# Terrestrial Invertebrate Taxon Advisory Group Best Practice Guidelines for Desertas Wolf Spiders

Version 1.4 – August 2018

Mark Bushell[1, 8], Calvin Allen[2], Tyrone Capel[3], Dave Clarke[4], Alex Cliffe[3], Nicola Cooke[1], Graeme Dick[7], James Gotts[7], Caroline Howard[5], Jamie Mitchell[4], Phil Robinson[6], Carmen Solan[1], Ryan Stringer[5]

Edited by Mark Bushell

**HOGNA INGENS EAZA BEST PRACTICE GUIDELINES – Ver. 1.4 AUGUST 2018**

**TITAG Chair**:
Mark Bushell, Bristol Zoo Gardens, Clifton, Bristol, BS8 3HA.

**TITAG Vice-Chairs**:
Tamás Papp, Chester Zoo, Moston Rd, Upton, Chester CH2 1EU.
Vítek Lukáš, Zoo Praha, U Trojského zámku 3/120, 171 00 Praha 7, Czechia.



**Author Details:**
1 – Bristol Zoo Gardens, Clifton, Bristol, BS8 3HA
2 – Berkshire College of Agriculture, Hall Place, Burchetts Green Rd, Burchett's Green, Maidenhead SL6 6QR
3 – ZSL Whipsnade, Whipsnade, Dunstable LU6 2LF
4 – ZSL London, Regents Park, London NW1 4RY
5 – Askham Bryan College, Askham Bryan, York YO23 3FR
6 – The Deep, Tower St, Hull HU1 4DP
7 – Longleat Enterprises, Longleat, Warminster, Wiltshire, BA12 7NW
8 – Corresponding Author

**Reference:**
Bushell, M., Allen, C., Capel, T., Clarke, D., Cliffe, A., Cooke, N., Dick, G., Gotts, J., Howard, C., Mitchell, J., Robinson, P., Solan, C., Stringer, R. *EAZA Best Practice Guidelines for Desertas Wolf Spiders.* EAZA 2018.

**DOI:**
10.61024/BPG2018DesertasWolfSpiderEN



**Preamble**

Right from the very beginning it has been the concern of EAZA and the EEPs to encourage and promote the highest possible standards for husbandry of zoo and aquarium animals. For this reason, quite early on, EAZA developed the "Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria". These standards lay down general principles of animal keeping, to which the members of EAZA feel themselves committed. Above and beyond this, some countries have defined regulatory minimum standards for the keeping of individual species regarding the size and furnishings of enclosures etc., which, according to the opinion of authors, should definitely be fulfilled before allowing such animals to be kept within the area of the jurisdiction of those countries. These minimum standards are intended to determine the borderline of acceptable animal welfare. It is not permitted to fall short of these standards. How difficult it is to determine the standards, however, can be seen in the fact that minimum standards vary from country to country.

Above and beyond this, specialists of the EEPs and TAGs have undertaken the considerable task of laying down guidelines for keeping individual animal species. Whilst some aspects of husbandry reported in the guidelines will define minimum standards, in general, these guidelines are not to be understood as minimum requirements; they represent best practice. As such the EAZA Best Practice Guidelines for keeping animals intend rather to describe the desirable design of enclosures and prerequisites for animal keeping that are, according to the present state of knowledge, considered as being optimal for each species. They intend above all to indicate how enclosures should be designed and what conditions should be fulfilled for the optimal care of individual species.

## Introduction

The information in this Best Practice Guideline has been collated from the small amount of information available on the natural history of the species. The majority has come from first-hand experience of either the *in-situ* habitat on Desertas Grande or from observations of rearing this species in captivity.

This document is very much living and will no doubt go through numerous incarnations as we learn more about the wolf spiders, although all best efforts will be made to ensure that updates are timely and relevant. As with all species new to captivity, a lot of trial and error is experienced, and making sure all information is recorded is important; these guidelines hope to answer some of these questions and hopefully pose new ones for future work.

The current captive population began a group of 25 juveniles, collected from Desertas Grande Island in May 2016 and reared at Bristol Zoo Gardens, UK. Of these, six females and three males were reared to adulthood, which then went on to produce over 1,500 spiderlings, which have formed the entire of the current captive population within EAZA collections. At time of writing there are seven institutions with populations of the species, with some 600 individuals currently alive and well.

I would like to extend my thanks to all the colleagues who have become involved in the conservation programme and rearing the species in captivity, helping us all learn more about this fascinating and beautiful species of spider, both in captivity and in the field. Without your hard work, dedication and enthusiasm for this species and the conservation programme we wouldn't have achieved nearly as much as we have – thank you.

Mark Bushell
Curator of Invertebrates
Bristol Zoological Society
EEP Coordinator – *Hogna ingens*

## Contents:

# Section 1: Biology and field data

## Biology

### 1.1 Taxonomy

- Order - Araneae
- Family – Lycosidae
- Genus – *Hogna* Simon, 1885
- Species – *ingens* (Blackwall, 1857)
- Common name(s) – Desertas Wolf Spider

### 1.2 Morphology

- Weight: Not known at this time.
- Leg-span: Large females can attain a span of 120mm (Bushell, *pers. obvs.* 2016), but generally the species at maturity is between 70-80mm. New hatched spiderlings are 4-5mm leg-span
- Body length: Up to 40mm in adult females (Bushell, *pers. obvs.* 2016), males are between 30-35mm in length. New hatched spiderlings are 3mm body length
- Coloration: Adults are uniformly mid-grey on the body, with the exception of the cephalothorax which is slightly darker and features white edging and a patch of white near to the joint of the opisthosoma. The chelicerae are black with a small red dot on either side of the jaws. The legs are strikingly banded black and white in a manner reminiscent of members of the genus *Poecilotheria* Simon, 1885. Newly hatched spiderlings and the next few moults are uniformly brown to the naked eye, although when examined closely are a mottled black and brown colouration with chevron markings on the dorsal surface of the opisthosoma and the characteristic striping on the legs, albeit back and brown. Adult colouration starts to develop at approximately 25mm leg- span.
- Description: A large, stocky spider, with quite a large body in relation to its leg span; this is very obvious in adults, although as spiderlings they are “generic” wolf spider in shape, but gradually fill out and become more bulky with each moult.

