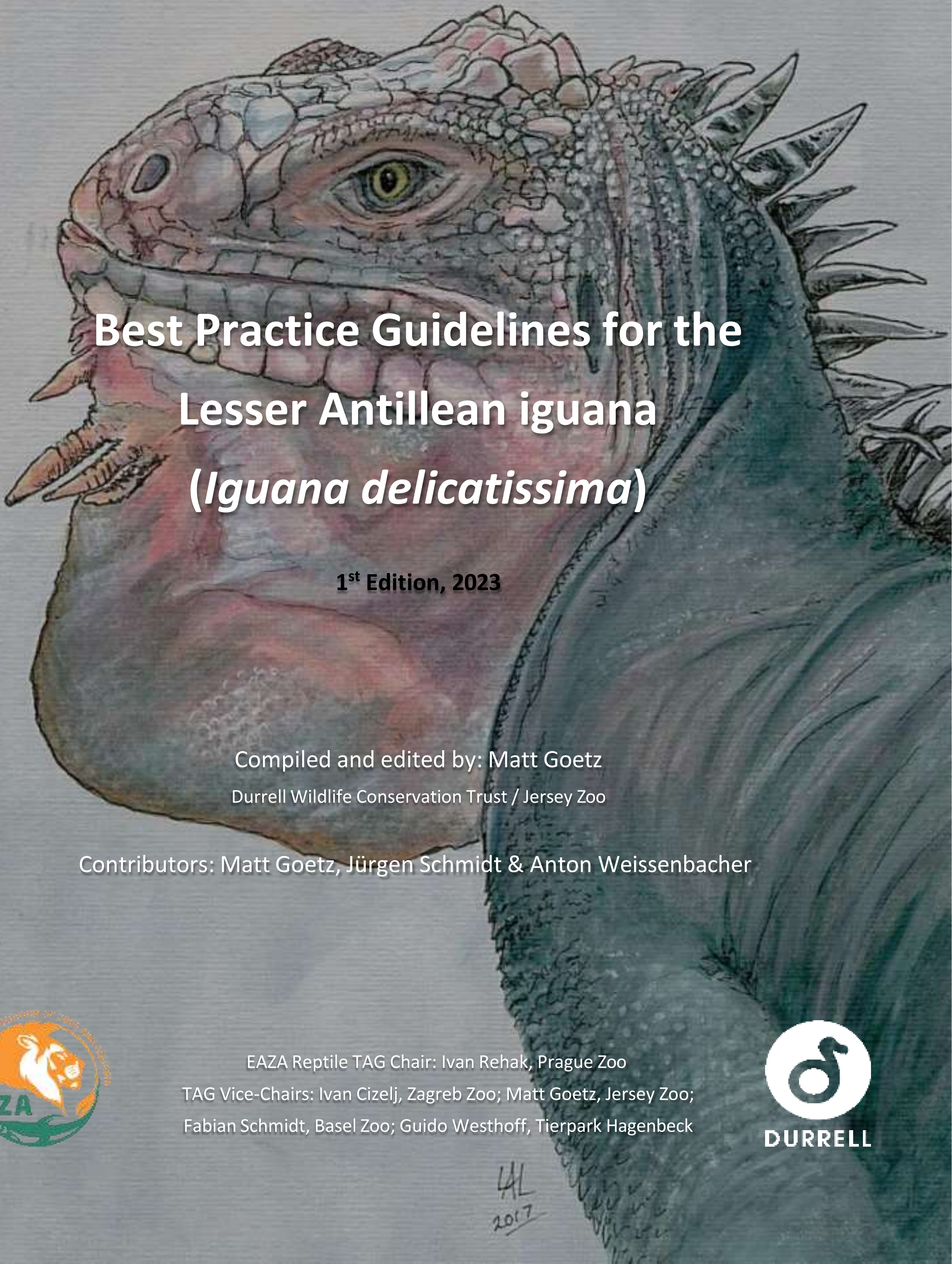
EAZA Reptile Taxon Advisory Group



Best Practice Guidelines for the Lesser Antillean iguana (*Iguana delicatissima*)

1st Edition, 2023

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Disclaimer

Preamble

Right from the very beginning, it has been the concern of EAZA member institutions 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, specialists of the EAZA 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 guidelines for best practice. As such, the 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.

Citation: Goetz, M., J. Schmidt & A. Weissenbacher (2023). EAZA Best Practice Guidelines for the Lesser Antillean iguana (*Iguana delicatissima*) – *First edition*. European Association of Zoos and Aquariums, Amsterdam, The Netherlands.
DOI: 10.61024/BPG2023LesserAntilleaniguanaEN

Front cover picture: portrait drawing of an adult male *Iguana delicatissima* at Jersey Zoo. © Lesley Lawrence.
Back cover picture: a hatching *Iguana delicatissima* at Jersey Zoo. © Dan Lay/Durrell.

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Introduction

The Lesser Antillean iguana is a highly threatened Caribbean iguana species facing a high probability of extinction in the near future if solutions to its rather recently emerged main threat, the hybridisation with the invasive common green iguana (*Iguana iguana* s.l.), cannot be found. Therefore, the still small captive population in zoological institutions has rapidly increased in importance and needs increasing both, in terms of size and in its genetic sustainability. It is hoped that these husbandry guidelines will encourage more institutions to house Lesser Antillean iguanas under the umbrella of the EAZA Ex-situ Programme (EEP), and facilitate and promote the successful, long-term husbandry and breeding of this impressive species.

NB: These guidelines are designed for the captive husbandry and breeding of Lesser Antillean iguanas (*Iguana delicatissima*) in temperate countries and indoor enclosures. Although many chapters are of course universally relevant, these guidelines do not necessarily guide or represent how the species should be or is being kept in outdoor short-term or permanent enclosures in their natural range or in any other country where suitable outdoor housing is available throughout the year and suitable natural climates exist.
However, the more universally relevant chapters, e.g. on nutrition, social structure or breeding and incubation are equally suitable for the in-country husbandry of *I. delicatissima* and other Lesser Antillean insular taxa and populations of the genus *Iguana*.

Section 1. Biology and field data

1.1 Taxonomy

- Order: Squamata
- Family: Iguanidae
- Genus: *Iguana*
- Species: *Iguana delicatissima* LAURENTI, 1768

Common names: Lesser Antillean iguana (English); L'iguane des Petites Antilles (French); Karibischer Grüner Leguan, Antillenleguan (German); Iguana del Caribe, iguana antillana, iguana de las Antillas Menores (Spanish); Antillenleguaan (Dutch).

1.2 Morphology

Iguana delicatissima is a large iguana. Maximum known snout-vent length (SVL) for males is 434 mm and for females 401 mm (Breuil, 2002), but considerable variation exists in the maximum sizes of animals from different island populations (Breuil, 2002; Breuil, 2003). Maximum recorded body mass is 3.5 kg in males and 2.6 kg for a gravid female (Day et al., 2000). No enlarged sub-tympanic plate occurs at a distance of 12 or fewer small scales from the border of the tympanum, which is the main differentiating feature to the other *Iguana* species, together with the absence of any stripes on the tail.
Typically, snout scales are flat and unaligned (Schwartz & Henderson, 1991). Sexual dimorphism is evident in adults; males often show enlarged nuchal dorsal crest scales, enlarged gular spikes on the

dewlap, enlarged femoral pores and increased occipital scale development (Breuil, 2013; Day et al., 2000; Gerber, 1997; Schwartz & Henderson, 1991).
Adult body colour is usually uniform but may vary greatly between individuals. Juvenile coloration is bright green, often with white streaks on the posterior region of the lower jaw and the shoulder, along with three white lateral blotches or sidebars on the abdomen present in the first 6-9 months after hatching (**Figs. 3)**. Colour darkens with age starting at the extremities and proceeding to the torso with the last area to change being the venter (**Figs. 2)**. In some clutches, this colour change can start and progress rapidly and be concluded by the age of two years while others, especially females, can take up to six years to fully change colour (M. Goetz, pers. obs.). It is not known whether this is determined genetically or environmentally. Female juveniles tend to change colour somewhat later and retain their juvenile coloration longer than males. In most populations, all adults will change to a drab grey-brown, but in some populations, females will retain their green colour throughout life. Consequently, adult coloration may include variations of green, slate grey, and greyish brown. The jowls, jaw, parts of the throat, and the snout whiten with age. Sexual dichromatism varies between populations, being much more distinct in the mesic southern populations and less varied in the xeric limestone island populations. In some populations, both sexes exhibit pink coloration around the jowls, although in most populations this trait is limited to males, particularly in the breeding season (**Fig. 1 + 26)**. Dorsal crest scales and dorsal head scales can have a pale blue hue in adult males. Some females show pink coloration around the occipital region; this may be related to scar tissue induced by mating behaviour.

Fig. 1: Adult male Lesser Antillean iguana. © J. Schmidt.

Fig. 2: Young adult female Lesser Antillean iguanas on Petit Terre, Guadeloupe. © M. Goetz/Durrell.

Figs. 3: Hatchlings of *Iguana delicatissima*. Note the white lateral bands on the abdomen.
© left: M. Goetz/Durrell; right: B. Angin.

1.3 Physiology

There are hardly any data available on physiological aspects of either wild or captive Lesser Antillean iguanas other than the reproductive data listed further below (see chapters **1.6** and **2.5**). Some potentially comparable data exist for other large iguanid species, e.g. blood parameters for wild *Cyclura* sp. and *Conolophus* sp. (e.g. Kishbaugh et al., 2020; Rainwater et al., 2020) which might be useful in comparison when examining *Iguana delicatissima*. Wild baseline data for the immediate congener commonly kept as a pet species, *I. iguana*, are not available while a number of blood parameters are published from captive individuals (e.g. Harr et al., 2001; Jacobson, 2003; Finkelstein et al., 2003; Krysko et al., 2003) and might be used as a proxy for *I. delicatissima*. However, to this purpose, the available data uploaded onto the Zoological Information and management System (ZIMS) are likely the most current and versatile parameters for comparison with other captive iguanas.

1.3 Longevity

Due to the scarcity of long-term field research on *Iguana delicatissima*, the species' longevity in the wild is yet unknown. Longevity for the Lesser Antillean iguana's sister taxon, the common green iguana (*I. iguana*) in captivity is usually thought to be around 20 years (Slavens & Slavens, 1992) although animals of nearly 30 years are known from captivity (J. Binns, pers. comm. 2019); wild data are missing for *Iguana iguana,* too.

M. Breuil (pers. comm. 2021) recaptured two adult *I. delicatissima* (23 cm and 27 cm SVL) in 2017 and 2018 which were first marked in 1997 (Breuil & Day, unpubl. data), which would make these an estimated minimum 23 and 24 years old, confirming that the presumed longevity in this species under natural conditions can exceed 20 years (Knapp et al., 2014).

The oldest age reliably recorded for *I. delicatissima* in captivity is 32 years for a male and 27 years for a female (both now deceased), at Jersey Zoo (Goetz, 2020).

1.4 Conservation status, zoogeography and ecology

1.4.1 Distribution

Historically, this species is believed to have existed throughout the northern Lesser Antilles, from Anguilla to Martinique (**Fig. 4**).

Its range included:

Anguilla, Saint-Martin/Sint Maarten, Saint-Barthélemy, St. Eustatius, St. Kitts and Nevis, Antigua and Barbuda, Guadeloupe, including the islands of Grande-Terre, Basse-Terre, Îlets du Petite Terre, La Désirade, Les Îles des Saintes, and Marie-Galante, Dominica and Martinique. The Lesser Antillean iguana has since been extirpated from Sint Maarten/Saint-Martin, Antigua, Barbuda, St. Kitts, Nevis, and Marie-Galante. Ongoing surveys conducted on Guadeloupe since 2007 suggest that populations have been extirpated recently from Grande-Terre and Les Îles des Saintes. However, individuals are still present along with green iguanas (*Iguana iguana*) and hybrids on Basse-Terre, but biologically viable populations are most likely extirpated (Breuil et al., 2007; Breuil, 2013; Knapp et al., 2014).

