

6.6 Feeding Regime

Adult specimens should be fed once or twice weekly, a single cricket or desired insect is sufficient. If you intend to feed less regularly, this will not damage your spider, the feeds should consist of a few more insects.

Females, who are coming into breeding season, and / or gravid, should have a daily feed until they lay to ensure they are in peek physical condition. Once they are carrying the egg-sac itself, feeds should return to normal. However if your female is not feeding, it is important that any food not taken by her should be removed from the enclosure (particularly if it's a small enclosure) so as not to stress your spider or cause any undue damage. A simple check a few hours after the feed itself is always advisable and food can be removed at this point in time.

As previously stated, young will feed on one another at a self-regulated rate. Once they reach a size large enough to be fed insects such as pin-heads, constant access to food should be allowed, to discourage cannibalisation, until they reach a size where they can be individually housed.

6.7 Plant propagation; for each species, note:

This point is irrelevant unless you plan on having live plants in your exhibit. Should you choose to do so, care will depend on species chosen. All plants, to my knowledge, are harmless to all species of wolf spider, choice in which plant you decide to exhibit is purely to your tastes, aesthetics or species appropriate habitat plants. Care sheets can be found on the internet or information can be easily obtained from the nursery staff when you are purchasing you plants or even at a later date if you simply wish to ring and find certain information. Don't forget that most plants when purchased have attached to them a simple summery and care information.

7 Capture, Restraint, Handling and Transport

7.1 Timing of Capture and Handling

Time of the day is irrelevant to capture. Only time considerations need to be made in capture and handling are seasonal (see OH&S), and relate to females carrying young.

7.2 Capture Equipment

If conditioning has been implemented, as previously suggested, capture can be done simply with your hands (care and PPE to be used) or your chosen conditioning implement (spoon, container etc). The spider can then be either carried in hands or a small pet pack, depending on reason for capture.
If conditioning has not been implemented, greater care and tools will need to be used. Coaxing or guiding the spider into small pet pack or containers is ideal, if done gently this process will be relatively stress-free for the animal.
Only equipment needed for this capture method are gloves, small pet pack and tongs or other instrument to guide the spider.
All equipment should be properly cleaned between each use.

7.3 Capture and Restraint Techniques

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

If conditioning method has not been implemented, refer to 7.2 this would be the best method, otherwise inspections, movements and/or containment are best achieved by placing the animal in a container of some kind.

7.3.2 The best method of luring and trapping stray animals

Best method is to corner, isolate and/or trap escaped or lose animal with container of some kind, unless the animal has not fed recently luring will be a waste of time and resources. Do not use hands unless gloved, as this experience will be stressful for the animal and is likely to provoke an aggressive response, resulting in a bite. Once trapped under the container, the lid or a piece of paper can be used to slide gently underneath it. Be sure not to move to quickly and allow the animal to walk onto the object underneath if at all possible, to avoid and injuries that may be caused by a hasty motion. Once paper or lid is under the container it can be gently and slowly turned up right and sealed.
If all else fails, use your initiative.

NOTE: If the animal is going to be left in the container for more than a few hours ventilation should be in place to avoid death resulting from suffocation.

7.3.3 The best method for collecting in the field

Physical and mechanical methods are the only ones applicable to this species.

Nocturnal collection

If collecting from the field, night collection is desired. This species is mostly nocturnal, and most easily spotted by the reflection of light in their abnormally large eyes. Use of a head torch or flashlight strapped to one's forehead is best, this ensures that any reflective light from the flashlight returns from their eyes directly back towards yours.

Timing and speed are essential, as this species is fast moving. For capture methods see 7.3.2. Be aware that females, who are carrying young or sacks, should always be approached with caution, as they become aggressively defensive.

Diurnal Collection

Day collections are just as successful and often more convenient. As the animal will be in its burrow the only method of collection is to find the appropriate burrows and physically dig up the specimen in question. Caution and protective gloves should be used as you are likely to dig up other spiders more venomous than the Wolf in the process.

7.4 Weighing and Examination

Only way of realistically weighing specimen is by placing in an empty pet pack that has previously been tared from scale weight.
Examination is purely visual, as no form of anaesthetic, to my knowledge, will do anything but kill the animal. Restraint also is not an option as it is highly likely you will be able to perform this task without damaging the animal or being bitten.
I am unsure if conditioning would be successful enough, in a spider, to cause it to present in certain positions, am doubtful. A successful method, if fangs or belly need to be examined, is to provoke or lure the spider into a rearing position.
Tools such as magnifying instruments may need to be implemented in procedures to allow for a more detailed and closer examination.

NOTE: Any detailed examination is going to be difficult and unnecessary, unless inspecting for wounds or mites upon your animals body. For purposes other than this or individual specimen records (weight, size etc), examinations are irrelevant. If animal is presenting abnormal behaviours, isolation and observation are your best approach. Signs of illness in insects are often presented too late for any cure and are often undetectable in examinations, I suggest that visual checks are the way to go as they are stress free for both parties and will show no less than an up-close inspection.
It is crucial in these circumstances that your records are up to scratch. They may be the difference in being able to diagnose the cause of illness or death in you animal where an examination will fail.

7.5 Release

To release animal, merely lower into exhibit and allow it to enter of its own accord, encouragement may be needed with tool of some kind. Always encourage gently as damage to the spider and stress association can easily occur under these circumstances.

7.6 Transport Requirements

It is possible to send bees, leeches, silkworms and other harmless insects domestically, and sometimes internationally, via Australia Post or Australian air Express as long as you adhere to a number of guidelines. These guidelines are available on-line at auspost.com.au/Pdfs/DangerousGoodsGuide.pdf – refer pages 41-43.

Live insects and organisms generally require Next Day delivery at all stages, as a result they can only be shipped Mon – Thursday. It is advised to limit the time your spider spends in transit as much as possible, to avoid any undue stress or resulting death.

7.6.1 Box Design

Transport boxes for spiders consist of a size appropriate plastic, sealable tube. Ventilation should be present in either lid or container itself, this can be as simple as size appropriate holes or more complicated in the form of an open mesh section (appropriate on lid).
Tube is then placed in padded postage box, tissues or cotton wool are excellent for this purpose, to avoid further movement and resulting damage.
Labelling is a must. Stickers such as 'live insect', 'do not place heavy weights on box' and 'handle with care', should be placed on postal box with no exceptions.

7.6.2 Furnishings

Tube should only contain padding such as tissues, cotton stuffing, cotton wool or sphagnum moss, the choice is up to you. I prefer sphagnum moss as is doesn't rolls into a ball like tissues (this is known to bash into the insect and cause death) or catch on the insect itself as cotton fibres will. Peat moss is also great as water can be added to it to avoid dehydration and resulting death during the transport process.

NOTE: Determine regulations of area you are sending insect to before packing as items such as plant matter are prohibited through mail internationally as well as interstate in some cases.

7.6.3 Water and Food

No food needs to be provided during trips both long and short though animal should be fed before hand. Water can be provided in packing material such as sphagnum moss, peat moss, cotton stuffing or cotton wool by simply moistening prior to packing.