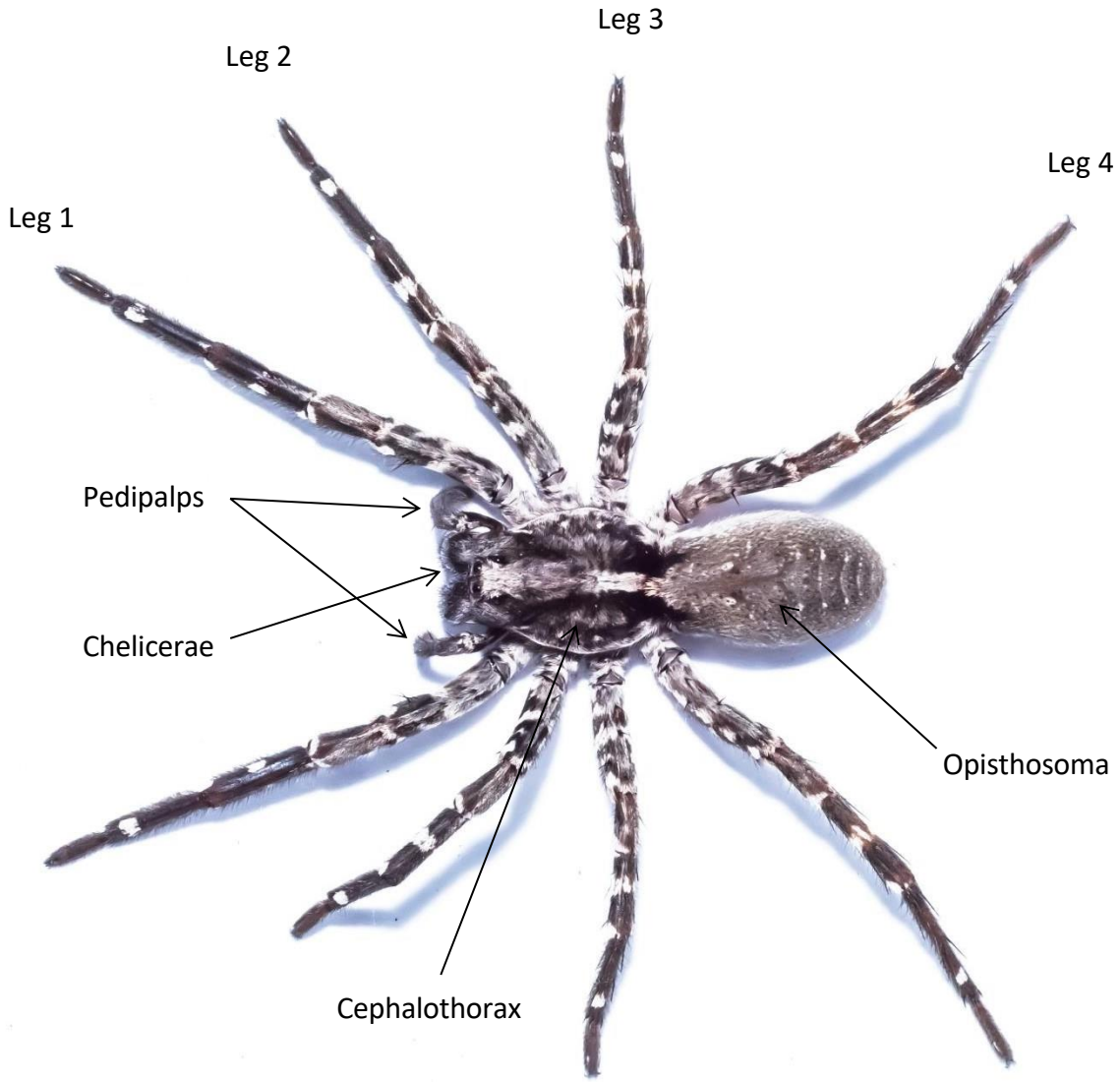


**Figure 1: General morphology of *Hogna ingens* (photo by J. Dunbar)**

**Figure 2: Adult female *in-situ* (photo by P. Cardoso)**


**Figure 3: 2nd instar spiderling in captivity (photo J. Dunbar)**

## 1.3 Physiology

Not much is currently known regarding this. As with other spiders they are poikilothermic and behaviour and activity is affected by the environmental temperatures.

## 1.4 Longevity

At present we are unsure as to the lifespan of this species in captivity and also in the wild, although can extrapolate from related species to a lesser degree. Males appear to die within 10 months of reaching sexual maturity, although this is only from data collected on three individuals in captivity. In other wolf spider species, females die soon after producing offspring but this species seems to survive long enough to produce second and third egg sacs, although this could be an artefact of a better diet and living conditions in captivity.

At the moment it is thought that the spiders take up to two years to attain adulthood,. There are apparently two subpopulations present in the wild; a summer sub- population reaches maturity in June and a winter sub-population in September/October. At present the species is only represented by the “winter” subpopulation in captivity.

# Field data

## 1.5 Conservation status, Zoogeography & Ecology

*(from Cardoso, Bushell, Stanley-Price, 2016)*
The Desertas sub-archipelago, 20 km southeast of Madeira, is composed of three islands, the Deserta Grande (10 km$^2$), Ilhéu Chão (0.5 km$^2$) and Bugio (3 km$^2$). Due to the harsh environment and lack of water sources, the Desertas remained uninhabited, despite historical attempts to colonize the island of Deserta Grande. The geomorphology is rugged with very steep slopes, rising from sea level to about 400m.