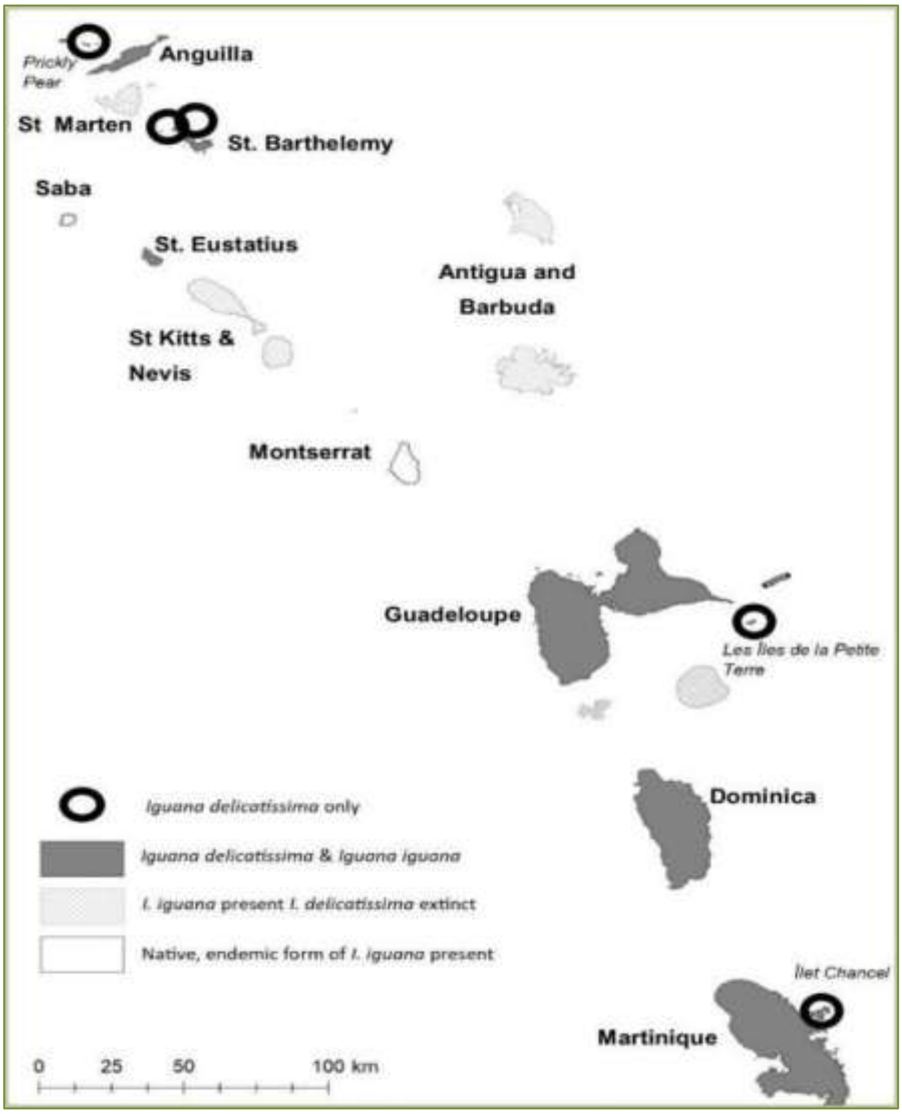


Fig. 4: Current (2021) and historic range of *Iguana delicatissima* in the Lesser Antilles. Only five uninhabited offshore cays are free of *Iguana iguana* and support pure *Iguana delicatissima* populations.
Image adapted, taken with permission from Pounder et al. (2020).

1.4.2 Habitat

The Lesser Antillean iguana occupies habitats from sea level to approximately 300 m although it has been found close to an elevation of 1000 m on Dominica; even on the larger and more mountainous islands it largely occupies the coastal areas and might be restricted to lower altitudes by its thermal requirements (e.g. Day et al., 2000). The species exists in xeric scrub, dry scrub woodland, littoral woodland, and mangrove, as well as lower and mid-altitude portions of transitional rainforest on the large islands (**Fig. 5-8**). The condition of these habitats varies from island to island, with iguanas able to survive in extremely xeric degraded habitats (less than 1,000 mm annual rainfall) to mesic forests (3,000–4,000 mm annual rainfall), in the absence of introduced predators or competitors (Day et al., 2000). Both hatchlings and juveniles live predominantly in bushes and low trees, usually in thick vegetation offering protection, basking sites and a wide range of food. With age, they climb higher and inhabit larger trees. Especially on the larger, forested islands like Dominica, adult iguanas can be found on mature trees whereas on small islets like the Îlets du Petite Terre off Guadeloupe, hardly any trees apart from mangroves exist and iguanas of all age classes can be found on low shrubs and often on the ground or on rocks.

Figs. 5: On some less forested islands, *I. delicatissima* can be more ground dwelling and is found on rocks or on lower bushes, as seen here on the Petit Terre islands, Guadeloupe.
© top row: M. Goetz; left: B. Angin.

Figs. 6: Variations of Lesser Antillean iguana habitat in the French Antilles. Top left: Ilet Chancel, Guadeloupe; top right: northern La Desirade, Guadeloupe; bottom: northern Martinique.
© top row: B. Angin; bottom row: N. Duporge.

Figs. 7: Lesser Antillean iguana habitat on St. Eustatius. © top row: T. Cornwell.

Figs. 8: Low, dry shrub/dry forest habitat on Anguilla's Prickly Pear West. This is typical for the smaller, northern, more arid Lesser Antillean islands. © left and bottom row: M. Goetz.

1.4.3 Climate

The Lesser Antilles have a tropical hot and wet climate with a more or less pronounced dry season with slightly lowered temperatures especially at night throughout the first 3-4 months of the year. Generally, dry periods and actual droughts are much more pronounced on the smaller islands while larger landmasses like the Guadeloupe mainland and the Windward Islands of Dominica and Martinique remain more humid throughout. It should be noted that even during dry periods, ambient air humidity remains relatively high through constant evaporation of the warm sea water surrounding the islands; therefore, "dry periods" refer more to actual rainfall food plant abundance through soil conditions than to relative air humidity.

Fig. 9 – **Fig. 11** serve as a good principal approximation for the annual climate *Iguana delicatissima* experiences throughout its range.

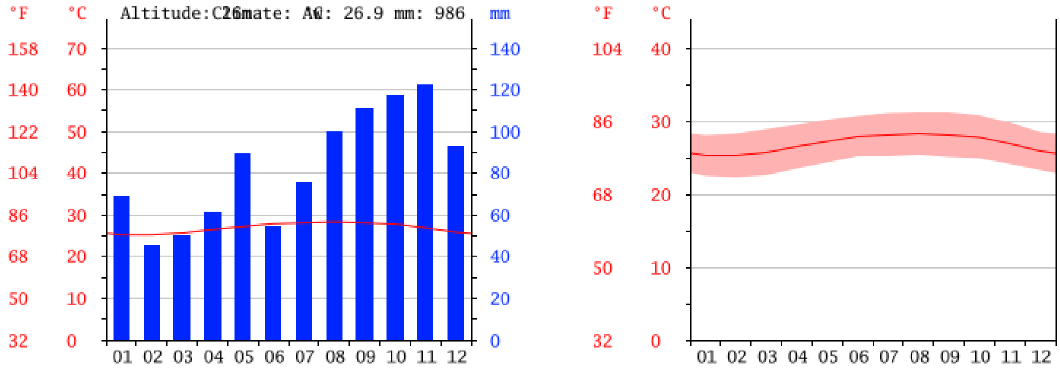


Fig. 9: Left: annual precipitation pattern (blue bars); right: annual average (solid red line) and min. and max. temperatures (shaded area) on Anguilla.
Image taken from https://en.climate-data.org/

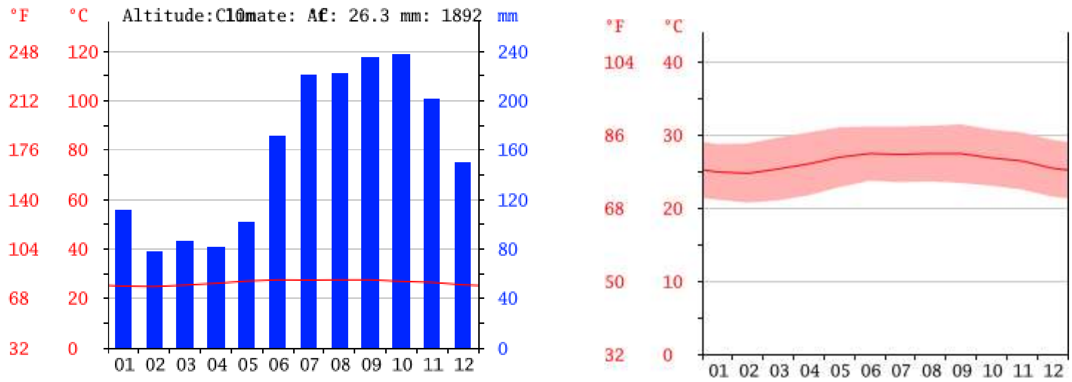


Fig. 10: Left: annual precipitation pattern (blue bars); right: annual average (solid red line) and min. and max. temperatures (shaded area) on the west coast of Dominica.
Image taken from https://en.climate-data.org/

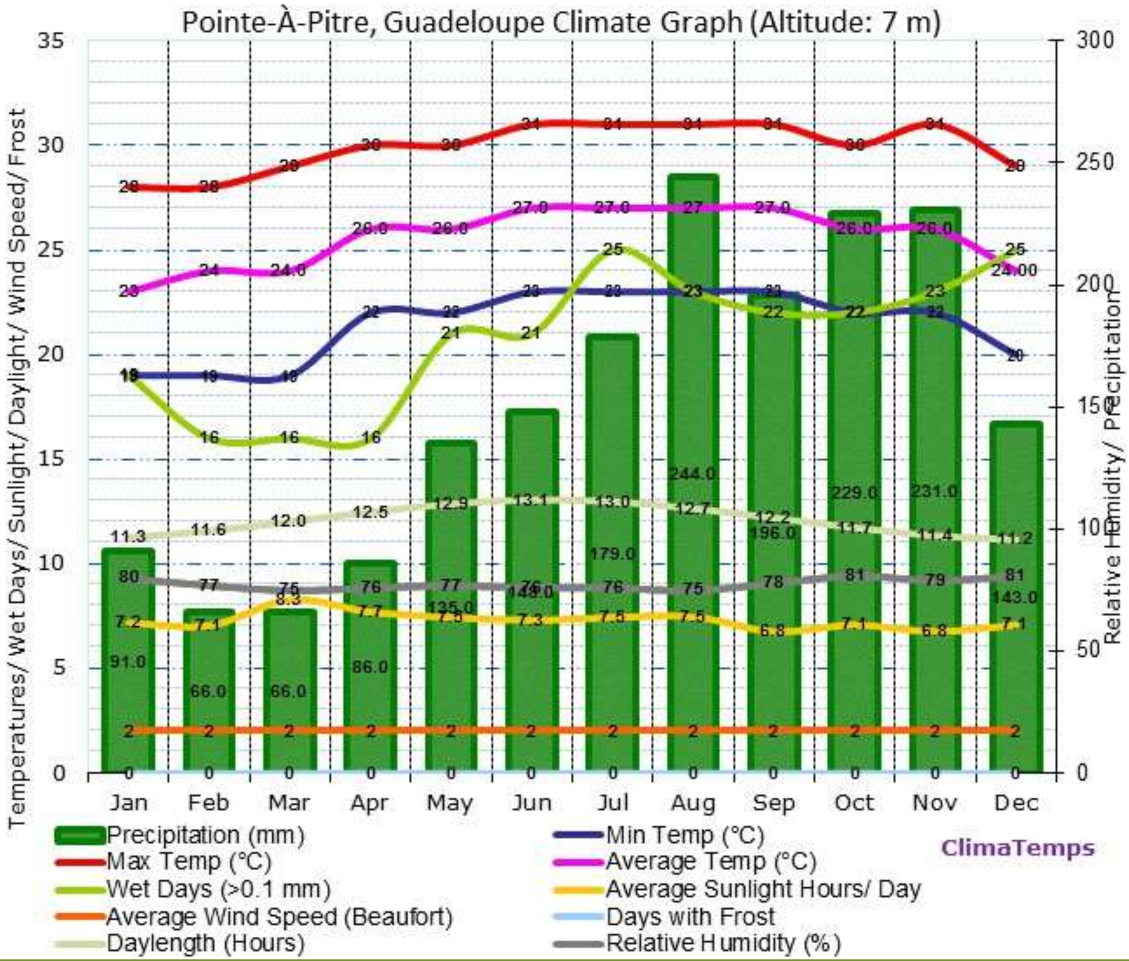


Fig. 11: annual climate pattern on Grande Terre, Guadeloupe.
Image taken from http://www.guadeloupe.climatemps.com/graph.php

1.4.4 Conservation status

IUCN Red-List status: Critically Endangered, A3ce (v.d. Burg et al., 2018).

The Lesser Antillean iguana required a markedly fast assessment change on the IUCN Red List from Vulnerable in 1994 and in 1996 to being assessed as Endangered in 2010 to "facing an extremely high risk of extinction in the wild" (i.e., Critically Endangered) in 2018 (v. d. Burg et al., 2018). Displacement through competition and hybridization with common green iguanas (*Iguana iguana*) is now the dominant and most rapid acting factor for this very high extinction risk and the reason for the more recent disappearance of this species from islands throughout the Guadeloupe archipelago (Breuil et al., 1994; Vuillaume et al., 2015). Post-invasion displacement is rapid and population extirpations have been recorded from several islands in the French West Indies (Breuil, 2013).
The threat is very time-sensitive on all other islands due to the recent arrival of common green iguanas and subsequent hybridization on all islands. Presently (spring 2021), only Les Iles de la Petite Terre (Guadeloupe) and the tiny offshore islets Prickly Pear East (Anguilla), Îlet Fourchue, Ilet Fregate

(both St Barthelemy) and Ilet Chancel (Martinique) remain free of common green iguanas and hybrids.
I. iguana arrives as stowaways in freight shipments and containers, as runaway or deliberately released pets, as stowaway on any boats or as a misunderstood “good deed” by recreational small boat owners and through dispersal by storms and sea currents (Breuil et al., 2010; v.d. Burg et al., 2020).
Common green iguanas are much more reproductively vigorous compared to native Lesser Antillean iguanas, with 3–4 times the number of eggs laid up to twice per year (e.g., Jacobson, 2003); the species is also bigger and more aggressive than *I. delicatissima* and possesses, through its continental evolution, antipredator strategies towards larger mammals (e.g., dogs, cats), which *I. delicatissima* lacks.
Unfortunately, hybrids are fully fertile; hybridization through a whole population is therefore extremely rapid after invasion by a single or a handful of common green iguanas or hybrids. It is important to note that, globally, nowhere have common green iguanas been eradicated or controlled successfully after they started breeding and currently there is no effective method to reverse their impact once they have arrived, even if such measures are attempted on a very aggressive scale, e.g. as trialled on Grand Cayman (Rivera-Milan & Haakonsson, 2020; Rivera-Milan et al., 2022).