NOTE: The packing should be moist not dripping or sodden. Too much water will drown your animal during transportation.

7.6.4 Animals per Box

Wolf spiders should always be restricted to 1 per box and mothering females should wait until separation from young before shipping is undertaken.

7.6.5 Timing of Transportation

Transport should always be express to minimize time spent travelling and stress related symptoms that can stem from experience.
This can be undertaken at any point during the day, but is best done early in the morning. Hopefully this will allow it to be delivered 'same day' enabling reciprocates to remove and re-home the animal before the day is out, again minimising the amount of time spent in transportation.

7.6.6 Release from Box

Transport in live insects is always a challenge as signs of stress are minimal if present at all.
Animal should be able to rest in transport container (tube portion) at similar temperature to new housing for a period of time before it is introduced.
Food should not be introduced for first 24hours but should be readily available after this time before desired feeding regimes are implemented.
H2O should always be available, in either mist or dish form.
Ensure new enclosure is entirely set up before the actual release to minimize stress on the animals.

When time comes for the release itself, angle the transport tube to encourage the spider to enter the exhibit of it own accord. You may need to give it some encouragement by gently shoving the spider with a tool of some kind that is NOT your hand.
If animal has been conditioned ask appropriate method to use from its former owner.

8 Health Requirements

8.1 Daily Health Checks

Routine observations should be undertaken daily during the cleaning and feeding times spent with your spider. Any abnormalities or unusual behaviours witnessed at these times should be noted immediately in records.
Any weights, if taken, should be measured to 0.01g. The best method when weighing your spider is to place it within a small plastic container, replace in enclosure, re weigh container and determine the difference. This is relatively stress free for your animal if done appropriately.

Signs of illness;
Lethargy
Inactivity – in same location for extended period of time
Lack of appetite/ feed response

8.2 Detailed Physical Examination

This is not often required as obtaining close inspections of a spider can be rather difficult. Again the use of a small plastic container can be beneficial, once contained within a magnifying glass can be used to observe the animal in more detail.

8.3 Routine Treatments

There are no routine treatments applied to this species and very few treatments implemented in general with spiders.

8.4 Known Health Problems

Very few health problems are known to spiders. Diseases and viruses do not affect them, deformity rates are not applicable as any that do occur result in death. The problems more commonly encountered health problems involve Mite and Worm species – see Predators 3.4.

Image 26. Wolf Spider with unknown mite infestation (provided by Lindsey, T. 1998)

Laelaptid mites (genus *Ljunghia Oudemans*) are one mite that affects multiple spider species, Wolf Spiders included. Mites are easily spotted with the naked eye. An infestation is visually observed, see Image 15 above.
Treatment is simple enough; mites can be washed off using water or 70% ethanol/water blend. Great care should be taken when using ethanol around your spider as incorrect measurements and application will result in death. This procedure should only be done by a veterinarian or experienced invertebrate keeper. If bathing you spider is not a desired method of mite removal, biological methods can be introduced. The *Hypoaspis* species of mite can be introduced to the enclosure to clear infestations as this species of mite eats other mites and fungus gnats.

Prevention is common sense; good hygiene and regular substrate changes, ideally before an infestation occurs, or when mites are first spotted.

8.5 Quarantine Requirements

Generally this animal is housed in solitary due to its nature. If you have a new specimen with which you plan to breed, it would be advisable to allow it to remain in a solitary enclosure for at least a month. This will enable you to observe the presence of any potential diseases or parasites that may have come with the new specimen.

8.6 Vet Procedures

No vet procedures on spiders could be found.

8.7 Euthanasia

This is a simple enough procedure if required. Though, it should be noted that most spiders if ill will not exhibit any symptoms until they are dead.
One method is is to place the animal into a small plastic container, or something similar, is required before placing the container and occupant into a fridge. This allows you to slow the animal's metabolism down enough before implementing the euthanasia itself and endangering the keeper. After a short period (e.g. ~1 hour) the container can be further moved into a freezer where it should remain over night.
The more professional method is to use a "killing jar". This is simply a sealed container with a cotton ball soaked in chloroform or acetone. This will slow and eventually stop their respiration.

8.8 Post Mortem results

These should be left to the vet. Please note spider internal systems are small and intricate making it unlikely for you to obtain any results other than parasite infestations – which are sometimes visible to the naked eye.

9 Behaviour

9.1 General Behaviour

Much of a spiders behaviour is governed by instinct – that is genes not only determine its morphological and physiological make-up but also how it carries out its everyday tasks and responds to it environment. Equally behaviours and skills are learnt just as much through repetition and practice.

As stated several times throughout this paper Wolf Spiders, like all spiders, are predacious. Should one come into contact with another it is likely that one will fall victim to the others appetite. This is also why males must take extra precautions when searching out a mate (see 9.4).

With enough food and space spiders will obliviously coexist in the wild though if contact is made as stated above the smaller, weaker or more determined of the two will inevitably devour the other.

Humans are not considered food to a spider and therefore will not usually attack unprovoked, rather preferring to flea from harms way. As a rule spiders avoid us though will attack if the spider considers its life on the line. Provided we keep this in mind at all times our safety can be ensured when handling and caring for these animals.

9.2 Activity

Wolf Spiders are highly active animals. Most species are nocturnal, though there are a few who to not confine to this classification and are diurnal (*L. hilaris* a New Zealand species is one such animal).
The majority of their time is spent roaming, migrating and hunting for any unfortunate insects or arachnid that happen to cross their path.

During mating the males will go in search of females, travelling large distances until they find the scented drag-line with which to track them down.
Females continue to travel and hunt whilst encumbered with young. The spiderlings though do not lave her back until they are of a safe size to hunt and survive. During this time they may balloon and take part in the phenomenon of 'gossamer flight' travelling to incredible altitudes and covering sometimes thousands of kilometres.

9.3 Social Behaviour

Being a spider social behaviour is not something that is often encountered, being predacious in nature. Females will care for young but only to a certain age and size, once separated from the young all maternal ties are also severed. Should she meet her young at a later point in time, by which they are now near or fully grown, no lingering maternal behaviours or recognition will be displayed. Instead one of the two spiders will be consumed.

9.4 Reproductive/Courtship Behaviour

All wolf spiders are hunters. A male therefore has to ensure that any female he approaches realises that he is a potential father for her young and not an especially obliging meal.