*H. ingens* is known to historically occur only in one valley, the Castanheira Valley, at the northern end of Deserta Grande Island). This valley is approximately 2.8 km long and between 180 – 400m wide, and has an estimated area of 83 ha. The

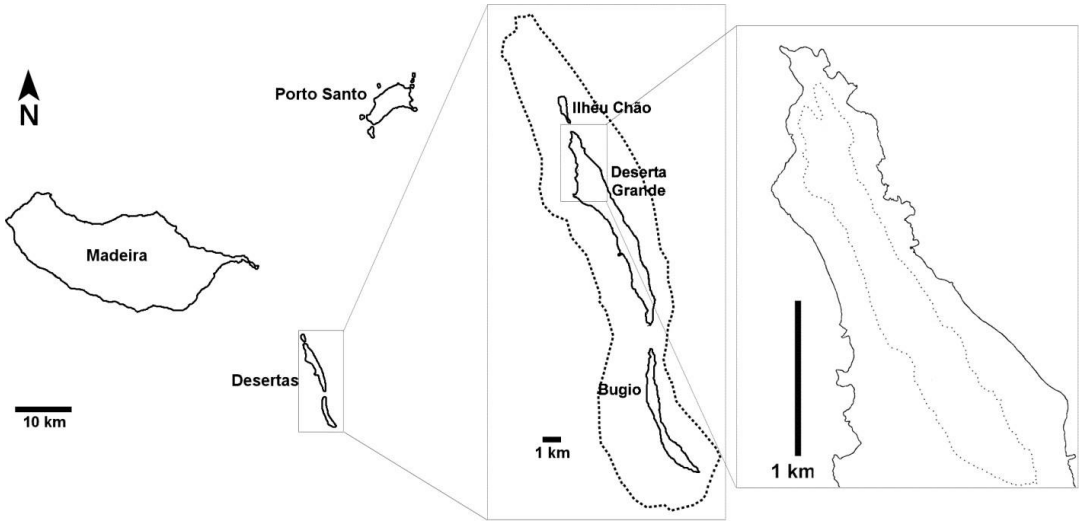


**Figure 4: the Madeira Archipelago**

geomorphology separates the valley into two distinct areas. For most of its length, two opposing slopes are divided by a small riverbed, which is dry most of the year. However, at the north end of the valley, near the site where the riverbed meets the ocean, a small plateau rises which extends to the end of the island. The elevation of the valley ranges from 150 - 350 m a.s.l.

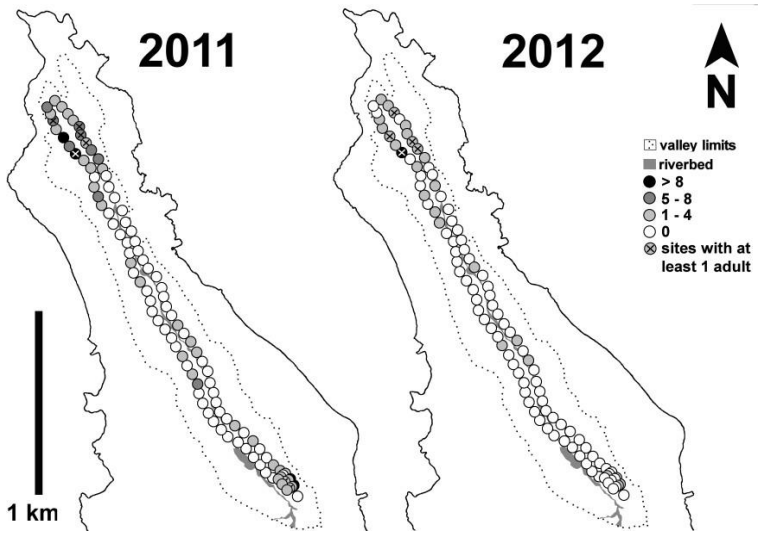


**Figure 6: Current distribution (including Extent of occurrence and Area of Occupancy)**

This site was possibly originally occupied by patches of microforest/scrub and a mix of native grasses. Most of it is now occupied by one or more species of *Phalaris* spp*.* (of status currently undetermined), grasses that recently expanded dramatically in the valley (expansion detected in 2005). These plants cover the entire surface of the soil and crevices, preventing access to shelters that are usually occupied by both the spider and other endemic fauna. Before *Phalaris* became dominant, *H. ingens* inhabited the entire valley. Since 2005, the spider´s range has declined abruptly, as has the range for a number of other endemic taxa such as land snails.

It was assessed as Critically Endangered according to the International Union for the Conservation of Nature (IUCN) criteria (Cardoso 2014) but is not protected by any international, national or regional legislation or agreements

A conservation strategy has been realised for the species (Cardoso, P., Bushell, M., Stanley Price, M., 2016) and the EEP for the spider is a key component of the conservation efforts for *H. ingens*.

## 1.6 Diet and feeding behaviour

Although not observed feeding in the wild during fieldwork in 2016, the species has a habit of lining the walls of their burrows with the remnants of prey items; mostly millipede, isopods and beetle remains. This could potentially be a false positive as we have found in captivity they are more than happy to take soft-bodied prey and we know that there are cockroaches (*Loboptera decipiens*) and crickets (*Gryllus bimaculatus*) present which would not leave many noticeable remains.

**Figure 7: *H. ingens* juvenile female on Desertas Grande - note the remnants of previous prey items webbed into burrow walls. (photo M. Bushell)**

## 1.7 Reproduction

### 1.7.1 Age of sexual maturity

The species is thought to mature in two years, although further research is currently being done to ascertain this. Males mature faster, in line with other species of arachnid.