Habitat loss and fragmentation were historically most extensive on the least mountainous islands, which have been systematically cleared for agriculture. On these islands, the species either has become extinct (e.g. St. Kitts and Nevis, which might be the very mountainous exemption proving the point) or remains only in tiny remnant populations (e.g. on St. Eustatius and Anguilla). As tourism has superseded agriculture in importance, coastal development has further reduced the remaining habitat and significantly affected already limited communal nesting sites.
The species is also impacted by a range of other invasive alien predators. Feral and pet cats and dogs and Small Indian Mongoose (*Herpestes auropunctatus*) can regularly be observed as significant predators of iguanas.
Free-ranging and feral browsing competitors are present among almost all iguana populations, with the notable exceptions of Îles de la Petite Terre and most of Dominica. Goat and sheep populations are particularly large and of most concern on Anguilla and St. Eustatius.

1.5 Diet and feeding behaviour

The Lesser Antillean iguana is a generalist herbivore feeding primarily on a diet which includes leaves, flowers, and fruits of a wide range of herbs, shrubs, and trees. Both hatchlings and juveniles live predominantly in bushes and low trees, usually in thick vegetation offering protection, basking sites, and a wide range of food. With age, they climb higher and inhabit larger trees (Knapp et al., 2014). Seasonal variation in feeding ecology exists, with folivory during the dry season shifting to folivory and frugivory during the wet season. Feeding is selective, with fresh leaf growth, flower buds, and ripe fruits preferred. Seed dispersal by iguanas may be significant for a number of coastal forest plant species, especially those with large or unpalatable fruits that are not dispersed by small birds or bats (Day et al., 2000). Differences between populations in feeding ecology exist, reflecting local variation in plant species composition (either natural or as a result of introduced browsers). Like *Iguana iguana,* the Lesser Antillean iguana has been observed to be opportunistically carnivorous (Lazell, 1973); however, this might be less pronounced and more of an individual preference than in *I. iguana* as occasional offers of animal protein to captive animals have so far not been accepted.

1.6 Reproduction

1.6.1 Age of sexual maturity

This species becomes reproductively active by the age of 2-3 years (Knapp et al., 2014); this is generally true in captivity but might be delayed in the wild if food availability is suboptimal, e.g. due to drought or hurricanes and therefore growth rates would lack behind. In larger populations, it is unlikely that males will engage in reproductive activities before reaching near adult size due to their inability to achieve dominance in a suitable territory (Knapp et al., 2014).

1.6.2 Clutch and offspring size

Nests are excavated in sandy, but also in clayish, well-drained soils exposed to prolonged sunlight (Breuil, 2002). Clutch size is variable and has been reported from 20 to 30 eggs on Martinique (Bouton, 1640), 13 to 25 on Guadeloupe (Du Tertre, 1667), and up to 26 from iguanas originating from Dominica (Schardt, 1998; Durrell Wildlife Conservation Trust, unpubl. data). A female from Îlet Chancel, Martinique oviposited 16 eggs with a mass ranging from 19.5 to 22.5 g (Legouez, 2007). Eggs hatch a few weeks after the onset of the rainy season, usually in August and early September. Wild data on hatchling size are missing; in captivity hatchlings measure 74-89 mm SVL and weigh 14-21 g [n=381; Schmidt (2021), M. Goetz, unpubl. data].

1.6.3 Nesting and incubation

Lesser Antillean iguanas inhabiting xeric environments (e.g., Petite-Terre and La Désirade) tend to exhibit a relatively synchronous reproductive season with females ovipositing one clutch generally from June to mid-August (Breuil & Thiébot, 1994; Breuil, 2002; Barré et al., 1997, Lorvelec et al., 2000, 2004a, 2004b, 2007). In more mesic environments (e.g., Dominica and Îlet Chancel, Martinique), the reproductive season is more asynchronous with oviposition starting in February (Dominica) or March (Îlet Chancel, Martinique) and continuing through August (Îlet Chancel, Martinique) and September (Dominica) (**Figs. 12 – 14**).

Eggs are usually laid in nest chambers excavated in sandy soil on open, sunny patches. Depending on the population, these areas can be a smaller clearing between surrounding vegetation (M. Goetz, pers. obs.) or large, open sandy slopes on the coast (Knapp et al., 2016).

Nothing is known about the incubation in the wild. But see chapter **2.5.3** for additional information.

Figs. 12: Nesting areas on Îlet Chancel, Martinique. © B. Angin.

Figs. 13: Nesting areas on La Desirade, Guadeloupe (left) and Dominica (right; with drift fencing installed to capture hatchling iguanas for a research study). © left: B. Angin; right: C. Knapp.

Fig. 14: Potential nesting area on Prickly Pear West, Anguilla. © M. Goetz.

It has been suggested that iguanas from Dominica may lay two clutches in one year (Day et al., 2000), although Knapp (pers. comm., unpublished data) found no evidence of multiple clutches on Dominica from 2007 to 2010. Some breeding pairs in private hands do regularly produce two clutches per year (J. Schmidt, pers. obs.; R. Carlseen, pers. comm. 2019). The island heritage of these animals is unknown. In zoos, only two of six pairs kept for several decades at Jersey Zoo produced two clutches in 2020 and 2021, respectively. One female among five did so at Vienna Zoo. Whether these discrepancies in the ability to produce two clutches per year stem from a difference in husbandry or whether they follow the island provenance of these animals is unknown and needs further investigation. It seems highly likely however, that it is due to energy available and hence a result of nutritional differences.

The incubation period and related temperatures in the wild is unknown (but see section **2.5.3.**). For data on artificial incubation in captivity see section **2.5.3.**

1.7. Behaviour

1.7.1 General and seasonal behaviour

The Lesser Antillean iguana is a generally arboreal species but is known to frequently descend to the ground to forage or move between sites. Some animals can also spend the day on a tree but retreat into a rock crevice at night. On islands with little tree cover (e.g. on Petite-Terre, Guadeloupe), the species can also be found living permanently on low shrubs or living terrestrially nearly full-time (M. Goetz, pers. obs.).

Iguana delicatissima is known to remain fairly static throughout most of their life, with wider movement mainly restricted to the dispersal life stage immediately after hatching until the animal has settled in a suitable area. However, on some islands (e.g., Dominica) females will seasonally migrate to communal nesting sites (Burghardt & Rand, 1985; Bock & McCracken, 1988; Knapp et al., 2016) while on others, (e.g., St Eustatius) this seems not to be the case (v.d. Burg et al., 2021). It is unknown whether this difference in behaviour is due to the inherited genetics of a population or simply a reflection of the availability or absence of nesting sites or their properties at a given time.

Interspecific interactions mainly entail head-bobbing and shaking of the head and throat fan as an indicator of territoriality and dominance, which is often also displayed towards humans as a sign of discomfort when approached too closely.

Please see chapter 2.5.1 for sexual/mating behaviour.

1.7.2 Predation

Natural predators of mature Lesser Antillean iguanas are very few and might only include opportunistically large raptors and possibly, although not yet reported, large specimen of *Boa nebulosa* on Dominica. Hatchlings and small juveniles fall into the prey size-spectrum of large *Alsophis* species and local birds of prey like American kestrels (*Falco sparverius*) and barn owls (*Tyto alba* and *T. insularis*). On some islands the iguanas are, or were in the past, hunted for consumption by humans.

Non-native predators introduced by humans include (in order of significance on most islands) mongoose, cats, dogs, rats, and possibly opossums (Martinique) and racoons (Guadeloupe).

Section 2. Management in zoos and aquariums

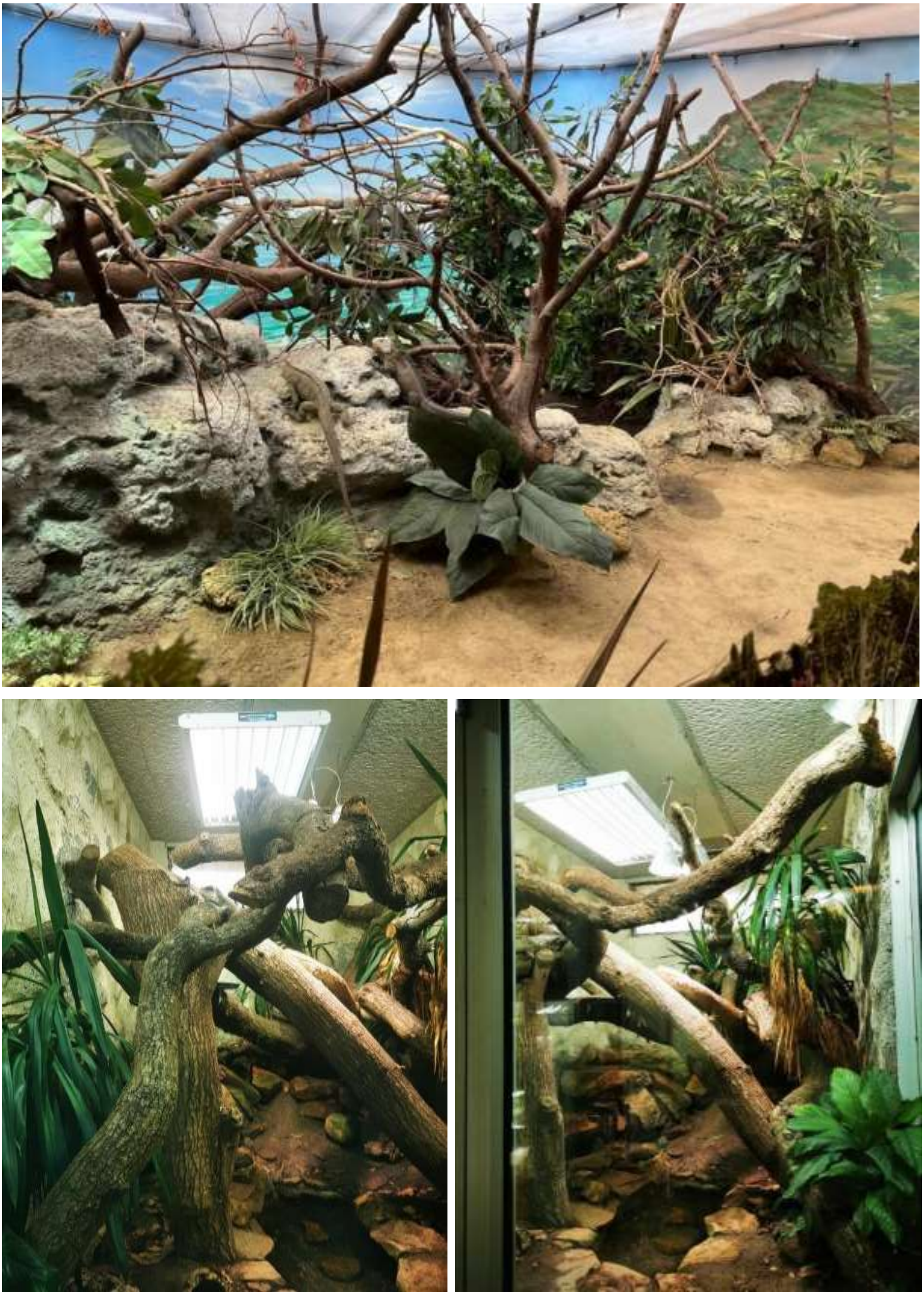
When thinking about the captive requirements for *Iguana delicatissima*, it would be intuitive to take the ubiquitously kept *I. iguana* as a template due to its morphological similarity and sharing the same genus name. However, in terms of ecology and habitat requirements, on most islands *I. delicatissima* is more similar to rock iguanas of the genus *Cyclura* than to *I. iguana*.
Indeed, as a rough guide, when developing a husbandry regime for the Lesser Antillean iguana, we should think to create an enclosure for "an arboreal *Cyclura*" rather than for *I. iguana*; information on *Cyclura* sp. husbandry is available from e.g. Lemm et al. (2010) or Lemm & Alberts (2012).

2.1 Enclosure

2.1.1 Boundary

A variety of enclosure types are suitable for Lesser Antillean iguanas, ranging from very large glass vivariums for juveniles (**Figs. 29**) to practical mesh cages in climate-controlled rooms (**Figs. 17**) to large, planted exhibits (**Figs. 15 -16**). The main considerations will be animal size, the population size and structure and options for climate control and appropriate lighting and heating.
Enclosures will need to provide access for large logs and branches and need to be very well lit with the more natural light reaching the enclosure, the better. Enclosure height is an important factor, both to be able to create a suitable temperature gradient, and for the iguanas to be able to sit high enough to feel safe and remain calm when keepers are working in the enclosure; bearing in mind that lamps/heat spots will need extra space above any branching.
If any mesh is involved in enclosure construction, it is important to select the correct mesh size to prevent iguanas which climb the mesh having their curved claws stuck and subsequently torn out. For adult iguanas, a mesh size of >2 cm needs to be used.

Iguanas are very visually oriented and territorial animals. If mesh or glass enclosures are used, care need to be taken that animals in adjacent cages, especially males, are not able to see each other. While this serves to reduce stress in females, adult male *I. delicatissima* will react aggressively towards other adult male *I. delicatissima.* This can also extend to other iguana-like animals such as *Cyclura* sp., larger *Ctenosaura* sp. or tegus (*Tubinambis* sp., *Salvator* sp.) (R. Gibson, pers. comm. 2005; M. Goetz, pers. obs.).



Figs. 15: Examples of public zoo exhibits for *Iguana delicatissma*.
© top: M. de Boer/Rotterdam; bottom row: C. Westgate/Durrell.