In temperate countries mating and egg laying tends to occur around spring (August to September) or early summer (October to November) occasionally continuing over the summer months. After copulation the male and female continue as they did before the act, living separate lives. It is not uncommon for the male to seek another mate; while the female catches food, in large quantities, to nourish her developing eggs.
It is always the male who seeks out the female, never the other way around. The urge to mate is presumed to overcome his predatory instincts for food. Nevertheless, without a way to persuade his prospective mate that the time is opportune for mating rather than eating, he will unfortunately be consumed. (Forster, R., Forster, L. 1999)

Some adult male Wolf spiders of smaller-sized species are known to disperse by air in order to find mates. (http://www.austmus.gov.au/factsheets/wolf_spiders.htm)

A male is able to discover from the smell of the females drag line whether or not she is receptive to copulate. This information is extremely important to the male, for if he advances on a female prematurely, or on one who has already been mated, he will almost certainly be consumed by her. Even if she is fertile and awaiting a partner, he has to proceed with caution, ensuring she knows who he is and what his intentions are before he reaches her striking range.
To achieve this end the male sends a long sound signal by tapping his legs on the ground or upon a fallen leaf. Some species have evolved small corrugations on their palps with which they send a buzzing sound (Attenborough, D. 2005). Since Wolf Spiders hunt on the ground, they all have exceptional eyesight; therefore the male is able to back up his mating calls with visual signals. The palps and forelegs of the male are usually somewhat conspicuously marked with black or coloured bands/tufts of hair. These he waves with vigour, the movements are often jerky and give the impression that the animal is moving in slow motion, or frame by frame, as each joint change is clearly perceived.

One European Wolf Spider, *Pisaura mirabilis*, has developed a mating ritual that has yet been observed in any other species of spider. The male begins by catching a fly or other appropriate insect species. Instead of eating it, he carefully wraps his prey in silk and, carrying it within his jaw, seeks out of a female. When he eventually finds prospective mate he approaches with caution, like all males, *P. mirabilis* however deliberately enters within the females striking range. As he does so he straightens his front legs so that his body tilts upwards allowing his gift to become quite evident – and strategically placed – it is between him and her jaws. She attacks bitting into the gift. As soon as she does this, the male relinquishes his gift and swiftly swivels his body around, pointing his head is downwards. While she is busy eating his offering, he ducks under her abdomen, swiftly finding her genital pore before inserting his palps. Once the male has inseminated the female he leaves as quickly as possible. (Attenborough, D. 2005). See below image.

Image 27. *Pisaura mirabilis* Courtship ritual (provided by Attenborough, D. 2005)

9.5 Bathing

Literature and anecdotal experience indicates spiders as a whole, do not bathe. This is due to their size, biology and feeding habits. There is no real need for a creature such as a spider to bathe or clean itself due to their exoskeletons and the regular shedding of such. "Exoskeletons provide excellent protection and they can act as almost impermeable barriers to water." (Knox *et al*, 2001)

Some behaviours, such as the 'sucking' of the tips of their feet, have been observed in captive Huntsmen Spiders. This generally takes place directly after they have been misted, whether it is a cleaning behaviour, drinking or merely the animal tasting its surroundings one cannot determine without further observations and study.

9.6 Behavioural Problems

No behavioural problems have been witnessed, by myself, other than aggression, though as stated continuously, being predacious Wolf Spiders will attack any invertebrates of appropriate size who come within range. This is just a feed response rather than attacking an animal for dominance or any other reason as some animals will do. This behaviour coupled with their solitary nature dictate their need for individual housing. Once housed as such they are quite content and display no negative or worrisome behaviours.

Having said this should the animal be housed inappropriately lethargy, unresponsiveness, or erratic behaviours may be observed. If you spider is happy any healthy there should be no abnormal displays witnessed by yourself. Do not ignore abnormalities in your animals

with invertebrates these are often the only warning signs you will receive before death occurs.

9.7 Signs of Stress

There are very few and they are often no different from behaviours considered natural. The best way to counteract this disadvantage is to know *your* animal. Should any behaviours listed below be uncommon with your particular specimen then there is a problem. Detection of problematic behaviour early is key to finding the source and putting a stop to it. Stress kills all animals, though with invertebrates very few signs are displayed over a short period of time before death is encountered. Witnessing the below behaviours on occasions and by themselves is not something to worry about as these will occur naturally.

Signs;
Abnormal aggressiveness
Erratic or jittery behaviours – with or without your presence
Lethargy
Inactivity – in same location for extended period of time
Unresponsive to food and actions in cage
Hiding
Constantly scaling the walls of cage
Regular escape attempts
Sitting or jammed up in corners of the roof
Anything out of the ordinary or never before seen.

9.8 Behavioural Enrichment

Behavioural enrichment is not necessary if you are feeding the animal live insects and it has space enough to move freely with somewhere to hide from perceived dangers. I have yet to find a need or form of enrichment for this or any spider other than the ability to behave as it would in the wild.

9.9 Introductions and Removals

These should always be done with care and preparation to avoid stress, enable a quick response from you should things turn ugly or anything unexpected occurs.

Introductions – should only be implemented if you desire to breed your specimen. There are two ways to introduce your animals to one another; they are the 'soft' and 'hard' methods. Despite what method you choose you should always feed up your female prior to the meeting so she is less inclined to consume your male.
Soft Method – Allow your female to roam over the substrate of a, longer than wide, container. Once she has run several times around the enclosure and left a sufficient amount of drag-line throughout separate the cage into 2 sections with a mesh divider. Place Female at one end and Male at the other.
This will allow you to gage whether your female is interested in attacking your male and allow the male to discover the female's drag-line triggering the mating desire in him. Once you judge the situation safe for both spiders remove the divider. If mating occurs, great! But be sure to remove the male directly after so he is not consumed by the female.
Hard Method – This entails merely placing a male into the enclosure of a well fed female and hoping for the best. Should mating not occur remove the male so neither of them

decide to feed. If mating does occur again remove the male immediately after copulation has finished.

Removals – this can happen at anytime; removing a male after breeding, removing young or removing a single animal from an enclosure in need of a clean. The first and last have been covered in section 7.3.2 with a trapping method. To separate young from their mother the female must first be removed, again use trapping method – you may end up trapping a few young in the process, but these can be removed from mum later. Your next step is to ensure the cage your young are left in is escape proof, see section 4.2.
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9.10 Intraspecific Compatibility

Again being predacious in nature it is best to house separately from any other spiders same species or otherwise. Only mothers can be housed with their young.

9.11 Interspecific Compatibility

As stated, the predacious nature of this species does not allow for compatibility with any other species or specimen. Unless you house this spider with animals they are physically incapable of killing and in turn being killed by, it is inevitable your spider will eventually consume its fellow occupant.

Regards the solitary disposition of Wolf Spiders, it is advisable that you house this species alone. This will avoid any aggressive interspecies relations and any undue or resulting stress from said encounters.

9.12 Suitability to Captivity

Wolf Spiders, in my experience, adapt extremely well in captivity. Some can suffer from illness or a severely decreased life span if their activity levels are constantly stimulated or interrupted. If a natural life settings is not available and/or high levels of stress are encountered on a daily basis your animal's condition will suffer.
If the vicinity of your spiders' home endures high levels of daily traffic, constant loud noises /disturbances or is in an interactive area, then it is likely that your specimen will unfortunately suffer a life expectancy of approximately 6 months. Removal of you specimen from this area is advised.

If however you locate and house your specimen appropriate to their natural requirements, there should be no need for concern. These spiders adapt extremely well to a captive environment often living past their wild life expectancies.