### 1.7.2 Seasonality of cycling

From Cardoso *et. al.* (2016), there are thought to be two breeding event with this species, with two "distinct" subpopulations. One breeds in the spring whilst the other breeds in the summer, although further research needs to be done to establish if they are potentially differing subpopulations, or just a staggered breeding cycle. They have slightly differing colouration, so again this needs to be further researched.

### 1.7.3 Incubation

The data for this is not known at present – please see the rearing in captivity section for more details.

### 1.7.4 Clutch size

The wild clutch size is not known, but in captivity it can be in excess of 500 spiderlings. This is likely affected by the captive diet so an estimate might be between 200-250 spiderlings in the wild.

### 1.7.5 Hatching details and season

Spiderlings appear to spend between seven and 10 days riding on the females before dispersing to fend for themselves. As mentioned before, there are thought to be two subpopulations of the species that breed at differing times of year, with one in the summer and other in the winter, although exact timings are not currently known.

## 1.8 Behaviour

### 1.8.1 Activity

Further field observations are required, but initially observations seem to suggest the spider is possibly crepuscular. During the day they remain in their burrows under rocks and were not seen unless disturbed.

### 1.8.2 Locomotion

As imagined, this spider can move very quickly from a standing start and are quite unpredictable when startled, such as when their burrow is opened. Initially they will stand still and sometimes rear up in threat posture, but will also move quickly away from (and in some cases towards) the perceived threat if they are further disturbed.

### 1.8.3 Predation

*(From Cardoso, Bushell, Stanley-Price, 2016)*
In the absence of any native terrestrial mammals, this spider is a top predator in its habitat. Although its major prey consists of other invertebrates, such as the staphylinid beetle *Ocypus olens* (Müller, 1764) and the invasive millipede *Ommatoiulus moreleti* (Lucas, 1860), adults have also been seen predating on juvenile *Tiera dugesii mauli* lizards (Mertens, 1938). The latter, along with birds and mice, are the major predators of *H. ingens*, mostly during its juvenile stage. This is when the spider is most vulnerable to predators, because in addition to its smaller size, it tends to disperse in order to find new shelters, thus maximizing the likelihood of encounters with potential predators, including conspecific adults.

#### 1.8.4 Social behaviour

No field observations have been made on the social behaviour of this species in the wild. A mature pair was seen in the same burrow (Bushell, *pers. obvs.* 2016) but this was a singular event and no other spiders were seen together.

### 1.8.5 Sexual behaviour

Please see the section on captivity for detailed breeding behaviours.

# Section 2: Management in Zoos and Aquariums

## 2.1 Enclosure

### 2.1.1 Substrate

Individually potted spiderlings only have coir substrate at Bristol Zoo Gardens (BZG) which they construct burrows into with relative ease. Studies are presently showing that they seem to have a preference for soil that is free-draining and able to support burrow construction, although their silk is quite strong.

Juveniles were initially given a loam soil mix that had been dried out as this was closest to their natural substrate, but they adapted to a 3:2 coir:sand mix relatively quickly and this seems to be preferable from a husbandry point of view due to ease of obtaining and mixing.

### 2.1.2 Furnishings and Maintenance

Enclosures are usually fairly sparsely furnished. Juveniles and older were provided with a small hide; half a plastic flowerpot cut in half seemed sufficient, although as long as the spider is able to comfortably fit inside they don't seem to have any preferences as to what it is made of, although prefer opaque materials. If the substrate is deep enough they will excavate a burrow, usually where the hide has been placed, although this is generally quite shallow but may go back for up to 15cm from the burrow entrance.

For display purposes it is possible to add small rocks, dead leaves and other decorations to mimic their natural habitat. No observations were seen of interaction with the decorations although the animals would deposit a silk line over everything they walked on during the evening.

### 2.1.3 Environment

It is much easier to control the temperature of the room for the individual animals rather than try and heat each enclosure separately. At BZG they are all housed in a room kept between 23-26°C using an air-conditioning unit, although for seasonality we raise or lower the temperature accordingly.

Desertas Grande is overall a very dry, "inhospitable" place, but unsurprisingly the soil under stones where the wolf spiders reside is much more humid, providing an environment at roughly 70% (M. Bushell, *pers. obvs.* 2016). Although when initially brought into captivity we were informed that they should be kept as dry as possible and infrequently given water, we found that they did not do well and we had some losses early on.

Temperatures on the surface of the island can get quite hot (~30°C), but in the microclimate the spiders reside in it is much cooler, being approximately 23-25°C. If temperatures are too high for spiderlings (≥26°C) they will retreat to their burrows and silk up the entrance (Robinson, *pers. comms,* 2017), presumably to prevent

desiccation and to wait until a more favourable temperature is reached. This could be potentially confused with moulting (which also mostly occurs inside burrows) but if several animals decide to web themselves in unexpectedly then checking the temperature is advisable.

Spiderlings in particular are kept slightly higher, at 80%, and do well. This is maintained by using a syringe to add 1-3ml of water (distilled or reverse osmosis) to the substrate where it soaks in. We also kept some individuals drier (60%) to see if this made a difference to their development but it did not appear to do so, other than increasing the amount of time the spiders were seen drinking. It may also be linked to moulting issues which have been seen with some spiderlings, so in the interests of caution it would be better to keep them on the humid side.

In captivity the spiderlings construct burrows in soil well and seem to be able to regulate their own humidity as appropriate, providing the soil is slightly damp to start with.

At BZG, lighting is provided by T5, 6% UVB strip lights in the room – they don't appear to be particularly fond of bright light so provision should be made for them to be able to hide away, if required.

## 2.1.4 Dimensions

### *Spiderlings*

At BZG, communally housed animals are being kept in enclosures measuring 600mm x 300mm x 250mm. These are made of glass and were manufactured by Custom Aquaria™ to our specifications (see figure 4). These will also double for holding adults during breeding trials.