Fig. 16: Example of a very suitable public zoo exhibit for any *Iguana* sp. © M. Goetz.

Figs. 17: Example of off-show, stainless steel mesh enclosures for rearing juvenile and semi-adult iguanas. © M. Goetz/Durrell.


Figs. 18: Examples of off-exhibit enclosures for an adult pair (left) and for rearing juveniles (right) of *Iguana delicatissma*. © left: J. Schmidt; right: R. Kainradl/Vienna.

2.1.2 Substrate, furnishing and maintenance

Branches/perching

The main feature of the enclosure are large branches offering good climbing, resting and basking opportunities in all areas of the enclosure; care needs to be taken to have suitable perching throughout and in all height levels of the enclosure for the iguanas to be able to effectively thermoregulate and to be able to avoid conspecifics in the same enclosure.

While all iguanas, but especially juveniles, will often climb and sleep on thinner twigs for predator avoidance, branching for adults needs to be thick enough for effective locomotion, comfortable resting and especially effective heat uptake during basking. Therefore, at least the perching in the basking area should be as thick as or thicker than the body width of the largest iguana in the respective enclosure; this allows effective and uniform heat uptake not just via radiation from above (see also section 2.2.1) but also through convection from the heated branch.

Care also needs to be taken to use branches with rough and resilient bark. If perching is or becomes too smooth over time, the iguanas' claws might not wear appropriately and can grow too long with an inevitable sideways curving. This, once occurring, can usually not be rectified and will then negatively affect locomotion and security when climbing for the rest of the animal's life.

Rather surprisingly, *Iguana delicatissima* is not a very deliberate climber and can have difficulties when too thin and/or smooth branches are provided. This is important to address, as animals can fall off their perch e.g. when trying to turn on a thin and smooth/slippery branch without enough purchase for their claws – especially if these are already curved from too little wear. Falling to the ground can be problematic and might be lethal for animals which are gravid (internal bursting of eggs), have ingested substrate (possible gut torsion) and for older animals suffering from tissue calcification through too high calcium/vitamin D3 supplementation (rupture of major blood vessels). Especially in off-exhibit enclosures, where aesthetics are secondary, thin or smooth branches can be easily made suitable for basking and climbing by screwing or cable-tying larger pieces of cork bark to a branch (e.g., **Figs. 17, 24, 26, 29**). Branching should always reach taller than a person's height: height is critical for providing security to the iguanas, will greatly reduce stress, keep the animals feeling safe and greatly facilitates any desired habituation (see **2.7**) (Reichling, 2000).

Plants

Planting of the enclosure is optional but often desired in an exhibit space. Plants are also beneficial to provide visual barriers in enclosures for an increased feeling of security and to reduce constant low-level stress when the iguanas can avoid seeing each other permanently. Larger specimen of hardy species like *Ficus* sp., *Yucca* sp., *Dracaena* sp. and palms are suitable and are not usually eaten. In off-show enclosures, plants can be substituted by e.g. dried palm fronds which are hung next to each other from the ceiling or from branches in a way that small "curtains" are created to provide the desired visual barriers but with a means of iguanas being able to still walk through them (**Fig. 17**).

Substrate

The enclosure substrate needs to facilitate the daily removal of faeces and leftover food, it needs to hold moisture well and absorb the water from heavier spraying during the wet season. What type of substrate to use can be decided by economics, practicalities and the needs of other species potentially housed together with the iguanas (see also section **2.4.2**).

The use of pure sand can be problematic as it will remain very loose and can pose a lethal danger to the animals when ingested too frequently. Iguanas will forage on the ground for food items which have fallen from elevated food bowls and, through their tongue-feeding action, will then ingest enough of the sand particles together with the food items to eventually cause gastric blockages and/or facilitate gut torsions which usually end fatally. If sand is used, it should be mixed with soil, compost or loam etc. to bind the particles together, avoiding too much loose sand and its uptake by the animals. The use of pure sand is therefore cautioned; if pure sand is used, the food bowls used must be deep, must be strictly placed on the ground and the animals only fed there to prevent any food items falling out of the bowls and onto the sand, which is common when food bowls are located in the branches (**Fig. 19**).

Fig. 19: If pure sand is used as enclosure substrate, a safe way to provide food for adult iguanas is to use stable, high-walled food bowls placed on the ground so that no food items fall onto the sand, avoiding sand uptake by the iguanas. © J. Schmidt.

Water features and hides

A pond is not required but can be incorporated for other species mixed with the iguanas and/or as a useful feature to heighten the air humidity. Although Lesser Antillean iguanas swim very well, in captivity this species has only very rarely been observed to voluntarily enter any water body to bathe/soak (M. de Boer, pers. comm. 2023).

Equally unnecessary seem any form of enclosed hiding areas as iguanas will usually sleep on branches in the open. Some individuals and especially juveniles do occasionally use e.g., cork bark tubes, but not as a regular feature which could be interpreted in way of a preference or necessity.

Nesting site

If females are housed, suitable areas for nesting need to be provided, even if no males are present. Females will still ovulate and will in many cases not resorb follicles/ova but develop (unfertilised) eggs. To avoid problems through egg retention, a suitable nesting area needs to be provided permanently throughout the year as captive *I. delicatissima* do not always exhibit a uniform, reliable nesting period and even two clutches laid at various times per year are common without this being strictly predictable or controllable.

An area of sandy substrate with a minimum depth of 50 cm should be used as a permanent nesting area, suitably heated and illuminated e.g. by halogen flood lamps, so that the substrate temperature at the depth of the future egg chamber reaches 28-30˚C. The area needs to be large enough to allow the digging of nesting tunnels up to 1 m in length with the egg chamber at the end (**Fig. 20**). The substrate must not be kept too wet but just humid enough that any tunnels dug will not collapse (think of sand just humid enough you could construct a sandcastle with). The nesting area needs to be carefully regulated to provide a very constant temperature and humidity throughout the nesting period for females to accept the site and not delay egg deposition which can very quickly lead to dystocia. Some females can be encouraged to nest by providing items of structure, e.g. half dug-in branches, for animals which prefer to dig in tighter spaces.

As smaller, artificial (and possibly temporary) nesting sites, lidded bins (>70 litre) have proven useful with some females. Laid on its side, with an entrance hole cut into the top (i.e. into the bin's side which now faces upwards) and completely filled with a mix of sand and soil (ratio ~3:1), it is easily and rapidly installed but not accepted by all females (**Figs. 21**). The substrate needs to be compressed quite firmly, kept slightly humid and any material excavated during the trial digs needs to be re-filled on a daily basis.

Fig. 20: Female *Iguana delicatissima* filling her nest, using an open, sunned area in the enclosure, filled with deep, humid sand. Note the presence of a large log which the animal dug close to and under as a general preference. © J. Schmidt.

Figs. 21: 70-litre plastic refuse bin modified for use as an off-show nesting box and heated/illuminated by a halogen flood lamp. These boxes are readily accepted by some (but not all!) *Iguana delicatissima* females. Note the complete fill of substrate which will need to be maintained on a daily basis.
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2.1.3 Dimensions

Enclosure dimensions are largely dependent on the number and size of the animals kept, the respective, country-specific legal framework and the need to provide sufficient space to establish suitable thermal gradients. For adult iguanas, the enclosure must be at least 180 cm high (plus sufficient space above for lighting and heating) to achieve enough thermal gradients and for the animals to feel sufficiently safe. Any enclosure surface area should exceed $3m^2$ for an adult animal or $4m^2$ for an adult pair. Note that public exhibits need to be larger than that, as *Iguana delicatissima* is much more prone to stress than e.g. *I. iguana*. This holds especially true for reproducing females which are ideally kept off-exhibit but otherwise in very large exhibits with plenty of visual barriers to prevent stress-related problems. Permanent stress can prevent successful reproduction and can even lead to the death of a female.

2.2 Environmental parameters

Lesser Antillean iguanas should be kept under environmental parameters mimicking the natural climate and seasons found in the Lesser Antilles (**Figs. 9-11**). Emulating seasonality seems especially important for retaining a long-term annual rhythm to help with appropriate stimuli to initiate successful reproductive cycles, whether actual breeding is desired or not. The reproductive cycle of the species seems to be influenced by day length, sun irradiation and the temperature gradients throughout the seasons.
Seasonality is mainly simulated by a hot and wet season from April/May until October/November where fruit and flowers form a portion of the diet, and a slightly cooler but noticeably drier season in

the winter months (November until April) where feeding fruit should be largely avoided. Night-time temperatures in the dry season should be dropped to 20-22°C (minimum temperatures can temporarily reach but should not drop below 18°C) for at least one month which might facilitate sperm production in males but will definitely help with annual cycling.

2.2.1 Lighting and heating

General thoughts

For effective and suitable lighting and heating of reptile enclosures, and especially full-sun basking species like iguanas, it is essential that the principal thoughts and precautions laid out in Baines et al. (2016), Highfield (2015) and Muryn (2018) are understood and considered. These principles form the baseline for any further thoughts. The above references (full citations in Section **3. References**) can be accessed freely online and are also available through the editor of these BPG.

With the general considerations outlined in these references in mind, it is apparent that lighting and heating for large iguanids, including *Iguana delicatissima,* should principally involve:

- very strong/bright light with a balanced, natural spectrum and with the highest levels of brightness and heat focussed on the basking zone.
- UV radiation within the assumed correct limits, i.e. suitable and safe UV-A and UV-B levels. UV-B levels must be regularly measured and adjusted using a Solarmeter 6.5. UV Index Meter (Solar Lighting Company, PA, USA) or the identical Digital UV Index Radiometer (ZooMed Laboratories, CA, USA).
- basking-zone heat provided mainly as IR-A (also termed Near Infra-Red, NIR), i.e. never using IR-B or IR-C emitting elements, especially not ceramic heaters or other non-luminous heated bodies to heat the basking zone.
- the area of the basking zone being larger than the largest animal in the enclosure.
- a suitable gradient of light, heat and UV-B radiation throughout the enclosure.

It would be highly beneficial if the enclosure could benefit from natural light, e.g. through a sky light. If this is not available, and to counter low light levels and a shortened photoperiod in the higher latitudes during the winter months, metal halide (MH) lamps are highly recommended as they emit the most balanced spectrum of any affordable artificial light source. 6500K LED flood lamps might also be used; however, since reptiles possess a UV-A cone in the retina and LEDs do not provide UV-A radiation, these lamp types do not yet provide a balanced light suitable for natural colour vision in reptiles. They should therefore at least be combined with MH lamps or natural daylight (Reichling, 2000; Wunderlich, 2015; Wunderlich, 2002: https://www.licht-im-terrarium.de/led/reptilien).

UV radiation

UV-A radiation can penetrate normal glass and is therefore sufficiently provided by MH lamps or through natural light entering a window. For UV-B radiation, a gradient must be available with an UV-B Index (UVI) of zero in lower areas outside the basking area towards a maximum UVI of around 3-6 in the basking zone. The lower range, UVI 3-4, seems best used for juveniles and up to a UVI of 5-6 for adults.

UVI levels measured in the natural habitat in the Caribbean are of course reaching much higher values, with an UVI of up to 13 in the summer mid-day sun under a clear sky. However, it is very rare for iguanas to expose themselves to full sun for extended periods in those circumstances (M. Goetz,

unpubl. data). Moreover, the properties of the UV spectrum from artificial light sources are not quite the same as from natural sunlight with an artificially created UVI of, say, 7 being equally biologically potent than an UVI of ~10 created by sunlight (Baines et al. 2016).
A bank of multiple T5 fluorescent tubes is the most versatile and adaptable method to achieve adequate and stable/long-lasting UV-B radiation in the enclosures (**Figs. 22**). Using MH lamps for UV-B radiation makes only little sense in enclosures larger than what is used for hatchlings and the output and longevity of UV-B radiation through those bulbs is inherently unpredictable. Therefore, MH lamps are highly recommended for their light intensity and spectrum but not as the sole UV-B radiation source. The vast range of options which T5 fluorescent tubes provide and their very consistent and durable UV-B output make them the superior and more cost-efficient option for UV-B provision. Depending on enclosure and animal size and needs, dozens of combinations in tube length, UV-B strength, attachment height and number of tubes used together with or without reflectors are possible - from a single fluorescent tube for a UV-B gradient in a hatchling enclosure to creating large UV-B zones in basking areas several m^2 in size when several panels of multiple T5 tubes are used in combination.

Heat/IR radiation
Modern principles and standards in reptile husbandry and animal welfare show that, to achieve adequate heat uptake of an animal during basking, the temperature in the basking zone should be evenly distributed to an area larger than the largest animal in the enclosure, so that the animals' whole body is evenly heated when basking. If animals are larger and MH spot lamps were insufficient to create a zone large and/or hot enough, the basking zone might need additional heating.
As mentioned above, this must be achieved using visible light and IR-A radiation but in no case through ceramic heaters. Good IR-A producing lamps of sufficient size and wattage are linear halogen flood lamps and quartz-halogen heaters (e.g. outdoor patio heaters). Higher-wattage MH lamps are an excellent option but can have a quite narrow heat projection and thus would need to be used in pairs or triplets to achieve a heated area large enough. A single lamp will often not be sufficient to create an adequate basking area for an adult iguana.
The best approach would be to combine a halogen or quartz-halogen lamp with two MH lamps and a T5 fluorescent panel to achieve the best of both worlds: the spread and uniform heat of the halogen's IR-A, the brightness, balanced spectrum and some UV radiation of the MH lamp and the fluorescent tube panel providing additional light and stable, adjustable UV-B radiation (see **Figs. 22**).