10 Breeding

Genetic diversity is one of the most important aspects to every population and any facility wishing to ensure a healthy breeding program/population would be advised to keep records on such to ensure that inbreeding and the repercussions of such an event never occur.

10.1 Mating System

Mating stances vary between species of spiders. Wolf Spiders adopt a posture common to most ground dwelling, hunter variants.
Generally the two mating spiders face one another, the male climbs atop the female thus enabling him to reach down, beneath her abdomen with his palps. (Forster, R., Forster L. 1999)
Some Wolf Spiders have evolved other methods of mating, as mention in section 9.4 with the European Wolf Spider, *Pisaura mirabilis*.

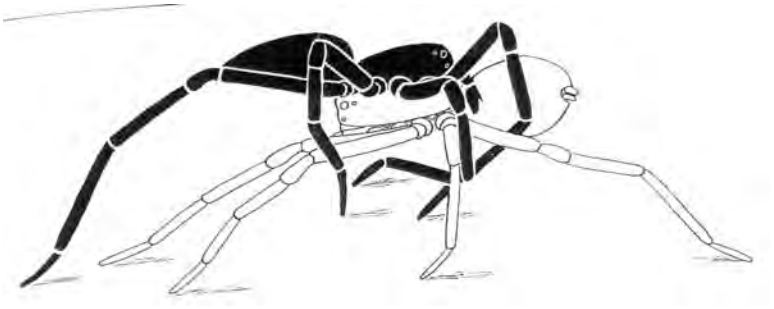

Image 28. Mating stance of Wolf Spider (provided by Forster, 1999)

Image 29. Mating stance (provided by Attenborough D. 2005)

10.2 Ease of Breeding

Regards the opportunistic feeding nature of these animals breeding can be a tricky business. Enabling your female to accept your male is the most challenging aspect of the procedure. However if a female is well fed and the introduction of a male is organised and controlled (see 9.9) there is a likelihood of success.

10.3 Reproductive Condition

As with any animal you intend to use for breeding, both parties must be of a healthy and robust nature. Ensure the insects you feed are also healthy, and if neither animals are of a desirable size or condition, delay breeding until they are.

10.3.1 Females

Your female, especially, is going to need to be well fed (see section 10.11), not only to discourage her from your male but to ensure she has the appropriate body mass to successfully sire hundreds of offspring.

10.3.2 Males

Feed your male specimen up also, he is just as capable of devouring your female as she is of him. It is less likely for the male to attack though should he be underfed there will be less of a desire to breed on his part.

10.4 Techniques Used to Control Breeding

Being of a solitary and predacious nature, housing is separate for all specimen. This method instantly enables you to control all aspects of breeding as contact between the male and female is done by your choosing.

10.5 Occurrence of Hybrids

I have found no evidence to support this occurrence; this however does not rule the chance of hybrids out completely.

10.6 Timing of Breeding

Breeding occurs in the warmer months, spring to early summer, though if you instigate artificial climates within your facility there is nothing stopping you from breeding all year round.

10.7 Age at First Breeding and Last Breeding

Breeding can occur the minute the spider in question reaches sexual maturity - has fully developed genitalia. As the rate of growth in these animals is related to food consumption and environmental conditions time taken to fully develop sexual organs varies - see 3.6.

10.8 Ability to Breed Every Year

All Wolf Spiders are able to breed annually but keep in mind that the more often you breed your anima, the greater the likelihood of decreasing their life expectancy, especially your females. If you are breeding from the same animal every year you also diminish the genetic diversity amongst your population.
If you keep all these factors in mind and continue to feed you female as stated before copulation and whilst she is gravid there is nothing to stop you from breeding you spider every year.

10.9 Ability to Breed More than Once Per Year

A female can store a male's sperm in her body, after copulation, for an extended period of time. This ability enables her to produce multiple egg sacs, without a males continual presence. Keep in mind their may be varying time delays between the egg sacs, as your female will only lay once conditions are suitable. See also 10.8.

10.10 Nesting, Hollow or Other Requirements

These are all irrelevant. Nothing new need be added to a Wolf spiders environment as she creates an egg sac to protect her eggs which she then carries about with her until eggs are ready for hatching. Other than the diet changes, which have already been outlined, nothing should change in the females enclosure.

10.11 Breeding Diet

As mentioned earlier, the only change necessary is the amount of food you present to your female spider. If she is well fed she is more likely to accept the presence of a male with less chance of consuming him (see Behaviour 9.4). Having her in a healthy condition is also indispensable to the successful nourishment and production of healthy, viable eggs and numbers.

Food should be presented to the female daily until she refuses; introduction of the male now is good when she is full and unlikely to attack. Once mated food should be constantly offered but removed whenever no interest is shown. You may return to your original adult feeding regime once the presence of the egg sac is confirmed.

10.12 Incubation Period

This is best left up to the female as she carries the egg sac around with her. To attempt removal would be both pointless and most likely incur an attack on your person. It is also likely that the young would perish in the removal process.

Some species have been observed physically incubating their egg sacs by exposing them to the suns rays, often at the entrance to their burrow, whilst alternately displaying the sides to the available warmth. (Lindsey, 1998) A certain level of humidity is also maintained within the sac as explained further below.

For the most part though, if left in the care of their mother, the unhatched spiderlings will eventually emerge healthy and on mass.

Mothers Method of Egg Care

Below is some information on the mother's process of egg sac construction and care in the wild.

No spider species lays her eggs immediately after copulation; the majority take at least a week.

Wolf spiders usually wait between 2-3 weeks after the act of copulation. The eggs themselves are not laid until the first stages of an egg sac have been. The female will often retreat into her burrow or and appropriate hiding place before this occurs.

Generally in Wolf Spider egg sac construction the female begins by creating a small disc of silk. She does this with the use of a unique form of silk possessed solely by female spiders; neither as strong nor elastic as regular silk. Once this silk emerges from her spinnerets it comes into contact with the air giving it a spongy texture unlike that of her other silks. On completion of this initial disc the female extrudes the fertilised eggs upon it before adding the male's separately stored sperm. After which she delicately spins a second disc covering her precious young before finally pinching and oversewing the two layered silk discs together along their edges. (Attenborough, 2005)

While this cover forms a partially effective barrier against predation is also helps to maintain a constant level of humidity, and provides the eggs with protection from fungus infections. (Forster, 1999)

Wolf Spiders stick their egg sacs distinctively to the ends of their abdomen, where the female carries it, attached with strong silk to her spinnerets. The abdomen must be held in a slightly raised position to keep the egg case from dragging along the ground. This does not make the female incapable of hunting while so encumbered. In fact, he female will be in this position for, normally, 2 to 3 weeks before the young start to emerge.

The eggs hatch inside the protective cocoon of the egg sac. The tiny creatures that hatch within are colourless and lacking in any hairs and/or spines. While within the egg sac, the spiderlings moult for the first time becoming miniature versions of their parents, complete in every detail and patterned markings except for their genitalia. In most cases, they are no larger than a pins head. (Attenborough, 2005) Even at this stage their mothers do not desert them, see weening 10.14.