**Figure 8: Row of tanks containing communal groups of spiderlings (photo M. Bushell)**

Individually housed animals are currently being kept in small specimen pots, dimensions 55mm x 30mm (see figure 5). They feature a flexible snap-on lid that makes removal for feeding and maintenance easy and air holes can be added with a sharp object such as a pin. Also, they fit quite neatly into plastic trays for ease of carrying batches during feeding for example.


**Figure 9: standard pot being used for rearing spiderlings (photo M. Bushell)**

### *Juveniles*

At BZG, these are housed in "Braplast" tubs – dimensions of 185mm x 125mm x 75mm (see figure 6)

**Figure 10: standard enclosure used for juveniles and adults (sponge plugs used as female had spiderlings on her back). (photo M. Bushell)**

***Adults***

At BZG, housed in the same accommodation as the juveniles with some females upgraded to long “faunarium” style plastic enclosures with carrying dimensions (average 450mm x 300mm x 250mm. See figure 7)


**Figure 11: Example "faunarium" housing an adult female. (photo M. Bushell)**

## 2.1.5 Environmental enrichment

At BZG we have not observed this species as to requiring complex environmental enrichment within enclosures; once they have established a burrow they do not seem to leave it. However, Capel (*pers. comms* 2017) has observed this species frequently interacting with “furniture” such as leaves and stones as part of their burrow, and on one occasion an individual actively moved the leaf it had attached its burrow against to another part of the enclosure, making a brand new burrow underneath it. There is currently a lot of research being undertaken into burrow construction and enclosure use which will add to the knowledge pool for this species in the near future.

# 2.2 Feeding

## 2.2.1 Basic Diet

***Large juveniles to adults***

At BZG, so far we have not found anything invertebrate-based that this species is not willing to at least attempt to feed on in captivity – the main bulk of their diet has comprised of large juvenile to adult lobster cockroaches (*Nauphoeta cinerea*) and

imago mealworm beetles (*Tenebrio molitor).* The latter are particularly favoured; perhaps this is a reason the species has quite muscly chelicerae and relatively blunt fangs. Black crickets (*Gryllus bimaculatus*) and brown crickets (*G. assimilis*) are also taken readily, as are various species of woodlice (*Porcellio* spp., *Trichorhina* sp.). Spiders at Longleat have been fed a variety of differing prey items, including *Blaberus craniifer, Blaptica dubia* and *Oniscus asellus*. (Gotts, *pers. comm*).

Frequency of feeding was originally suggested to be daily (I. Silva, *pers. comms.* 2016) but this potentially leads to obesity, depending on size of prey items offered. Maintaining a healthy weight is relatively easy with a prey item roughly the same size as the cephalothorax of the spider in question, either a cricket or cockroach, given every five to seven days. If feeding *T. molitor* imago it is possible to feed them daily and more than one a day – they should generally be considered as an addition to the main diet. It is important to monitor the body condition of the animal and adjust feeding accordingly; a healthy weight seems to be with the opisthosoma slightly less than double the size of the cephalothorax (see figures 1 - 3 for reference) – this can be more in gravid females and much less in mature males however.

This species will happily eat even if obese, so care must be taken to avoid over- feeding them.

### *Spiderlings to small juveniles*

Even though spiderlings are relatively small they are just as feisty as larger individuals when it comes to food items we have found; a 1st instar spiderling can quite happily take down a large *Drosophila hydei* with no problem, sometimes even two if accidentally added.

Currently two methods of rearing spiderlings are being used: individually potted and communal rearing. These will be gone into more detail further in the manual. Communally reared animals are given prey items from the following list daily.

- Fruit flies – *D. melanogaster* & *D. hydei*
- 1st instar crickets – *G. assimilis* & *G. bimaculatus*
- Tropical woodlice – *Trichorhina tomentosa*

At BZG, a colony of 100 spiderlings “seems” sated with roughly the same number of prey items, accounting for some missing out due to enclosure location. This can be mitigated by dispersing the live food equally over the enclosure but cannot be totally ruled out. We have not experimented with larger items as of yet but predict that they will happily take larger crickets. Cockroaches are not being used as a prey item for these as it is too difficult to target feed the spiders currently and a risk of them establishing a colony in the tanks is being avoided.

Individually potted spiderlings are currently being given 1-3 fruit flies every week on a Monday or Tuesday (purely for staffing reasons). They are checked again a couple of days later to see if they have eaten or need another feed, although we are trying to limit their growth to what it would be in the wild; We imagine that it would be quite

easy to overfeed these and artificially accelerate their growth which is fine for display animals but for reintroductions could prove disastrous.

As they develop the prey items can be scaled up, and we have had success with feeding juvenile *N. cinerea* at appropriate sizes (roughly the same size as cephalothorax and opisthosoma combined), although they will readily tackle prey larger than this!

### 2.2.2 Special Dietary Requirements

So far the only special additions to the diet have been increased feeding for gravid females, at roughly double the number of feeding events.

### 2.2.3 Method of Feeding

Spiderlings being individually reared can simply have the food items tapped into their enclosure, using a pooter to "harvest" the initial food from the colony. Communally reared spiderlings can have the prey items sprinkled liberally and evenly over the surface of the substrate to try and encompass as many individuals as possible.

With larger animals, to ensure prey items are actually being taken it is possible to feed them directly using forceps. This is particularly useful to monitor diet intake, or to use a food that perhaps doesn't trigger a hunting response from movement etc.; this species quite often grabs whatever is dropped within 30mm of it regardless of it being prey or not. If leaving prey that is not going to be eaten immediately it should be removed after four hours and feeding reattempted the following day.

### 2.2.4 Water

For large juveniles and adults a small water dish (~30mm diameter – old plastic bottle tops sufficiently cleaned are good for this purpose) has been used at BZG – these should be checked daily and topped up, and cleaned thoroughly weekly. Communally reared spiderlings receive a light spray on the surface of the enclosure substrate to act as artificial "dew". Individually potted animals do not receive additional water other than from prey items and what is added to the container using a syringe during enclosure maintenance.