In the basking zone(s), temperatures must reach at least 38-45˚C throughout the year while ambient temperatures in the enclosure fluctuate between day and night and throughout the seasons around the following minimum/maximum values:

	Day	**Night**
January/February	26 - 28 ˚C	18 - 22 ˚C
March	26 - 30 ˚C	20 - 24 ˚C
April/May	28 - 32 ˚C	22 - 26 ˚C
June – September	30 - 34 ˚C	24 - 28 ˚C
October/November	28 - 32 ˚C	22 - 26 ˚C
December	26 - 30 ˚C	20 - 24 ˚C

General/ambient room lighting should be regularly adjusted throughout the year to facilitate seasonality and alignment of breeding cycles with a maximum 14 hours in the summer and minimum 10 hours in winter.

Figs. 22: Examples of provision of heat, light and UV radiation for a basking area of large iguanids by combining artificial light and heat sources. © M. Goetz/Durrell.
Left: combining MH basking spot lamps with a T5 fluorescent tube panel and (if a very large heat footprint is needed) a quartz-halogen IR-A heater. Equipment in this example for *Cyclura nubila*: two Lucky Reptile Bright Sun Ultra Desert 150W metal halide floods (illumination, UV-A and light spectrum); six Arcadia T5 D3+ fluorescent tubes (UV-A and UV-B radiation); one SunSwitch BaskZone quartz-halogen 1.5kW heater (heat/IR-A radiation).
Right: for *Iguana delicatissima* by combining MH basking spot lamps with a double T5 fluorescent tube unit. Equipment in this example: one Lucky Reptile Bright Sun Ultra Desert 150W metal halide flood flanked by two Lucky Reptile Bright Sun UV Desert 70W metal halide floods (basking heat, illumination, UV-A radiation and light spectrum); two Arcadia T5 D3+ fluorescent tubes (UV-A and UV-B radiation); in the background a 4x fluorescent tube panel with a mix of standard daylight and Arcadia T5 D3+ tubes (illumination, UV-A radiation).

2.2.2 Humidity

Seasonal changes in humidity can be achieved through various methods, depending on the size and type of enclosure. Spraying the enclosure more or less heavily and frequently depending on the season is a good way to simulate the rainy season and increase air humidity. Generally, spraying the enclosure in the morning needs to be done daily and a second time in the evening during summer months. Good results have also been achieved by additionally employing evaporation room humidifiers (e.g., Trotec B400; Trotec GmbH, Germany), suitable for a larger room where mesh cages are installed to keep iguanas off-exhibit.

2.3 Diet, water and feeding

2.3.1 Diet and feeding

For nearly any herbivorous reptile, variety is key and apart from a few exceptions, no single type of food plant should be considered “good” or “bad” for the iguanas by itself – it always depends on how much of the overall food mix this particular type of plant consists of. The vast majority of food plants can be considered “good” or “suitable” if they are mixed with many others at every feed. Conversely, most food plants should be considered “bad” food if they are given exclusively and then over-deliver certain nutrients over time while other important components are lacking.

The basis of the food should be a mix of as many species of dark leafy greens and herbs as possible all year round (e.g., Lemm et al., 2010; Lemm & Alberts, 2012; Schmidt, 2022). However, some experiences caution the use of vegetable greens of the cabbage family (Brassicaceae); these should only be fed sparingly or avoided altogether as they can increase the potential of gut impactions and gut torsions through the formation of gasses, especially when night-time temperatures are kept on a higher level which might increase the formation of gasses (J. Schmidt, pers. obs.; A. Weissenbacher, pers. obs.).

During the summer wet season, the variety of the mix should be increased by incorporating native herbs, browse and flowers. Various fruits (e.g. kaki, mango, papaya) and vegetables (e.g. grated carrot, pumpkin, courgette/zucchini) can then be offered in small amounts as well (**Figs. 23, 25**). Whole branches of native shrubs and trees placed in the enclosure, can provide additional browse and enrichment in the spring and summer months; this could be e.g. hazel (*Corylus* sp.), lime trees (*Tilia* sp.), false acacia (*Robinia pseudoacacia*), willow (*Salix* sp.), hornbeam (*Carpinus betulus*) etc.

The currently most productive and consistent breeders of *Iguana delicatissima*, Juergen Schmidt and Vienna Zoo, feed their iguanas throughout the summer almost exclusively with cuts collected from nearby meadows containing around 50 different herbs and weeds, but mainly dandelion (*Taraxacum* sp.), plantain (*Plantago* sp.), clover (*Trifolium* sp.), Alfalfa (*Meticago* sp.), non-salad *Lactuca* species, thistles, goutweed (*Aegopodium* sp.), nettles and grasses (Schmidt, 2022). It is important that any grasses are cut into short pieces to prevent digestive problems.

To achieve the above-mentioned mix and prevent the iguanas from picking out favourite bits, all food should be roughly chopped and mixed into a “salad” fed out in bowls or trays. For adults, high-sided bowls can be placed on the ground if the iguanas are used to it. More sensitive individuals and indeed all hatchlings and juvenile iguanas do not feel safe on the ground and will usually only feed in the safety of elevated positions; here, the trays must be fixed to the branching (**Figs. 24**). Please also note the comments on location of feeding trays in the chapter Substrate **2.1.2.**

All animals, regardless of age, sex or size, should ideally be fed daily but can receive one day per week when no food is offered.

2.3.2 Supplementation

To increase the fibre content of the diet for adult iguanas, pieces of hay cobs (e.g. Agrobs Tortoise, Agrobs GmbH, Germany) can be sprinkled (sparingly!) over the prepared salad.

Since the iguanas are supplemented with UV-B lighting by lamps radiating the correct wavelengths, adequate levels of vitamin D3 should be produced by the animals. Involuntary ingestion of high amounts of calcium through over-supplementing the normal diet might thus carry the risk of hypercalcemia and the calcification of tissues at older age; therefore, calcium and vitamin supplements should be given sparingly, and the focus should lie on a large variety of food plants which can provide calcium through the normal diet. More specifically, vitamin supplements should not contain vitamin D3, at least not in high levels, if sufficient UV-B radiation is provided. Calcium supplementation as calcium carbonate can be lightly sprinkled about once or twice per week over the food, more often if the quality and variety of food plants is low. If the less absorbable calcium phosphate is used (e.g. using grated cuttlefish bone/sepia), small daily doses every two days are suggested. As always, there is not enough knowledge on reptile nutritional and especially mineral/vitamin needs to make definite recommendations. It is probably advisable to insist on maximising the variety of food plants, providing good UV-B radiation and using supplements sparingly, especially outside the breeding season. If egg clutches laid prove not to be properly calcified, this would be an indication to either increase the calcium supplementation or the quality of UV-B radiation. An artificial supplementation with vitamin D3 would be a last resort if quality UV-B lighting cannot be achieved although it is uncertain how well iguanas are able to absorb vitamin D3 which is given orally.

2.3.3 Special dietary requirements

Animal protein should not be offered to Lesser Antillean iguanas. Iguanas, being herbivores (Rand et al., 1990; Iverson, 1982; Troyer, 1984a; Troyer, 1984b), are physiologically adapted to process specific kinds of dietary protein, i.e. those found in plant materials. Animal protein contains components which iguana digestive physiology cannot deal with in large amounts over a prolonged period of time (e.g. fats, different purine/pyramidine ratios, different amino acid ratios). Animal protein might also unbalance the natural gut fauna herbivores such as iguanas possess in their hindgut, reducing digestion efficiency of plant matter (McBee & McBee, 1982). While animal protein can be principally metabolised and might be very occasionally ingested by wild iguanas (Lazell, 1973), it is likely to overwhelm the system in excess. Nucleic acids in the foods are degraded to nucleotides and ultimately pyrimidine and purine bases while more are synthesised from amino acids in the liver. Any of these which are not used by the body are broken down into uric acid. With animal proteins provided in excess (the threshold of which is unknown), iguanas end up with an excess of uric acid in the body fluids. Over time, and especially under captive conditions which often facilitate chronic dehydration, uric acid crystallises out and deposits these crystals irreversibly in tissues throughout the body, impairing their function and often leading to serious health problems and premature death (Boonman, 2005).

Although we are far from knowing enough about the exact physiological needs and safe limits of certain nutritional components in iguana species, the current knowledge compels us to be cautious; not because a little animal protein is strictly problematic, but because too much will most certainly be – and we don’t know the threshold, nor do we know any other influencing factors. On the other side, we do know that feeding a strict herbivorous diet poses no problems at all and lets the animals thrive.

For the same reason, feeding commercial iguana/herbivore pellet diets is discouraged as these contain untested ingredients, incl. animal protein in various levels and amounts. Of course, a small amount of pellets can be fed for a short period of time if needed, but it should not make up a large, and especially not a constant portion of the animals’ diet.

Figs. 23: Examples of daily portion of mixed greens, fruit, and vegetable for individual (top) and three (bottom) adult Lesser Antillean iguanas. Note the stable, high-sided bowl needed to prevent substrate ingestion when feeding on the ground. © top row: R. Kainradl/Vienna; left: J. Schmidt.

Figs. 24: Exchangeable trays for food attached to branches – most *Iguana delicatissima*, but definitely juvenile animals, prefer to feed in elevated positions. At the right a metal ring in which the ceramic bowl is placed; on the left a plastic plant tray in which a second tray as in **Fig. 25** are placed.
© left: R. Kainradl/Vienna; right: M. Goetz/Durrell.

Fig. 25: Example of daily portions of mixed greens, flowers, and fruit for Lesser Antillean iguanas ready for distribution into enclosures. One tray caters for one adult animal. © M. Goetz/Durrell.

2.3.4 Water

A water bowl with clean water exchanged daily should always be provided.
Although of course able to swim very well, *Iguana delicatissima* in captivity have only been observed to enter water bodies to soak in one institution (M. de Boer pers. comm.); hence, no pond or other larger water body is strictly required in the enclosure, although it can be a very useful feature to heighten the air humidity.

2.4 Social structure

2.4.1 Basic social structure

Lesser Antillean iguanas generally show a rather docile nature and aggressive interactions between individuals are rare. Nevertheless, even amongst juveniles, a hierarchy is established and subordinate, smaller animals can suffer from delayed access to food and from constant low-level stress.
In the first months after hatching, juveniles still greatly benefit from being reared in groups, as is known from rearing common green iguanas. If only one or two hatchlings are reared, they can sometimes struggle to start feeding and will experience some delayed growth (see section **2.5.5.**), although this is not necessarily always the case (M. de Boer, pers. comm. 2020).
An ideal group size for rearing hatchlings is 6-8 animals. This is large enough a group to provide security and stimulate feeding but small enough to ensure a consistent overview of how well each

individual is doing and to prevent stress among the social group, which might cause some individuals to stop feeding.
Once juveniles are sexed after about 4-6 months, males should be separated as soon as possible as subordinate males will start to greatly lack behind in growth or fail to develop male features such as higher crest spines or broader heads. However, the early non-expression of these male features through subordination is reversible at least in the early stages and e.g. crest spines will again grow larger if the affected male is separated.
Two to three females of similar size can be kept together permanently without any problems provided that sufficient space, basking areas and food bowls are available. Adult groups can therefore principally consist of one male and one to three females. This might also be of benefit to divert the attention of a male from one to several females as some males can exhaust females with continued mating attempts. This is very different from animal to animal and pairs to pairs; however, if a male exerts too much attention and stress to a female, the addition of another female might be advisable, or the pair separated for a period of time. The same holds true if a group or a pair is harmonising "too much" to the effect that the male lost interest in mating; a separation over the winter or for around a month or so will usually increase the male's interest again.

2.4.2 Changing group structure

No particular precautions are necessary when changing the group structure, (re-)introducing an animal to an existing group or (re-)introducing two animals to each other, apart from observing the animals for a few days or weeks. If it becomes apparent that one animal is constantly suppressed and does not regularly feed and/or loses weight, the new individual will need to be removed again. However, this would be a very rare event usually only observed in larger groups, especially of maturing juveniles. Adult animals will very usually tolerate new introductions, even of different sizes, without problems and usually only increased head-bobbing will be seen in the first few days (pers. obs.; Schmidt, 2022).

2.4.3 Sharing enclosure with other species

Lesser Antillean iguanas have been mixed with good success with a variety of other herpetological species from the Caribbean region such as large anurans (e.g., *Leptodactylus fallax*, *L. pentadactylus, Rhinella marina*), anoles (e.g., *Anolis lachii*, *A. roquet*, *A. grahami*, *A. equestris*), curly-tail lizards (*Leiocephalus carinatus*) or red-footed tortoises (*Chelonoidis carbonarius*).
Mo & Mo (2021) provide an 11-page account of species which have been mixed with the common green iguana (*Iguana iguana* s.s.) in zoos around the world. It ranges from mammals, over birds to amphibians and reptiles, even other iguana species. While many are not geographically correct, numerous of the combinations found on a global level are also debatable from an animal welfare and disease point of view. We very much caution trying to replicate most of what is listed there as *I. delicatissima* does behave somewhat differently to *I. iguana*, has a narrower climate tolerance and is much more prone to stress and disturbance.
Especially males of *I. delicatissima* tend to react aggressively towards iguana-like species (i.e., *Iguana* sp., *Cyclura* sp. or *Ctenosaura* sp., *Tubinambis* sp., *Salvator* sp.), even if they are housed in separate enclosures but visible through glass or mesh (R. Gibson, pers. comm. 2005; M. Goetz, pers. obs.). Mixing of *I. delicatissima* with any other *Iguana* (sub-)species is strongly discouraged since these species readily hybridise. Even successful hybridisation with *Cyclura* sp. seems potentially possible

since at least *I. iguana* and *C. nubila caymanensis* are able to produce viable hybrids (Moss et al., 2018).
Although actual experience is lacking, it seems principally possible to mix *I. delicatissima* with smaller birds or terrestrial mammals such as agoutis (*Dasyprocta* sp.) in larger enclosures. Adding climbing mammals such as smaller new-world primates has not yet been attempted. Whether these are tolerated is probably dependent on the character of the individual iguana and the layout of the enclosure. However, *I. delicatissima* appears to be somewhat higher-strung than *I. iguana* and usually remains more easily stressed and agitated. As with other species, any constant source of stress, e.g., through nuisance or threats perceived from arboreal cage-mates might have negative consequences on the reproduction and long-term health of the iguanas. The mixing with climbing mammals is therefore not recommended at this time.