Once hatched the neonates are cared for by their mother, until they are ready to disperse by ballooning or on the ground. The egg sac itself is not abandoned right away. After the first spiderlings have emerged the female continues to carry the sac around with her for approximately a week; allowing time for all her young to appear before discarding her now redundant egg sac.Such a high degree of parental care is relatively unusual among spiders.

10.13 Clutch Size

To ensure their line persists most spiders need to produce hundreds even thousands of eggs each season as most will not make it to adulthood.
Depending upon species, an individual's condition and fecundity, and the access to sufficient food a clutch size can range from 400 right up to 1000 or more.
There is no real method of counting the eggs or young themselves (while in the sec or directly after hatching when on mums back without time and equipment) which is the other reason for the approximate numbers. By the time the young are large enough to count and starting to disperse from their mothers back, many of them have already been eaten by their siblings.

10.14 Age at Weaning

Young are not 'weaned' from their mother as they are within other animal kingdoms. Rather the young are cared for by their mothers until they have moulted for the second time and are able to disperse on their own.
Again leave this process to the spiders themselves as any premature attempts of removal may result in injuries from the mother, stress on the spiders and infant deaths.

Pisaura, a Wolf spider species common in Europe and America, spins a large silken tent for her young amongst bushes and shrubs. By doing so she creates a nursery in which her young remain until they have moulted for the second time. (Attenborough, 2005) See image below.

Image 30. *Pisaura* Nursery (provided by Attenborough, D. 2005)

Other mothers allow their newly emerged young to climb onto their abdomen where they gather in a pile, group together in a tight ball or assemble into a large pyramid formation; sometimes covering the entire cephalothorax and abdomen.
Even in this early stage in their lives, use of silk is vital. They attach a life line to their mothers back or side, so that if they fall off they can quickly climb back up the line to safety. (Attenborough, 2005)

Image 31. Shows a female, *L. godeffroyi,* carrying young (provided by Author 2008)

10.15 Age of Removal from Parents

Wild

Eventually young must abandon their mothers care and disperse.
Some simply walk away, as mentioned earlier, while others have a unique way of getting around that is exclusive to spiders. Below is a description of this method known as 'Ballooning' or 'Gossamer flights', as extracted from David Attenborough's *Life in the undergrowth,* 2005, page163.
"The tiny spiderlings climb to the tip or a grass stem, a twig or a leaf. They lift their little abdomens into the air and start to spin. As the silk streams from their miniscule spinnerets, even the slightest breeze catches it. The little creatures hold on tight to their perch with their legs, sometimes, if the breeze is sufficiently strong, they will let go and are carried away. If it is not, they will anchor the silk to their perch and clamber away to choose another sight from which to try again.
Maybe this position does not please them either and they return to their first position to see if conditions have improved. Eventually, as they cling to a filament, with yet another issuing from their spinneret and wavering in the air above them, they decide that the moment has come. Very deliberately they turn, sever their anchor with their jaws and away they go, sometimes they are swept up to great heights and travel for enormous distances, across forests, mountains and even oceans".

Captivity

In the captive environment you will find that your young will simply walk off their mothers back and begin to crawl about their enclosure freely. Once this happens in large enough numbers it is time to remove the female from the cage and house her on her own. This allows you to monitor, feed and maintain the young under separate conditions.

10.16 Growth and Development

As mentioned in other sections (e.g 3.6) growth rates are determined mainly by food consumption levels. The more regularly your young feed the faster they will grow. If housed in a humid and heated room they will further thrive, growing faster than those housed in cooler temperatures.

Food should grow in size relative to that of your maturing spiderlings. Start off with pin head crickets and move onto larger specimen when necessary. Once adults, a range of invertebrate species can be fed out.

Records should be kept at all stages of life, to ensure success in your growing young. Records are, at this point in time, indispensable. They allow you to follow the growth rates, food preferences, death rates etc of your spiderlings; thus enabling you to give your current, and future, young optimal conditions for development. Records of previous breeding attempts also increase the success for each future breeding season.

11 Artificial Rearing

11.1 Incubator Type

As the egg sac is maintained and in the possession of the mother at all times (often in a burrow), a pet pack type container with a toilet roll buried down into some soil will suffice.

11.2 Incubation Temperature and Humidity

L. godeffroyi is found in all states of Australia, in all subsequent environments (wet and dry). As they reside in a burrow appoximatly15-20cm deep, they are in a micro-climate which helps to mitigate the weathers extremes regardless of biome. Specifically, they have no 'preferred' incubation/hatching temp or humidity. They do mate and reproduce during the summer months; however this is most likely an attempt to take advantage of the most optimal weather conditions available.

11.3 Desired % Egg Mass Loss

This is not relevant to insects and is almost impossible to determine. Due to the nature of the Wolf spiders reproduction i.e. it produces an egg sac that it carries around, these kinds of measurements cannot be obtained – certainly not quantifiable, or with any degree of accuracy. One could attempt to obtain a pre-egg sac mass, and then try to get a gross mass of spider-plus-eggs over time; the risk of the spider dropping the egg sac and abandoning it however is almost 100% and thus not advisable.

11.4 Hatching Temperature and Humidity

Refer 11.2

11.5 Normal Pip to Hatch Interval

As the Wolf spider carries a sac full of juvenile spiders, there is no pip to hatch interval. When a combination of the right environmental cues and sufficient time has been met (approx 1 month), the sac ruptures spilling out hundreds of juvenile spiders.

NOTE: The act of 'pipping' is only done by animals in an egg with either a hard or parchment shell with the aid of either a beak or an egg tooth (birds and reptiles).

11.6 Diet and Feeding Routine

Through all stages of development the Wolf spider feeds upon the same type of prey items; the difference being that they are size appropriate. After the spiderlings hatch and emerge, they reside on their mothers back – during this time they do not feed. After they disperse they can prey upon each other if there is not enough space available. For a time this must be tolerated as providing small enough food items is almost impossible – it should be noted that this behaviour is perfectly normal in a wild situation, and is accounted for in the enormous number of young produced. After a period, when size enables, they must be separated and items such as pin-head crickets introduced.

11.7 Specific Requirements

As mentioned in section 11.2, these animals are found in almost all environments, so providing they have access to some dirt to burrow in they will be successful. Se adult requirements section 4.

11.8 Data Recording

With this type of reproduction data recording required is limited to: egg sac present/absent, notation of time between eggs hatching and young dispersal from the mother, feeding dates and their success or failure.

11.9 Identification Methods

Given the nature of this type of animal, identification is limited to their individual species code after they have been housed separately. Anything prior to this is not feasible, due to size of young and limits of marking visibility.

11.10 Hygiene

Hygiene is no different from that of non breeding adult spiders (see 5.1), though there is a little less work to do. Any dead food is normally too small to remove and silk lines again are too small to become an issue.
As with hygiene section 5.1 any decaying or mouldy items should be removed immediately, apart from this your cleaning regime is some what minimal.