ZSL Whipsnade had success using hydrated sponge as a drinking source for spiderlings and juveniles, although care must be given to keep them cleaned regularly to prevent bacterial build-up. This also doubles up as a handy method of ensuring humidity in enclosures is maintained.

## 2.3 Social structure

This animal appears solitary in the wild apart from occasionally two or more spiderlings living close to each other, and during breeding season when mature pairs were found under rocks (M. Bushell, *pers. obvs.* 2016). Further research is planned to investigate this although whether or not it pertains to a true social structure is unknown presently.

### 2.3.1 Sharing Enclosure with Other Species

Other than briefly with their prey item species, no other species have been attempted with *H. ingens*. Using some clever barriers it may be possible to exhibit them with other endemics of Desertas Grande and this may be looked at in the future.

### 2.3.2 Population Management

Individually housed animals are the best way of close monitoring of the population, although with large numbers of animals this can be a time-consuming way of rearing this species. Communal groups work well initially although no matter how much groups are fed there are always cannibalisation events, with the end result being a small group (2-5) of large juveniles. It is interesting to note that communal spiderlings develop much faster, probably an artefact of there technically being an "endless" supply of food.

Currently the population is being managed by institutions holding groups of individually housed spiders, ranging from 25 to over 300 individuals. All clutches of spiders are marked on ZIMS as to their sire and dam, so there is scope for some pair selection to prevent inbreeding as best possible, bearing in mind the small population starting size. For breeding purposes the EEP is envisaging each collection having at least one breeding event, with "unrelated" animals where possible, and then management of the resultant spiderlings to maintain sensible levels of animals without compromising staff time, resources or welfare.

In the future, plans are to reintroduce animals from the captive population while collecting new animals from the wild, in order to treat the two populations in a holistic way, with genetic transference occurring between the two. However, this may not be realised until 2019 or possibly a bit later, depending on logistics.

## 2.4 Breeding

Mature males are recognisable by the presence of palpal bulbs and also their coloration is a much lighter silver-grey, compared to the female which is slightly darker and has much more pronounced black patches on the legs.

Females can be sexed following the standard protocol for sexing skins from Theraphosid spiders. The skin section from the opisthosoma should be carefully unfurled and the area between the book lungs should be examined closely; females should have a developing epigyne. We are unsure at which age this becomes noticeable, but animals that were large juveniles (40mm legspan) were found to exhibit sexual characteristics. Details are viewable at 20x magnification.

**Figure 12: Anaesthetised mature male spider showing obvious palpal bulbs on underside of pedipalps, indicating maturity (circled).**

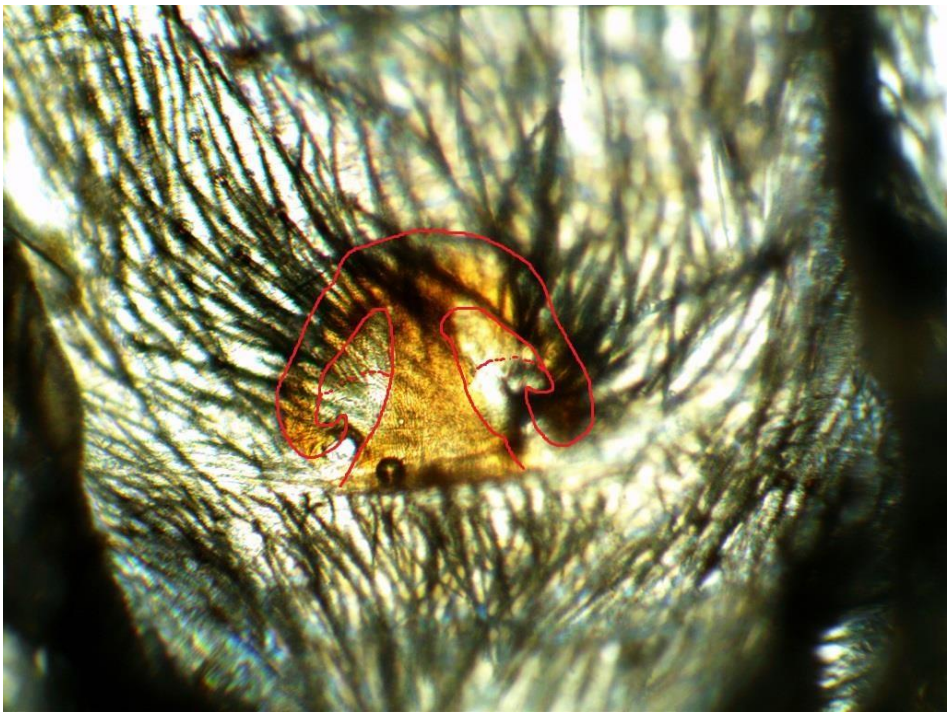

**Figure 13: Scleroterised epigyne in exuvia of mature female (outlined) at 20x magnification**

## 2.4.1 Mating

The following observations are from breeding trials at BZG. In captivity, mating arrangements followed the "standard" procedure with spiders of introducing the male to the female's enclosure. Upon touching a strand of silk the male responds by freezing for up to one minute, before starting to carefully explore the area. During this they also tap the ground with their front legs and also vibrate slightly in short bursts; we found that they will preferentially do both of these activities on "furniture" in the enclosure such as dead leaves, stones etc.. This is presumably to amplify the

vibrations, and we certainly saw females respond much quicker to the male when they used these items. If the female is receptive she will "reply" by tapping the ground also (we did not observe her vibrating), which in turn allows the male to pinpoint her location and increases the frequency of his tapping and vibrating.