2.5 Breeding

2.5.1 Mating

Mating behaviour can be observed once or several times throughout the beginning of the reproductive season spanning, in captivity, from roughly early March until September; the main mating period is usually in April when males can be seen with an increased pink flushing on the jowls and head scales (**Fig. 26**). There is not much behaviour in terms of pre-mating rituals apart from increased head-bobbing of the male; the actual copulation is initiated by the male biting the neck of the female. If the female is receptive and remains in place, copulation will swiftly commence and can last several minutes. Any superficial injuries on the female's neck and crest will heal quickly but can lead to minor but lasting scars.

Fig. 26: Adult male *Iguana delicatissima* with pink breeding colouration on the head. © J. Schmidt.

2.5.2 Gravidity and egg laying

In contrast to many other reptile species, gravidity in Lesser Antillean iguana females of good body condition is sometimes not easy to determine externally. This means that the approaching time to nest can go unnoticed until the animal starts to test-dig. On the other hand, the change in body girth in a female after nesting is immediately visible by its collapsed flanks (**Figs. 27**), which fill up rapidly again in the following weeks.

The period of gravidity lasts 30-45 days and females might bask somewhat more frequently and feed more vigorously. About 7-10 days before egg laying food uptake will be reduced signifying the latter stages of gravidity; but these signs can often be masked if other animal(s) are housed in the same enclosure. Especially animals which are not fully comfortable with human contact will inflate their body when approached or flatten it when basking and this additionally masks any smaller increase in body girth the developing eggs might affect.

Radiography is a fairly poor tool to determine gravidity in *Iguana delicatissima* as the eggs are not calcified until in the latest stage, providing not much contrast against any GIT content. Sonography is the better tool to determine and follow follicle and egg development. Another benefit of sonography is the fact that animals can be scanned on a branch *in situ* while radiography usually involves the catching, restraint and movement of the animal plus potentially a light anaesthesia if the animal is not habituated enough.

The catching of unhabituated, gravid iguanas should be avoided at all costs! Struggling and fleeing animals can very easily damage any developing eggs which then leads to a usually lethal egg-yolk coelomitis or, if treated surgically in time, to a sterile animal.

Figs. 27: Female Lesser Antillean iguanas immediately after nesting. Note the generally good body condition visible by the solid tail base and rounded hind legs but the very visibly collapsed flanks.
© left: Matt Goetz; right: J. Schmidt.

The provision of suitable artificial nesting areas is detailed in section **2.1.2.**. Female *Iguana delicatissima* are very demanding, particular and selective of their nest sites. Up to two weeks before egg laying, but sometimes only a day or two before, the female starts to look for a suitable area by test-digging shallow holes in various places. As these trial digs, once abandoned, are usually not visited again, keeper staff will need to fill these in again on a daily basis to encourage the female to try again. At the same time, adjustments in temperature and especially humidity need to be carried

out until the animal is accepting the area and constructs the actual nesting tunnel with egg chamber and finally deposits her clutch.
While it is often not easily noticeable when female *I. delicatissima* are gravid, the change in girth becomes very obvious once a female has laid. Unmistakable is also the instinctive scratching behaviour to cover the egg site with substrate, which females will often continue to exercise for hours to days after they laid their clutch.
If the nesting substrate is slightly humid and can hence prevent the eggs from desiccating, it can be beneficial to leave the female in peace until she voluntarily leaves the nesting area: it a) reduces stress for the exhausted animal and b) not always will all eggs be laid in one single event, so it is best not to interfere with the nest area and the female until she clearly lost interest in the site. If the eggs are in danger of immediate desiccation and needed for incubation, they should of course be collected as soon as practical.
When looking for a suitable nesting site and getting ready to deposit eggs, some females can be stressed by the presence of a male in the same enclosure. It can therefore be beneficial to separate the male during the nesting period and mix again once the female has recovered from gravidity and egg laying.

2.5.3 Incubation

After the eggs are carefully excavated, measured and weighed, any "good"/viable eggs are transferred into an incubation box filled with e.g., moist Vermiculite. Sufficient humidity is usually achieved by mixing one part medium-grain Vermiculite with one part water (in weight). The eggs should be buried about 1/2 – 2/3 into the Vermiculite so that at least half of the egg's surface is in contract with the substrate, but the egg can still be visually inspected and sufficient gas exchange is guaranteed (**Fig. 28**).
Non-viable eggs are usually immediately obvious by being flaccid, ill-calcified and/or yellowish-brown in colour, often with un-even surfaces resembling an old, somewhat dried potato. Whereas "good" eggs are white (but for any adhering substrate particles), evenly formed and turgid/plump. If a white and evenly formed egg is not quite plump, it might still be viable and just dried out a little. In such a case the high humidity in the Vermiculite usually compensates this and the egg will be fully plump after a few days' incubation if the egg is otherwise viable.
Fertility of eggs can be determined rapidly as blood vessels will be easily visible through candling the eggs in the first two weeks.

No information exists for incubation temperatures of *I. delicatissima* in the wild.
Usually, eggs of iguanas like *I. iguana* and *Cyclura* sp. are artificially incubated at around 30˚C and these taxa tend to prefer a rather constant temperature with only minimal fluctuation; a principle which works well for *I. delicatissima*.
Opportunistic studies on other Caribbean iguanas with nesting behaviours and nest site preferences similar to that of *I. delicatissima* (*Cyclura nubila caymanensis*, *Cyclura lewisi*) show natural nest chamber temperatures between min. 29˚C and max. 34˚C in a three-month period (June – September). Here, the range of temperature in each egg chamber only fluctuated by up to 3˚C over a period of three months, with daily fluctuations of less than 1.5˚C (M. Goetz, unpubl. data).
However, that such rather constant temperatures are merely a preference and not an absolute requirement shows an unnoticed egg which hatched a perfectly healthy juveniles at Jersey Zoo after

70-75 days. The egg was overlooked when a clutch was excavated, and it naturally incubated in the nesting bin (**Fig. 20**) at temperatures fluctuating between 27-32˚C.

All iguanids s.l. possess sex chromosomes and male heterogamety (e.g., Pokorna & Kratochvil, 2009; Altmanova et al., 2017) and therefore very likely have no mechanisms for environmental sex determination (ESD) incl. temperature-dependent sex determination (TSD) [but see e.g., Sarre et al., (2004) in case of any future surprises…].
All four clutches (N=22 eggs) which were hatched at Jersey Zoo yielded a sex ratio of 1:1 at incubation temperatures of constant 29-31˚C resulting in an incubation period of 84 – 95 days. Jurgen Schmidt achieves a sex ratio of 1:1 at 29-31˚C and after an incubation period of 83-97 days (N=396 eggs). At Vienna Zoo, nine eggs between two clutches incubated at a lower 28˚C hatched after 94 days with a ratio of 3:1 in favour of males on a Vermiculite: water ratio of 1:0.5.

2.5.4 Hatching

The hatching of a clutch usually occurs on the same day but over no more than three days. Although hatchlings possess yolk reserves for many days and can therefore remain in the incubation box (the same way iguana hatchlings often remain in their underground egg chamber for extended periods of time), it is advisable to remove any hatchlings immediately in order to prevent any damage to other, yet unhatched eggs. Any Vermiculite particles, which tend to stick to eyes, mouth and the umbilical area should be removed, e.g., by rinsing the hatchling under hand-warm running water.
Hatchlings should be measured and weighed and immediately transferred, ideally in groups of 6-8 animals, into rearing enclosures.

Fig. 28: Hatching *Iguana delicatissima*. Note the relatively shallow level to which the eggs are buried in the incubation medium to facilitate inspection and gas exchange. © J. Schmidt.

2.5.5 Development and care of young

Hatchlings and juveniles are offered the principally same diet than adults (see chapter **2.3.1**). In the first few days or weeks after hatching, some animals might first have to get used to the mix in the feeding bowls and during this time they can benefit from being fed more naturally looking and enticing food like whole flowers of pumpkin, zucchini/courgette, hibiscus or *Opuntia*, which they will greedily attack (**Fig. 30**). After a few days, these favourites can then be mixed with the other food items and the animals will learn quickly to anticipate their food bowls as feeding spots. If hatchlings are still struggling to start feeding, e.g. because they are single animals, rearing these in an enclosure with live edible shrubs (e.g., indoor hibiscus plants) provides natural, fresh food at all times and therefore making it easier and more convenient for the animals to start feeding.

While no studies have observed Lesser Antillean iguana hatchlings in the wild, hatchling green iguanas (*Iguana iguana*) spend the first month of life obtaining their hindgut fermentation systems before settling into their characteristic habitat. Newly hatched iguanas consume soil within the nest chamber, establishing populations of soil microbes in the hindgut before digestive activity begins in the stomach. Hatchlings dig their way out of the nest chamber during the first week after hatching; once on the surface, they may eat both soil and plant materials. The rudimentary microbial fermentation system acquired through soil consumption supports faster growth, and presumably more effective degradation of plant materials, than microbes obtained without contact with soil. During the following weeks of life, hatchling iguanas disperse away from the nesting area, associate with older conspecifics, and obtain a more complex and effective microbe community by consuming the faeces of their seniors (Burghardt et al., 1977; Troyer, 1984).
In captivity, eggs are usually incubated in relatively sterile media and juveniles removed from incubators directly after hatching, very likely resulting in a much poorer gut microbiome in the first weeks when the juveniles start to feed.
In case that juveniles feed less well or are not growing as anticipated, faeces of older/adult iguanas can be used for seeding the gut microbiome of the juveniles. It is sufficient to lightly smear some fresh faeces from a parent animal either on some pieces of food to be mixed or on branches in the juveniles' enclosure where bacteria are picked up in sufficient trace amounts by the juveniles routinely "lick-smelling" their perching. Of course, the adult animals should first be thoroughly tested for parasites and potentially problematic bacteria before inadvertently passing on harmful pathogens.

Figs. 29: Examples of off-show, communal rearing enclosures for *Iguana delicatissima*. Note the elevated feeding bowls, plenty of visual barriers and the branches underneath basking lamps enlarged by attaching pieces of cork bark for effective thermo-regulation. © left: M. Goetz/Durrell; right: J. Schmidt.

Fig. 30: A group of freshly hatched juveniles eagerly feeding on a first meal of courgette/zucchini (*Curcubita* sp.) flowers. © D. Lay/Durrell.

2.5.6 Population management and contraception

Chemical, reversible contraception in reptiles has been trialled in a very few species through GnRH-agonist implants with mixed results (Schoemaker, 2018; Cermakova et al., 2019). In green iguanas, GnRH implants have been used in a limited trial which did not give statistically significant results although a positive trend in its effectiveness was observed (Kneidinger, 2010).
Permanent contraception through surgical sterilisation can, in principle, be relatively easily and safely performed.

Population management for *Iguana delicatissima* is not recommended to involve the permanent separation of females from males as this can facilitate retained ovarian follicles (pre-ovulatory/ follicular stasis) through disruption of normal hormonal and temporal reproductive cycles (e.g., Dorrestein et al., 2007). If males and females are kept, it is highly recommended to let the iguanas mate and lay eggs naturally, regularly and annually and simply perform population management through euthanising/discarding of eggs.

2.6 Handling

2.6.1 General handling and restraining

In an ideal situation, the iguanas are accustomed to being approached and handled, e.g. for weighing, through training (see section **2.7.**) and can thus be moved without manual restraint. If an otherwise accustomed/trained iguana needs to be forcibly restrained, however, this should ideally be done by a person usually not involved in the daily husbandry of the animal: the carefully established trust between daily keeper staff and iguana is easily damaged by the unpleasant nature of a forced capture and often takes a long time to re-establish.
If restraint is needed, it is accomplished as for other large reptiles with one hand fixating the head with a firm grasp around the neck and the other hand around the hips/tail base. A blindfold works well to keep the animal calm, reduces stress and the likelihood of an accidental bite. Turning an iguana over on its back generally also helps to quieten an agitated individual during an examination or while taking measurements (Lemm, 2004; Lemm & Alberts, 2012).

If potentially gravid females are to be captured, special care needs to be taken that this is done very quickly and without the potential to damage internal eggs (also see chapter **2.5.2**). If the iguana is not restrained on the first attempt, the capture should be aborted. A second attempt is ideally performed only once the animal is positioned again in a favourable place allowing a quick and simple hold. Capture attempts which cause the female to panic and jump to the ground must be strictly avoided as are attempts to capture the fleeing animal on the ground as this can easily cause the damage of oviductal eggs and subsequent death through egg-coelomitis.
Therefore, it is strongly recommended to catch the animals, but especially females during the warmer season, during hours of darkness while they are asleep and to use a black bag or e.g., a black sock to cover the head.