11.11 Behavioural Considerations

The behavioural considerations of this animal are much the same as with any other – if startled or under threat they will adopt a 'flight or fight' approach. In the case of mum with eggs, she could desert the egg case; mum with spiderlings, she could eat them (not uncommon); and in the instance of individuals of a larger size, attempt a defensive bite.

11.12 Weaning

There is no artificial weaning process required with the Wolf spider. As with many invertebrates with this reproduction technique, after the juveniles first instar the neonates disperse.

12 Acknowledgements

I would like to acknowledge Sydney Wildlife World and its Invertebrate Keepers.
In particular I wish to thank Boris Lomov and Lisa Manson, and in particular Jason Hainke, for all their information, assistance, research, tolerance and every single opportunity that they gave to me throughout the duration of this paper.
Without out their aid and the access granted to me by them I would never have been able to complete it.

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15 Glossary

Abdomen – The last and final section of the body of an invertebrate.

Aesthetics – Visual appearance of something.

Araneomorph – A group of 'advanced' or 'modern' spiders whose fangs move sideways on a horizontal axis. Most spiders fall into this group.

Ballooning – A process where spiderlings send out a line of silk to be carried away by the wind, enabling the spiderling to travel long distances with minimal energy consumption – see 10.15.

Biome – A division of the world's vegetation that corresponds to a defined climate and is characterized by specific types of plants and animals, e.g. tropical rain forest or desert. The world's lakes and oceans may also be considered biomes, although they are less susceptible to climatic influences than terrestrial biomes.

Book lungs – Breathing structures located under the abdomen of spiders. Oxygen is absorbed by layers of gill-like plates arranged like the pages of a closed book.

Cannibalism – Eating or consuming that of ones own species.

Carapace – The carapace is part of the exoskeleton that covers the top of the cephalothorax in a single plate.

Cephalothorax – The anterior section of arachnids, such as spiders, and many crustaceans, such as crabs, consisting of the fused head and thorax.

Chelicerae – Either of the first pair of fanglike appendages near the mouth of an arachnid, such as a spider, often modified for grasping and piercing.

Cocoon – any of various similar protective coverings in nature, as the silky case in which certain spiders enclose their eggs.

Copulation – The physical act of reproduction.

Disperse –
1. To spread or distribute from a fixed or constant source

2. To separate and move in different directions; scatter

Diurnal – Active during the day.

Drag-line – The line of silk constantly produced by spiders as they travel. Allows males to find receptive females, spiderlings to aerially disperse as well as acting like an anchor for smaller species should they fall or be swept up in a strong breeze.

Enrichment – Anything that stimulates your animal in a positive manner, improving and naturalising their daily life and breaking up any stereotypic behaviour.

Exoskeleton – The tough outer covering of spiders, literally an external skeleton.

Family – A group of closely related genera.

Fecundity – Producing or capable of producing offspring in abundance.

Forelegs – The front pair of legs.

Genes – The basic physical unit of heredity; a linear sequence of nucleotides along a segment of DNA that provides the coded instructions for synthesis of RNA, which, when translated into protein, leads to the expression of hereditary character.

Gene Diversity –
1. One of the three levels of biodiversity that refers to the total number of genetic characteristics.

2. A common measure which summarizes genetic variation.

Generation –
1. A single step in natural descent, as of human beings, animals, or plants.

2. The entire body of individuals born and living at about the same time.

3. The offspring of a certain parent or couple, considered as a step in natural descent.

4. One complete life cycle.

Genus or Genera – A group of closely related species.

Hybrid – The offspring of two animals or plants of different breeds, varieties, species, or genera, esp. as produced through human manipulation for specific genetic characteristics.

Inbred, Inbreeding –
1. To breed (individuals of a closely related group) repeatedly.

2. To breed within; engender.

3. To breed by the continued mating of closely related individuals, especially to preserve desirable traits in a stock.

Instar – Final exoskeleton moult. At this stage the animal has grown to its full potentially and will no longer continue to develop.

Instinct –
1. An inborn pattern of activity or tendency to action common to a given biological species.

2. A natural or innate impulse, inclination, or tendency.

Invertebrate – An animal without a back bone or any internal skeleton, have an open circulatory system and respire through tracheae, spiracles or a book lung.

Kingdom – *Biology.* A taxonomic category of the highest rank, grouping together all forms of life having certain fundamental characteristics in common: in the five-kingdom classification scheme adopted by many biologists, separate kingdoms are assigned to animals (Animalia), plants (Plantae), fungi (Fungi), protozoa and eucaryotic algae (Protista), and bacteria and blue-green algae (Monera).

Microhabitat – An extremely localized, small-scale environment, such as a tree stump or a dead animal.

Montane –
adjective
1. Pertaining to, growing in, or inhabiting mountainous regions.
noun

2. The lower vegetation belt on mountains.

Morphological – The branch of biology that deals with the form and structure of organisms without consideration of function

Moult – To shed skin and replace with new, used when referring to invertebrates.

Mygalomorph – A group of 'ancient' or 'primitive', mostly ground dwelling spiders, whose fangs move up and down like daggers or a pick axe and who have 2 sets of book lungs.

Neonates – A newborn, especially one less than four weeks old. From the Latin 'neo' meaning – to be born.

Nocturnal – Active at night.

Nomadic – One who has no fixed home and moves according to the seasons from place to place in search of food, water, and shelter.

Order – A group of closely related families of animals.

Palisade – Post, pole, picket or stake.

Parasite – An animal completely dependant on the body of another animal for its food, usually feeding without killing the host.

Pedipalps or Palps – One of the second pair of appendages on the cephalothorax near the mouth of a spider, or other arachnid, that are modified for various reproductive, predatory, or sensory functions (touch, taste and scent). Nicknamed, due to their appearance, as 'boxing gloves'.

Physiological –
1. Of or pertaining to physiology

2. Consistent with the normal functioning of an organism.

Pinheads – Baby crickets; called such for there size is, as insinuated, the size of the head of a pin.

Poison – Biological poison which enters the body through absorption, either via the stomach lining or skin.

PPE – Personal Protective Equipment. Anything used to protect ones self during a task; Gloves, Goggles, Tongs, Boots, Sunscreen, Face Marks etc.

Predation – A relation between animals in which one organism captures and feeds on others as a means of maintaining life.

Receptive – Ready or willing to receive favorably. Often referring to a female during the courting process or mating season.

Species – The major subdivision of a genus or subgenus, regarded as the basic category of biological classification. Composed of related individuals that resemble one another, are able to interbreed to produce fertile young but are unable to breed with members of another species.

Spiderlings – Young or newly hatched spider babies.

Spinnerets – Any of various tubular structures from which spiders and certain insect larvae, such as silkworms, secrete the silk threads from which they form webs or cocoons. Located at the tip of the spiders abdomen.

Substrate –
1. The base on which an organism lives

2. The surface on or in which plants, algae, or certain animals, such as barnacles or clams, live or grow. A substrate may serve as a source of food for an organism or simply provide support.