Non-receptive females will not respond to the male's advances, and when the male is close will hit him away with her front legs. We did not see the females being overly aggressive to males and there were no mating fatalities, but did have one occasion of a female biting the male on his front leg; it didn't seem to cause any damage to him and he survived to mate with her at a later date.

Once the male has reached the female he will raise his front pairs of legs while quickly waving them, and, if receptive, the female will respond likewise. This courtship dance can last for up to 15 minutes, depending on where in the enclosure it is occurring.

**Figure 14: Male (left) and female (right) engaging in courtship dance.**

If the female continues to be receptive the male will climb directly over her front and lie on top of her. From here he engages his palps with her epygine on the underside, alternating sides with the closest palp. We observed the males inserting the palp on multiple occasions, always alternating after each successful mating event. This can take upwards of ten minutes.

**Figure 15: Typical mating position of *H. ingens*, with the male on top of the female.**

After mating, the male simply climbs off of the female and departs – we did not witness any aggression between the pairs on any occasion after a successful mating. We also experimented later in the breeding attempts by leaving the males in with the

females overnight (initially we paired in the afternoon to ensure that we were available to intercede if required)and we always found the male alive and intact in the morning with no obvious signs of aggression.

### 2.4.2 Egg Laying and Incubation

As a precursor to egg-laying, females will barricade themselves inside a burrow or other similar structure using a few strands of strong silk; this is gradually added to during the next few days. The female constructs a “hammock” shaped sheet of silk, suspended from the walls of the burrow, into which she deposits her eggs before pulling the edges together and silking the egg-sac closed, so it resembles a depressed sphere. As the incubation progresses the egg-sac should start to swell as the eggs develop and moult into nymph-1s and onwards to spiderling.

**Figure 16: Female holding egg-sac within burrow (note partial barrier constructed, this was completely sealed within one week).**

### 2.4.3 Birth/Hatching

On average in captivity the females carry the egg-sacs for 45 days after construction (a range of 41 to 49 days observed) before spiderlings are seen to be on the females backs. We have only observed the spiderlings being on the females back and never the “event” so assume it occurs during the evening or early morning.

**Figure 17: Spiderlings on the female's back - taken with USB microscope camera whilst still in burrow.**

### 2.4.4 Development and Care of Young

When on the females back, the spiderlings are already fully developed and able to live independently. After approximately six to seven days they start to depart from the female and can be found wandering around the enclosure. At this point they can be successfully removed and set up in individual rearing containers as required.

BZG did experiment with removing the spiderlings from the female before this point and it can be done successfully, although is likely quite stressful for the animals, plus can be extremely chaotic depending on the number of spiderlings involved!

### 2.4.5 Artificial Incubation

The females are more than capable of rearing their offspring to spiderling on their own, but at BZG there was an occasion where a female abandoned her egg-sac at the stage it was expected for her to have spiderlings. They decided to intervene and opened it to find a mass of dead rotting eggs and a small number (~15) of nymph-2 spiderlings present, although adhered to the dead egg-mass.


**Figure 18: Spiderlings within discarded egg-sac, viewed on screen using USB microscope.**

Using fine paintbrushes and a microscope they were able to separate the remaining live animals from the eggs and set them up in an artificial incubator consisting of a small plastic container with water inside and a double layer of fine fabric stretched over the top. The animals were placed on top of this fabric and allowed to continue development; it was partially successful, and eight spiderlings were found a week later to have successfully moulted.

Technically, it would be possible to do this with an entire healthy egg-sac which would be useful for population management purposes, although the chances of damaging the eggs/nymphs during the process of removing it from the female would be high and potentially too much of a risk to attempt this, although this could be used in the event of the female dying before the egg-sac hatched.

## 2.5. Handling

### 2.5.1 Individual Identification and Sexing

As with many species of invertebrate, it is quite difficult to distinguish individual spiders from one another. The simplest way around this is to house animals individually and ensure any identification marks (e.g. logical identifiers such as numbers) are transferred along with the animal during enclosure moves of animal moves.

Sexing the animals is problematic until they are nearly mature; males become lighter in colour and also the legs appear longer and thinner in relation to the body. Sexing is best done through examination of the shed exuvia, as detailed previously.

### 2.5.2 General Handling

It is not recommended to handle this animal directly due to the speed they can move and also the risk of being bitten by medium-large animals. If required for closer inspection it is recommended to transfer the animal to a small clear container so it can be observed easily from most angles.

### 2.5.3 Catching/Restraining

A see-through container such as a disposable cup and a piece of stiff card are more than adequate to restrain this species; appropriate sizing should be used depending on the size of the animal. Care should be taken to avoid trapping legs when attempting to restrain as the animals can move incredibly quickly.

In the event of needing closer examination that can be given using the aforementioned technique, it may be necessary to anaesthetise the animal(s) and manipulate when unconscious (see section 2.6)

### 2.5.4 Transportation

This species is best transported in small rigid plastic containers with sufficient air- holes to allow gas exchange. It should be noted to make sure that the containers are not too large, to avoid the animal being rattled about during transport. Kitchen paper or similar can be used to create a “cushion” within if required.

If transport is via road or public transport for s short period of time then all animals should be enclosed within a polystyrene box to protect them from rapid temperature changes. If a longer transport time (e.g. trans-continental or via air) is required then an IATA standard crate should be manufactured to hold the animals for the journey.

### 2.5.5 Safety

This species is quite aggressive, standing its ground when disturbed and grabbing anything that is moved into close proximity with their legs and chelicerae. They are venomous, although it is unknown how potent their venom is and this is something to potentially research in the future. I. Silva (*pers. comms.* 2016) said that he had been bitten several times and that the bite was painful for a while afterwards. Even though it is likely not dangerously venomous it is recommended that all risk of being bitten by the animal is removed or mitigated to prevent accidents.