2.6.2 Safety

Because of their large size and powerful jaws, adult iguanas have the potential to inflict severe bite wounds which need medical attention. Wearing gloves is recommended to capture iguanas which are unaccustomed to handling which can lessen the severity of a possible bite and also prevent the very common but usually benign scratch wounds from claws. Restraint is accomplished as for other large reptiles with one hand fixating the head with a firm grasp around the neck and the other hand around the hips/tail base.
The tail is also used in aggression and defence and a well-aimed strike to the face can result in severe or permanent damage to an unprotected eye. Therefore, especially iguanas resting in an elevated position should be approached with caution and the face protected from potential impacts. Once restrained, the tail might be secured under the arm which is grasping the hips/tail base.
Note that improper catching and restraint techniques might result in the tail of hatchling and juvenile iguanas breaking off.

2.6.3 Individual identification

As a current (2023) CITES Appendix 2 and an EAZA studbook species, all Lesser Antillean iguanas should be micro-chipped with ISO/TROVAN compatible passive integrated transponders (PIT-tags). The standard location is subcutaneously at the left dorsal thigh area; equally possible are the dorsal areas just proximal and, in older animals with a thicker tail, distal to the cloaca (**Fig. 31**). These locations provide the best assurance against the migration of the transponders.

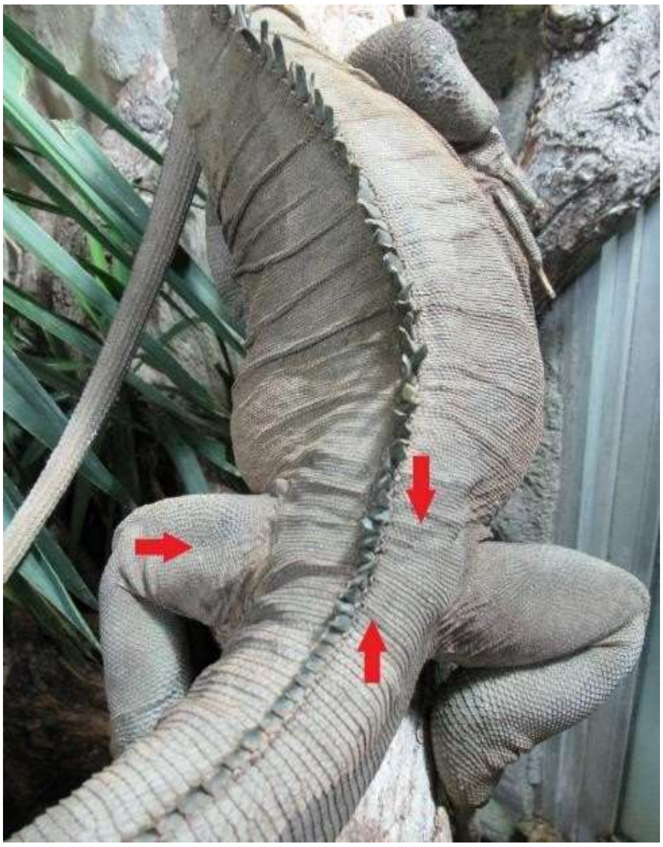

Fig. 31: Suitable locations of subcutaneous implantation of passive integrated transponders (PIT-tags) for individual identification. © M. Goetz/Durrell.

2.6.4 Sexing

The Lesser Antillean iguana is sexually dimorphic. Males are typically larger and heavier than females, with a more massive head, bigger jowls and dew lap, larger tubercles and to an extend a higher crest. However, crest height is only indicative in adults whereas juvenile females might have higher crests than juvenile males of the same age/size. Males' jowls typically flush pink during the breeding season. A thickening of the tail base in adult males is evident, as are greatly enlarged.
To sex younger animals from the age of 4-6 months, hemipenal probing is easily performed and gives quick and usually reliable results if more than one juvenile (for comparison) is involved. However, probing should be repeated two to three times as some animals will be able to constrict muscles around the cloaca enough that false male results can be achieved if only probed once.
It might also be possible to sex iguanas and even iguana eggs through genetic analysis, a method which is currently being investigated for a broader application in zoos (M. de Bour, pers. comm. 2023).

2.6.5 Transportation

Iguanas can be transported as any other lizards in suitable transport crates, compliant with IATA Live Animal Regulations (IATA, 2015). The animals should be individually packed in securely closed cloth bags of appropriate size and the remaining crate space suitably cushioned, but with a material that allows enough airflow through the crate, e.g., shredded paper.
Transport temperatures should ideally be maintained between 20°C and 28°C. For short periods, temperature minima and maxima of 15°C and 32°C respectively will be tolerated; an extended time at those temperatures or any further deviation up or down might result in the death of animals.

When shipping commercially by plane, extra precautions need to be considered. Airlines will usually ship live animals in a heated cargo hold; the pilots will need to be advised by the handling agent on the appropriate temperature the hold will need to be kept in and will engage the hold heating during pre-flight checks. However, the cockpit usually has no thermometer or any continuous influence over the hold heating which means that the cockpit might not be aware of a possible malfunction of the hold heating; in any case, there would not be anything that could be done during the flight to rectify a fault. Therefore, to make sure the animals survive a possible heating failure in the hold, longer shipments by plane, e.g. commercial trans-Atlantic flights, should only be undertaken when outside ambient temperatures on the ground during loading of the crates onto the airplane are >24°C. Monitoring commercial shipments by plane through temperature data loggers enclosed in shipping crates indicated that hold temperatures (in a Boeing 777) drop by about 1°C/h at cruising altitude if the hold heating is not functioning as intended (Durrell Wildlife Conservation Trust, unpublished data). Therefore, if the animal crate is loaded at 25°C air temperature, a critical minimum temperature in the transport boxes might be reached after >10h flight time. Of course, different airplane types and different circumstances during loading will likely influence this substantially.

2.7 Behavioural enrichment and training

Enrichment for Lesser Antillean iguanas can of course entail a range of suitable environmental stimuli in accordance with the necessary parameters, allowing the experience of daily and seasonally varying temperatures and light and humidity levels. A variety of climbing structures and elevation levels are as enriching as they are necessary.
Enrichment through scent and food is easily performed by providing different foods in varying places and providing freshly cut branches of suitable shrubs or trees such as e.g. hazel (*Corylus* sp.), willow (*Salix* sp.), lime trees (*Tilia* sp.), false acacia (*Robinia pseudoacacia*) etc. when in season with fresh growth.
Mirrors can be used to stimulate males in the breeding season and might also be added intermittently; however, care should then be taken not to keep mirrors in place for too long (i.e., more than a few days) as this can potentially become a source of permanent negative stress.

Habituation of iguanas to care staff interaction, including to touch, manipulation and displacement is possible through consistent engagement; but be aware that iguanas can differentiate faces and voices and react differently and with different levels of trust to different people. In general, habituation is important as it restricts aggression of especially male iguanas towards people and allows minor veterinary interventions such as claw trimming, blood draws or ultrasonography to be carried out in the enclosure and without restraint. It also calms the animals and iguanas habituated to people experience less stress-related problems.
Suitable guidance to habituate pet green iguanas exist (e.g., online https://www.thesprucepets.com/handling-pet-iguanas-1236878) and the same principles hold true for Lesser Antillean iguanas. However, *Iguana delicatissima* seems to be somewhat slower or less responsive than *I. iguana* and habituation might take longer to accomplish.
Actual training, e.g. target training takes much longer and can be relatively hard to achieve, especially due to the less immediate food response compared to other lizards or even other iguanas (*Cyclura* sp., *Ctenosaura* sp.), which makes positive reinforcement through immediate rewards difficult. However, if a suitable reward-food item can be found to work for an individual and the individual becomes used to it, target training is useful, enriching for animal and care staff and the universal animal training methods and principles apply.
Hatchlings and small juveniles will be much more relaxed and will become much quicker accustomed to people when their enclosure is heavily planted to provide plenty of cover and visual barriers but is at the same time exposed to frequent people traffic; the branches should reach higher than the people working with the animals; this will reduce stress, keep the animals feel safe and speed up the acclimatization. Juveniles kept in enclosures at table-height will usually remain skittish. Calm and unforced engagement with the juveniles on a regular basis can speed up habituation whereas regular catching events, e.g. to measure or weigh juveniles, will delay or prevent habituation due to the stress and the animals' associating people with negative events.

2.8 Veterinary considerations

As with all captive reptile species, many if not most veterinary problems can be avoided by providing optimum husbandry parameters and isolation of the animals from other species possibly carrying transmittable disease agents, incl. parasites. It is important to note that pathogens are not only spread between taxonomically close specimens (i.e., from iguanas to iguanas) but also via fomites, keepers, by food (contaminated plant leaves) and through taxonomically distant animals, e.g. by amphibians or turtles transmitting *Mycobacterium* or snakes carrying Paramyxoviruses (e.g., Hyndman et al., 2013).
General advice on the most common veterinary problems and techniques are plentiful in the literature and general veterinary knowledge for the common green iguana (*Iguana iguana*) (e.g., Divers & Scott, 2019; Jacobson, 2003) are equally applicable for the closely related *I. delicatissima*.

Pre- and post-ovulatory stasis and dystocia

The most common and problematic veterinary issue for Lesser Antillean iguanas in captivity to date seem to be pre-ovulatory (follicular) stasis, post-ovulatory stasis and dystocia in females, which can also develop into a lethal peritonitis/egg yolk coelomitis. In many cases immediate surgical intervention is necessary which can leave the animal sterile if ovariectomy must be performed. Iguanas do sometimes resorb developing but unfertilized follicles; however, this has proven to be no reliable mechanism and often the follicles are not resorbed. To help avoid this problem, animals should always be able to go through their reproductive cycle as naturally and stress-free as possible and with both sexes synchronized. This includes:

- providing the species with a seasonal climate and food regime.
- mixing females and males and allow mating even if no offspring is desired.
- providing a suitable nesting site and being aware that gravid *I. delicatissima* females don't necessarily look gravid and that egg deposition timing is therefore hard to predict; this means that optimal temperature, light and humidity conditions at the nesting site need to be maintained constantly.
- preventing stress in females by providing very large exhibits with plenty of visual barriers or, ideally, housing gravid females off-exhibit.
- habituating the animals to people to reduce stress especially in exhibited animals.

Devrieseasis

Attention to the impact of potential pathogens and associated antibiotic resistance is also particularly important in the light of a relatively new threat represented by the actinobacterium *Devriesea agamarum* (Ballmann et al., 2014). This bacterium causes chronic proliferative dermatitis, with lesions occurring in several areas of the body, including around the oral cavity, the pericloacal region, and the legs.
Septicemia is a frequent complication, usually resulting in the death of the affected animal. Since 2011, we know that *I. delicatissima* on the island of St. Barthelemy have been infected with *D. agamarum* (Ballman et al., 2014; Hellebuyck et al., 2017), most likely through introduced pet species like common green iguanas.
It is not yet known how lethal these infections are and what this means on a population level, although infected individuals were found dead and the lethality in other species can be high. Other reptiles such as *Anolis* seem to be able to act as carriers (Hellebuyck et al., 2017; F. Pasmans, pers. comm. 2019) and increase the possibility of spreading *Devriesea* to other islands. Indeed, apart from

St. Barthelemy, *D. agamarum* was isolated from two asymptomatically infected iguanas (one *I. delicatissima* and one *I. iguana*) from Guadeloupe in 2017 (B. Angin, pers. comm. 2019; F. Pasmans, pers. comm. 2019). On Saint Eustatius, lesions in appearance consistent with devrisiasis have been detected in *I. delicatissima* in 2019 (T. van Wagensveld, pers. comm. 2019).

The spread of this disease in captive reptile collections in Europe (e.g., Hellebuyck et al., 2009; Gallego et al., 2018; Brockmann et al., 2023) makes this a potential problem to remain vigilant about. Testing for this bacterium has been unreliable in the past with good detection in symptomatic animals but low/unreliable sensitivity in asymptomatic carriers; this changed in 2023 when a real-time PCR (qPCR) test was developed and published (Brockmann et al., 2023) which should allow relatively reliable screening of captive and wild populations in the future, once the test's sensitivity has been validated.

However, if animals were destined to return to the wild or if keeper staff travel to the field and might act as vectors of this disease (and potential others not yet identified as a risk): appropriate precautions and biosecurity measures need to be planned for and actioned. *Devriesea agamarum* can remain infectious in/on moist substrate for several months (Hellebuyck et al., 2011) but is susceptible to most common disinfectants (Hellebuyck et al., 2011).

Figs. 32: Left and middle: cutaneous granulomas consistent with devrieseasis in *Iguana delicatissima* on Sint Eustatius; right: *Devriesea agamarum* associated cutaneous granulomas and dermatitis in *I. delicatissima* on St. Barthelemy. © left/middle: T. v. Wagensveld; right: taken from Hellebuyck et al. (2017).

Claw care

In the wild, iguanas tend to do much more climbing and running over a variety of different surfaces than they do in captivity. This provides plenty of opportunities for their claws to be worn down naturally. Captive iguanas are often missing suitable hard-wearing surfaces and the opportunity to use these, and their claws can become too long and often curve sideways, making them useless for climbing. This situation is ideally prevented by providing rough climbing surfaces and exchanging these regularly before they become too smooth. A suitable addition is the incorporation of artificial surfaces in the enclosure, e.g. resting places or basking areas covered with a hard, waterproof base like tile glue or concrete which is then thrown with rough sand before it hardens. This durable, rough surface will help trim down claws naturally.

Regular checks of the claws are imperative, and claws should be trimmed before they reach a length which makes them prone to curving. Once claws have started to curve, this usually cannot be rectified.