Temperate – Moderate; not subject to prolonged extremes of hot or cold weather.

Tracheae – Slender chitinous tubes extending into the abdomen and sometimes into the cephalothorax (prosoma). These open to the exterior via stigmata (spiracles), where they deliver oxygen to the vicinity of various tissues and organs.

Venom – Biological poison which enters the body through the act of being physically injected and pumped.

16 Appendix

1. Below are the contact details to Pisces – Live insect suppliers

Pisces Enterprises PTY LTD, Established 1971
PO BOX 200, Kenmore, Brisbane, QLD 4069
Free Call: 1800 351 839
Telephone: (07) 3374 1839
Fax: (07) 3374 2393
Website: www.piscesenterprises.com
- Current in 2009.

2. The following is information on a study done to understand whether there is a trade-off between hunting ability and starvation tolerance in spiderlings of a wandering spider, *Pardosa pseudoannulata* in relation to size of carapace and abdomen. E.g larger carapace = more efficient hunting ability, larger abdomen = greater starvation tolerance.

INTRODUCTION

Trade-offs have a central role in life history theory (Stearns, 1992). Among various trade-offs a large number of studies have focused exclusively on a trade-off between egg number and egg size (Lack, 1954; Itô, 1978). It should be noted, however, that theories have implicitly assumed that resource allocation within an egg is fixed among mothers. If mothers can allocate resource differentially into different parts of an embryo in relation to future prospect of food conditions for their offspring, the maternal allocation strategy may have adaptive significance. This study experimentally examined the trade-off between hunting ability and starvation tolerance of the neonates in a wolf spider, *Pardosa pseudoannulata* Boes. et Str., widely known as a key predator of insect pests in paddy fields (Yaginuma, 1986). Both abilities have been regarded to be extremely important because carnivores live under fluctuating and unpredictable food conditions (Hairston et al., 1960; Miyashita, 1968; Anderson, 1974; Wise, 1975). A spider's body consists essentially of two parts: a cephalothorax and an abdomen (Foelix, 1982). The width of the carapace that covers the cephalothorax is often used as an index of a spider's body size, which may directly and/or indirectly determine hunting ability. For example, in an orb weaving spider, *Argiope amonea*, individuals with large carapace width can prey on larger organisms than those with small carapace width (Murakami, 1983). Among spiderlings of *P. pseudoannulata*, individuals with larger carapace widths had an advantage with respect to cannabalism over those with smaller carapaces (Iida, 2003). On the other hand, a spider's abdomen is highly distensible and contains many diverticula (Butt and Taylor, 1986; Yoshikura, 1987). In times of food shortage, spiders survive starvation by consuming lipids that have accumulated in their abdomen (Tanaka et al., 1985; Tanaka, 1995). Hence, abdomen size would be applicable as an index of starvation tolerance. Both hunting ability and starvation tolerance are of critical importance; however, a trade-off may exist between them as long as egg size is limited. In addition, large variation in egg size may mask the trade-off because both carapace width and abdomen width would be positively correlated with egg size. This may explain why few

studies have ever detected the trade-off. To exclude such putative effect of egg size, multiple regression analysis of carapace width and abdomen width on starvation tolerance was conducted. Appl. Entomol. Zool. 40 (1): 47–52 (2005)http://odokon.ac.affrc.go.jp/47

Trade-off between hunting ability and starvation tolerance in the wolf spider,

Pardosa pseudoannulata (Araneae: Lycosidae)

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Abstract

Experiments were conducted to investigate whether there is a trade-off between hunting ability and starvation tolerance in spiderlings of a wandering spider, *Pardosa pseudoannulata* Boes. et Str. The width of the carapace (the cover over the cephalothorax) was used as an index of hunting ability, as a larger carapace was confirmed as being advantageous for capturing prey. Abdomen width was used as an index of starvation tolerance because individuals with larger abdomens survived longer under fasting condition. Effects of carapace width and abdomen width on starvation tolerance were examined using multiple regression analysis. The carapace width was found to have a negative effect but the abdomen width had a positive effect on starvation tolerance. Moreover, the ratio of abdomen width to carapace width was significantly different among clutches. These results suggested that there is a trade-off between carapace width and abdomen width, that is, between hunting ability and starvation tolerance, and also suggested that the tradeoff might be an allocation strategy specific to each clutch. **Key words:** *Pardosa pseudoannulata*; body size; allocation strategy; wolf spider; trade-off

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MATERIALS AND METHODS

The wolf spider, *P. pseudoannulata*. *P. pseudoannulata* is a wandering spider that primarily inhabits paddy fields and preys on planthoppers and leafhoppers (Kiritani et al., 1972). Two or three generations are produced each year (Kawahara et al., 1974), leading to coexistence of various instars. This species is an iteroparous spider; for each egg mass a female makes a sac and attaches it to her abdomen until the nymphs emerge. The first instar nymphs molt within the egg sac and emerge as second instars. Once emerged, the spiderlings cling in a group to their mother's abdomen for several days and then disperse (Rovner and Higashi, 1973; Fujii, 1989). During this gregarious period, the spiderlings take in some water but do not eat (Yoshikura, 1987).

Preparation of the spiderlings. Adult *P. pseudoannulata* were collected from a rice field in the environs of Kyoto City, Japan, in October and November 2002. Each spider was reared individually in a plastic cup (100 mm in diameter and 45 mm in depth) with a piece of moistened cotton for humidity. The spiders were supplied with green bottle flies, *Phaenicia cuprina* and *P. sericata*, and small brown planthoppers, *Laodelphax striatellus*.

Rearing and experiments were conducted in the laboratory at 25°C and under a 16 : 8 light : dark cycle. In total, 23 egg sacs from 23 females were used for the analysis of the relationship amongcarapace width, abdomen width, and starvation tolerance of spiderlings.

Measurement of body size of spiderlings. Two days after oviposition, each egg sac was opened, and then eggs of each clutch were divided into groups of approximately 20 eggs to standardize the rearing density. Each group of eggs was placed into a cotton-plugged glass vial (2.0 ml), and the vials were kept within a plastic cup (130 mm in diameter and 55 mm in depth), which contained moist cotton, and was covered by a lid with air holes. Hatched nymphs were kept in the glass vials until reaching the second-instar stage. In principle, a total of 30 spiderlings were collected from each clutch by randomly selecting approximately the same number of spiderlings from each of the glass vials. For two clutches, however, 18 and 28 spiderlings were used, respectively, since no other nymphs developed into second instars in these clutches. Carapace and abdomen widths of the selected spiderlings were measured to the nearest 0.02 mm under a binocular microscope. Furthermore, the value of abdomen width divided by carapace width (hereafter noted as abdomen-carapace ratio) was calculated to quantify the resource allocation of a spiderling.

Starvation tolerance of spiderlings. After measurement of carapace width and abdomen width, the spiderlings were reared individually without food but with moistened cotton in a glass vial (1.8 ml). The number of days they survived was recorded and used as an index of their starvation tolerance.