## 2.6 Veterinary: Considerations for health and welfare

Keeping this species in captivity is still fairly new, and as a result there is still much to learn about the health and welfare of the species form this viewpoint. As with other species of spider, it is important that we allow the animal(s) to exhibit natural behaviours and this is reflected in the enclosure specifications earlier in this document, namely giving the individuals a place they can hide away as required and access to food and water. Research is currently being performed on substrate

preferences and their relation to burrow construction, so we will be able to fine tune the care of this species in captivity relating to what results we see.

Health-wise, we are still in the infancy of the project and are coming across cases of unexplained deaths with some collections and individuals; in particular a group of spiderlings from one egg-sac appears to have a higher mortality rate than others (Stringer, 2017. *pers. comms.*), although all examined animals have had inconclusive results from histopathology and gross post mortems.

At Bristol Zoo Gardens, to make sure that the males we had identified were actually mature, we anaesthetised them during a clinic session. General anaesthesia was induced with isoflurane on a cotton swab. At ~23°C the SVP of isoflurane should equate to approximately 35-40% isoflurane. This resulted in an excitement phase, circling urgently, with dorsal recumbence occurring at approximately 5 minutes post swab placement, and provided approximately 120 seconds of immobilisation. Sedation was accompanied by all the legs being lifted dorsally over the body. We are unsure as to if this had any ill effects on the animals, so should be reserved for rare use, rather than regular.

When originally brought into captivity, samples were taken and nothing unusual was noted, bar some indication of *Serratia marcescens* which was present on samples taken in the wild; as this is a fairly universal bacteria found all over the globe there was no cause for concern, although some animals that died did show signs of infection, although whether this was the cause of death or post-mortem colonisation was unclear. As always, we are continuing to research into this and will update these guidelines as appropriate with the latest information, including the production of the disease risk analysis for the species and subsequent conservation programme.

## 2.7 Specific problems

This species seems relatively easy to maintain in captivity, although as mentioned above there have been some mortality events within populations held at most collections since distribution of the spiderlings.

The majority of issues seem to stem from disecdysis relating to inappropriate humidity levels, although in the case of one institution the environmental conditions have been scrutinised closely and we still haven't worked out exactly what the issue is, as all appears to be well within the limits for the species and in fact optimal.

Although most invertebrates are capable of autotomy, this species seems to have problems with this during ecdysis, and most cases where they have had moulting issues and lost a leg in the process the animal has suffered catastrophic haemolymph loss and subsequently died. Currently there isn't much treatment we can do for this other than trying to seal the wound with superglue or similar, but unless caught early enough (and the animal being of suitable size for treatment) it is invariably fatal.

## 2.8 Recommended research

Currently several avenues of research are being looked into which are in discussion currently. The following table lists some topics that have been proposed (T. Capel, *pers. comms.* 2017) which fit into of the overall conservation strategy (Cardoso, Bushell & Stanley-Price, 2016) and would be an excellent baseline for research topics to enhance our captive knowledge of the species and by proxy help facilitate wild studies and areas we should be focusing on.

- ***Enclosure design and layout*** *– looking at different set ups including substrate types and depths, hide and cave types, inclusion of plants etc. and even down to tub sizes.*
- ***Enclosure usage*** *–looking at how and what the spiders use within the enclosures. This would be linked to the above and with the different setup and options provided we would look at the usage of each item and look at what may be preferred or used more.*
- ***Live-food trials –*** *we could look at trying out things such as woodlice and other isopods within a naturalistic type setup. These would be added to help break down matter within the exhibit but could also provide an opportunity to look at whether or not they would eat them as they do in the wild. (ed. Also to include various live food items as prey selection)*
- ***Burrow/ cave depth and structure*** *– linked to the first project and could be linked to substrate depth.*
- ***Activity log and behavior*** *– this can be completed throughout the time we have the species but would look at filming and monitoring select individuals throughout the day and night and look at the activity and behavior of the wolf spiders.*

## Acknowledgements

The authors wish to thank the Instituto das Florestas e Conservacão da Natureza (Madeira), the IUCN SSC Spider & Scorpion Specialist Group and the IUCN SSC Invertebrate Conservation Subcommittee for their support of the conservation programme and the support they have given thus far.

The British Tarantula Society has helped the programme not only with a bursary towards husbandry equipment and travel to the range country, but also general husbandry advice, so many thanks are extended for their support so far and the future support of the programme.

Also, a huge thank you to all the participants of the Desertas wolf spider EEP for their hard work and dedication to the species and conservation programme overall. Without the support you provide the programme it would not be as successful as it currently is, with the research and husbandry work being carried out a massive boon to the knowledge of this species in captivity.

# Section 3: References


- Bushell, M. 2017. Field observations on Desertas Grande Island.
- Saunders, R., Bushell, M. 2017. DISEASE RISK MANAGEMENT FOR THE DESERTAS WOLF SPIDER (Hogna ingens). Bristol Zoological Society.
- Cardoso, P. 2014. Hogna ingens. The IUCN Red List of Threatened Species 2014: e.T58048571A58061007. http://dx.doi.org/10.2305/IUCN.UK.2014-2.RLTS.T58048571A58061007.en.
- Cardoso P., Bushell, M. and Stanley Price M. 2016. *The Desertas Wolf Spider – A Strategy for its Conservation 2016-2022*. IUCN-SSC, Finnish Museum of Natural History, Bristol Zoological Society and Instituto das Florestas e Conservacão da Natureza, Funchal, Madeira. 42 pp.
- Capel, T. 2017. Email discussion about potential research topics, facilitated by Alex Cliffe.
- Gotts, J. 2018. Discussion via email of dietary items fed to spiders at Londleat.
- Robinson, P. 2017. Email discussion about high temperatures and subsequent burrowing and entrance closure.
- Silva, I. 2016. Discussions in Madeira regarding life histories of the species.
- Stringer, R. 2017. Discussions relating to mortality of spiderlings from differing egg-sacs.