Gut torsion

Gut torsion in iguanas is not often reported but might be an overlooked and hence more common problem than assumed. It is possible that many of the unexplained deaths, especially in pet green iguanas where post-mortems are rarely performed, might be attributed to this issue (M. Konecny, pers. comm 2023). Problems and causes related to gut torsion have been highlighted above (see **2.1.2** and **2.3.1**) and might be most commonly associated with substrate ingestion, falls from perching and the feeding of predominantly Brassicaceae facilitating the formation of gasses.

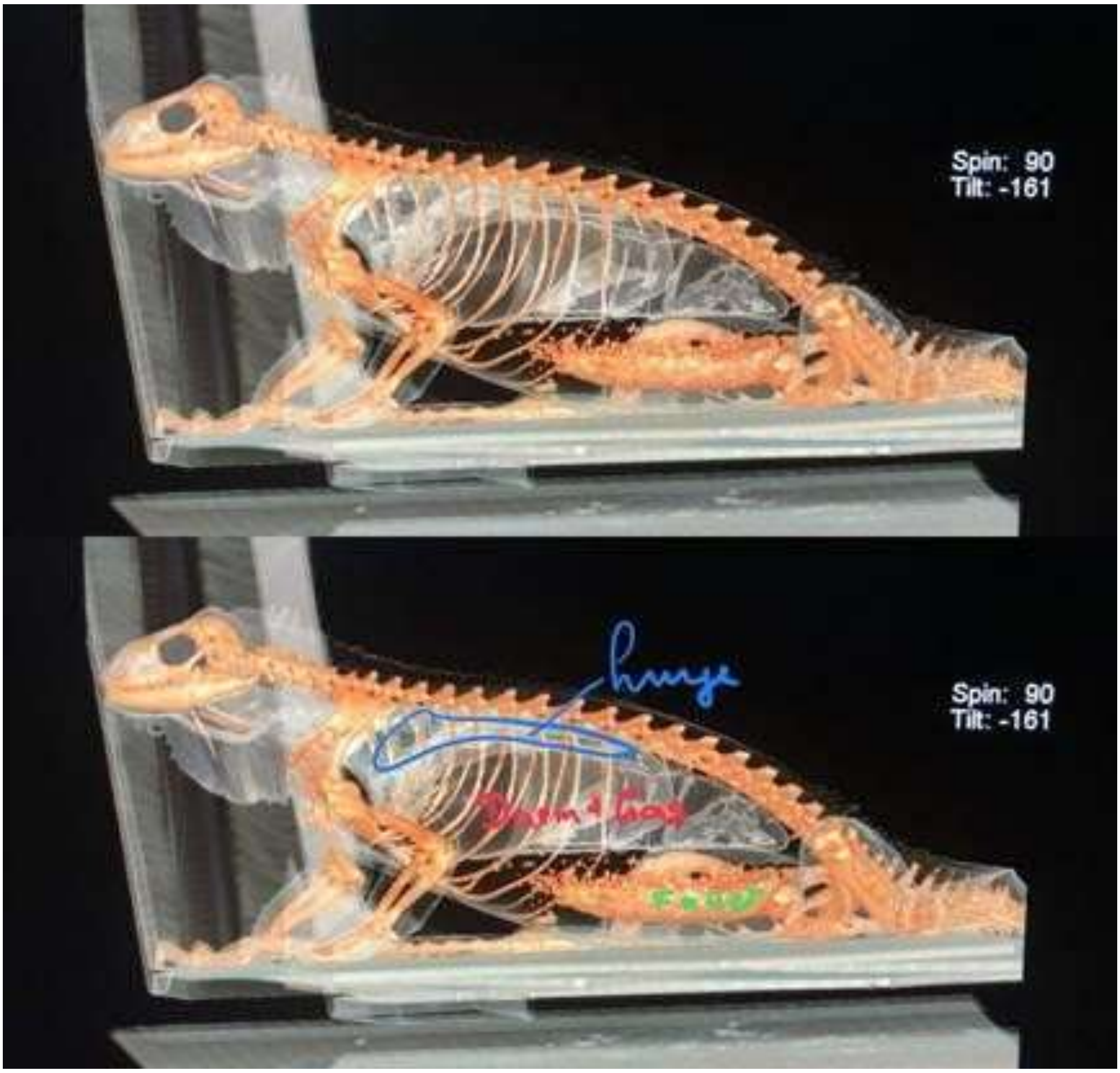

Fig. 34: CT scan of a female *Iguana delicatissima* suffering from gut torsion. Note the compressed lungs and the very large space the distended gut takes up. Lungs; gut/intestine and gas; food.
© M. Konecny/Vienna.

Fig. 33: Surgical treatment of a gut torsion in a female *Iguana delicatissima*. © M. Konecny/Vienna.

2.9 Specific problems

Hybridisation

The current main threat to the species in the wild is the very rapid hybridisation with its congeners *Iguana iguana* and *I. rhinolopha* on a whole-population scale. This threat of course holds true in captivity and mixing Lesser Antillean iguanas with any other *Iguana* species, subspecies or any hybrid combination thereof must be strictly avoided.

To be on the safe side, females under suspicion of having had the potential to mate with non-pure *I. delicatissima* males should be excluded from the breeding pool for at least two years due to the potential of sperm retention. However, at the same time such females should still have access to *I. delicatissima* males to avoid potential reproductive disorders, especially pre-/post-ovulatory stasis and dystocia (see **2.8.**). Therefore, clutches produced for two years should be discarded instead of the female being kept in isolation.

Alternatively, any offspring can be genetically tested; however, this avenue should only be taken after discussion with the EEP coordinator and only if the respective institution would be able and willing to immediately euthanise any proven hybrid offspring.

In many cases, especially multi-generational or back-crossed hybrids can be rather difficult to determine (e.g. Breuil, 2013; M. Goetz, pers. obs.) and, therefore, any wild caught or confiscated animals of unknown origin entering EAZA collections need to be genetically tested before they are imported.

Aggression and injuries

Because of their large size, iguanas have the potential to inflict severe bite wounds. The tail is equally used in aggression or defence and a well-aimed strike can result in severe or permanent damage to an unprotected eye.

Green iguanas (*Iguana iguana*) have been documented to become aggressive towards humans during their breeding season and aggression can also be triggered during the menstrual cycles of their human female caregivers (Kirchgessner et al., 2019). *I. delicatissima* can behave in the same way (M. Goetz, pers. obs.) which should be borne in mind if a sudden shift of behaviour, especially in male iguanas towards keeper staff is observed.

Diseases and bio-security

As with all reptiles, it is sensible to bear in mind that iguanas are also potential carriers of pathogens which can affect the health of humans, e.g. *Salmonella*; therefore, good hygiene/hand washing procedures after or wearing gloves during handling and enclosure maintenance is recommended. It is of note that multi-drug resistant strains of *Escherichia coli* have been found in *I. delicatissima* from Caribbean islands (Di Lallo et al., 2021).

In case a potential future release of captive bred iguanas into the wild were necessary, the highest biosecurity concerns will need to be considered and disease transfer risks minimised. We still have a very limited knowledge of diseases or parasites affecting iguanas and associated herpetofaunas; novel diseases are discovered regularly and the few diseases we do know of and can actually and reliably test for are very few. Therefore, it does not suffice to declare a captive reptile disease-free and fit for release to thew wild if the very limited tests we do have access to come back negative. One potential avenue how we might reduce the risks when using captive bred iguanas for releases is by rearing of juveniles in biosecure/quarantine settings until their transfer.
However, for this to be successful and for the substantial investment into biosecure facilities to be worthwhile, a vertical transfer of disease would need to be ruled out as much as possible. Many pathogens can be transmitted vertically (e.g. Marenzoni et al., 2018; Stengle et al., 2019) but it is often not conclusive whether this is a true vertical transfer or a contamination (e.g. Ariel, 2011; Popescu, 2018). Therefore, much more research and effort must be invested in the questions of vertical pathogen transfer, whether viral, bacterial, fungal or parasitic (see chapter **2.10**). This can most meaningfully and easiest be achieved in zoos; the results can open possible, responsible, and safe pathways for zoos to achieve their goal of “returning animals back to the wild” without having to walk the tightrope of potential irresponsible and short-sighted actions taken by assuming only the diseases we can reliably test for are important.

2.10 Recommended research

There is still limited knowledge on the ecology, physiology, behavior and nutrition of Lesser Antillean iguanas in the wild; this is problematic if we are to replicate the natural conditions in captive settings and to encourage natural behaviors in this species, including e.g. natural reproductive cycles and behaviours which help avoid problems like pre- and post-ovulatory stasis.

Stress and reproductive hormone analysis

Hormone analysis is a promising field of research, especially to investigate physiological processes like vitellogenesis and stress levels (Bourne et al., 1986; Jessop et al., 2015; Jessop et al., 2009; Moore & Jessop, 2003; Scheun et al., 2018; Umapathy et al., 2015).
Assessing and monitoring hormone levels can be achieved by analyzing blood plasma or fecal samples. Plasma analysis offers a quick and reliable hormone measurement but requires restraining and blood collection, which can be stressful for the animal; whereas fecal collection is non-invasive and therefor much less stressful (Bertocchi et al., 2018; Rittenhouse et al., 2005). However, hormone analysis through fecal collection has yet been poorly studied in reptiles and the available results are ambiguous: previous fecal hormone studies have been unsuccessful for varanids, while studies in chameleons, turtles, and ball pythons (*Python regius*) have shown promising results in assessing reproductive cycles with fecal-collected hormones (Bertocchi et al., 2018; Kummrow et al., 2010; Umapathy et al., 2015).

For Lesser Antillean iguanas, stress-associated parameters, i.e. corticosteroid/cortisol levels would prove very useful to improve welfare assessments, overall husbandry and potential influences of stress on reproductive problems.
As outlined above, Lesser Antillean iguanas in captivity can have a rather extended reproductive period and can produce one or two clutches per year. Additionally, it is often hard to visually determine the state of gravidity in females. Questions such as "this year, our female has not laid eggs yet – is this a problem?" or "do we need to be ready for another clutch or can we assume everything is fine after one clutch was laid many months ago?" we can so far only determine through resource-intensive ultrasonography, if at all. Hormonal screening could prove potentially very useful in this species.

Baseline blood parameters
Baseline blood chemistry parameters are an invaluable tool for the investigation of individuals which present with potential pathological symptoms. As Lesser Antillean iguanas live in quite different habitats on different islands, baseline blood chemistry from as many iguanas and islands as possible would be a great resource to have. Whenever blood can be drawn in the field, e.g. for genetic analysis, a sufficient amount should be set aside and blood parameters analysed. Collecting and analysing blood from apparently healthy captive individuals would complement this. Results should be uploaded to the Zoological Information and Management System (ZIMS) and also sent to the EAZA EEP coordinator for collation and distribution.

Vitamin D3 levels
Much has been achieved in the field of ultraviolet-B provision for captive reptiles in the past decade. Although not exclusively, achieving natural or at least useful vitamin D3 levels in our animals has been one of the main drivers for this development. However, what "natural vitamin D3 levels" actually are, is still unknown for most reptile species, including the Lesser Antillean iguana. Very few data have been collected from wild populations of other iguanid species, such as *Conolophus* sp. (Di Giacomo et al., 2022) or *Cyclura* sp. (Ramer et al., 2055); however, we don't know how much these data can be used as a proxy for *I. delicatissima* or indeed how these vary with different analytical processes at different laboratories. It is even still of debate whether the (usually mammal/human-calibrated) tests used by commercial laboratories are entirely appropriate for analysing reptile/iguana blood vitamin D3 levels (e.g., Jaffe et al., 2019; F. Baines, pers. comm.).
Therefore, an extremely important avenue of research would be to monitor seasonal vitamin D3 levels of wild iguanas in the Caribbean, calibrate the laboratory methods/tests and compare to animals in captive settings with a variety of nutritional supplementation and/or UV light equipment. To facilitate sample transfer from the field, dried blood spot analyses on filter paper would be the preferred method instead of blood/serum analysis which needs constant cooling and a quick turnaround. As results of these two samples will likely differ, developing a comparison chart for serum vs. blood spot results would be an invaluable tool.

Vertical disease transfer
As outlined in chapter **2.9**, when thinking of ways to reduce disease transmission risks through biosecure rearing of animals destined for release into the wild, a vertical transfer of disease would need to be ruled out as much as possible. Many pathogens can be transmitted vertically (e.g., Marenzoni et al., 2018; Stengle et al., 2019) but it is often not conclusive whether this is a true vertical transfer or a contamination (e.g., Ariel, 2011; Popescu, 2018). Therefore, much more

research effort should be invested in the questions of vertical pathogen transfer, whether viral, bacterial, fungal, or parasitic. This can most meaningfully and easiest be achieved in zoos. The results can open possible, responsible, and safe pathways for zoos to achieve their goal of "returning animals back to the wild" without having to walk the tightrope of potential irresponsible and short-sighted actions taken by assuming that only the diseases we can reliably test for are important.

Population genetics

Iguana delicatissima has been attributed five mitochondrial *ND4* haplotypes (Martin et al., 2015). However, it is thought that this picture, drawn from 46 samples, can be refined and that more detailed haplotypes will be uncovered – further genetic studies with more samples from all islands are planned in the not-too-distant future (M. Breuil, pers. comm. 2021; M. v.d. Burg, pers. comm. 2022, 2023).

Acknowledgments

Thank you to Mark de Boer for his helpful comments on the manuscript. Baptiste Angin, Mark de Boer, Thomas Cornwell, Nathalie Duporge, Rupert Kainradl, Charles Knapp, Martina Konecny, Dan Lay, Lesley Lawrence, Tim van Wagensveld and Ciaran Westgate generously supplied and allowed the use of their pictures or drawing.

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