Hunting ability of spiderlings. The rest of the nymphs that were not used for measurement of body size were also reared in the procedure above to examine their hunting ability. They were kept in glass vials (1.8 ml) without food for 5 d after molting to the second-instar nymphs. On the next day, carapace width of spiderlings was measured to the nearest 0.02 mm under a binocular microscope. Second-instar nymphs with various carapace widths were arbitrarily chosen regardless of their natal egg sacs and individually introduced into a 2.0 ml glass vial together with a male adult of small brown planthopper, *L. striatellus*, to quantify size dependent hunting success. If a spiderling could not capture the prey in spite of the close contact between them, the nymph was regarded to have failed the hunt. The trial was conducted once for every spiderling in each carapace width category, 0.64, 0.66, 0.68, 0.70, 0.72 and 0.74 mm. The sample size in each category was 28, 30, 30, 30, 26, and 11, respectively.

RESULTS

Spiderling body size and starvation tolerance The mean (SD) and range of the carapace width, abdomen width, abdomen-carapace ratio, and starvation tolerance are shown in Table 1. Moreover, coefficient of variation (CV) in each variable was calculated for both inter-clutches and intra-clutch. Consequently, CVs of carapace width were considerably small (2.8–2.9%), but CVs of abdomen width and of abdomen-carapace ratio were 4.3–5.0%, and starvation tolerance varied greatly, particularly among clutches (15.8% in CV). Overall, CVs of body sizes were similar between within-clutch and among-clutches. To determine whether each mother produces offspring of specific sizes and of specific abdomen-carapace ratio, means of the carapace width, the abdomen

width, and the abdomen-carapace ratio were compared among clutches. As a result, all of these were significantly different among clutches (Table 2). Furthermore, results of Tukey's HSD test (p0.05) showed that the 23 clutches were divided into 10, 10, and 11 groups within which no significant difference was detected for carapace width, abdomen width, and abdomen-carapace ratio, respectively.

Indices of starvation tolerance and hunting ability Abdomen width exhibited a significant and positive correlation with starvation tolerance (Fig. 1), thus abdomen width was applicable as an index of starvation tolerance. On the other hand, the rate of hunting success for each carapace width (0.64, 0.66, 0.68, 0.70, 0.72, and 0.74 mm) was 0.33, 0.33, 0.43, 0.67, 0.65, and 0.73, respectively. Regression analysis revealed that there was a highly significant and positive correlation between carapace width and the rate of hunting success (Fig. 2). This result implied that carapace width was an ap propriate index of the hunting ability of spiderlings in *P. pseudoannulata*.

Trade-off between hunting ability and starvation tolerance Relationship between carapace width and abdomen width was examined first to detect the trade-off between hunting ability and starvation tolerance. There was no correlation between the two variables ($R^2$0.00603, p0.05), and the carapace width was not correlated with the starvation tolerance ($R^2$0.0614, p0.05). Next, multiple regression analysis of starvation tolerance on carapace width and abdomen width was conducted to incorporate both effects of the two explanatory variants in the analysis. The carapace width was found to have a negative effect on starvation tolerance in contrast with the abdomen width

DISCUSSION

The result of the multiple regression analysis suggested that there was a trade-off between hunting ability and starvation tolerance in *P. pseudoannulata* spiderlings, though no correlation was detected between them by a simple regression analysis. The discrepancy could be attributed to the different quantity of maternal investment per egg among clutches; for example, spiderlings from larger eggs could have a larger cephalothorax and larger abdomen, while those from smaller eggs could have a smaller cephalothorax and smaller abdomen. If these data are plotted, a positive correlation should appear between them. Accordingly, variation in maternal investment per egg may mask the trade-off. Multiple regression analysis at least partly excluded the disturbance and could detect the trade-off. Previous studies, however, did not confirm the trade-off between carapace width and starvation tolerance (e.g., Tanaka, 1995; Walker et al., 2003). If heterogeneity of maternal investment into an egg was adjusted, the trade-off might have been detected in these studies. Why does larger carapace width suppress starvation tolerance? The cephalothorax has more muscles, which consume more energy when moving, than does the abdomen (Yoshikura, 1987). Consequently, individuals with a larger cephalothorax must have more muscles than smaller individuals. Spiderlings with a larger cephalothorax therefore may consume more energy, so as to have a lower starvation tolerance as long as abdomen size is fixed. Allocation of egg resources would appreciably affect the trade-off between hunting ability and starvation tolerance. If greater egg resources are allocated to either of the two body parts, then the other body part will obtain fewer resources, suggesting a potential trade-off between cephalothorax and abdomen sizes. Both hunting ability and starvation tolerance were important, but the results showed that they were antagonistic traits for spiders. Hence, if female spiders can

predict environmental suitability for their progeny based on their own experience of environmental conditions, they will determine the optimal size ratio of cephalothorax to abdomen for spiderlings in response to relative importance of hunting ability and starvation tolerance. For instance, if hunting opportunity for spiderlings decreases with time, mothers may allocate more egg resources to the cephalothorax than to the abdomen to enhance present hunting ability at the sacrifice of future hunting opportunities. ANOVA for body sizes of spiderlings showed that carapace width, abdomen width, and abdomen- carapace ratio were specific for each clutch. The important point to note is that the abdomencarapace ratio varied largely in comparison with the carapace width and the abdomen width. The ratio varied from 0.71 to 0.87 (Table 1), which was translated to 0.36 to 0.66 variation in volume. Hence, the maximum/minimum ratio was 1.83, whereas it was 1.37 for carapace width and 1.60 for abdomen width. Thus, allocation of maternal investment between cephalothorax and abdomen of spiderling differed greatly among mothers, though all mothers were reared under the same feeding conditions, temperature, and photoperiod in this study. This may be because the allocation had a certain genetic basis. If so, each mother might have a specific allocation strategy, otherwise, mother spiders might respond differently to the same environmental cues or simply be unable to control the spiderling size accurately due to physiological constraints. CVs of body sizes and of abdomen-carapace ratio were similar between inter-clutches and intraclutch. Hence, mothers of *P. pseudoannulata* may equalize the amounts of investment per offspring rather than employ a bet-hedging strategy (Schaffer, 1974; Stearns, 1992). In this experiment, equality of rearing conditions would have diminished the inter-clutch CVs. If mother spiders were allowed to oviposit under various environmental conditions, inter-clutch CVs might have been apparently larger than intra-clutch ones. Unfortunately, no causal mechanisms are known as to how mother spiders allocate egg resources between cephalothorax and abdomen. In the rainbow trout, photoperiod influences gonadotropin, which affects egg size, that is amount of investment into an egg (Bon et al., 1999). If a certain endocrine mechanism controls the allocation of egg resources in response to environmental cues in *P. pseudoannulata*, the allocation strategy would be adaptive. Alternatively, offspring may change their own size ratio between cephalothorax and abdomen in response to some environmental cues. To elucidate which mechanism is responsible, further investigation is required.

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