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Indicative 10 Project National Resource Material

Oriental Garden Lizard (*Calotes versicolor*)

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An Invasive Animals CRC Project

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Invasive Animals CRC

Australian Government
Department of Industry and Science

Business Cooperative Research Centres Programme

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Summary

Summary based on assessments carried out in (García-Díaz 2014a, b, c)

Species on VPC List 2007?	No
Species on the live import list (EPBC Act 1999)?	No
Risk of establishment:	Extreme (Bomford 2008)
Pathway:	Unintentional or via illegal pet trade.

Key Messages

Range: Considered to be the most widespread non-gecko lizard in the world.

Introduction pathway: cargo and people movement, illegal wildlife trade.

Establishment Risk: Once escaped, the species is considered an extreme risk of establishment because it is:

- highly adaptable
- able to thrive in urbanised areas
- a prolific breeder
- requires a low propagule pressure (introduction effort)

Impact to Environment: outcompetes native species and transmits disease

Identification Issues: Although adult males are easily recognizable by their red crest, females and juveniles are more difficult to distinguish from other Australian species.

Versatile reproductive strategies: Large numbers of eggs laid, can store sperm and retain eggs for 6 months. One incursion of a single female can potentially lead to the establishment of a viable population in Australia. Thus propagule pressure does not need to be high for the species to establish.

Figure 1. Male *Calotes versicolor*. Sometimes called 'Bloodsucker" because of the seasonal red colouration. Photo: Sek Keung Lo (CC BY-NC 2.0)

Classification

***Calotes versicolor* Daudin, 1802**

Class:	Reptilia
Order:	Squamata
Suborder:	Iguania
Family:	Agamidae
Genus:	*Calotes*
Species:	*versicolor*
Subspecies:	*versicolor farooqi* *versicolor versicolor*

Common names

Oriental garden lizard, eastern garden lizard, Indian garden lizard, common garden lizard, bloodsucker, changeable lizard

Figure 2. Male *Calotes versicolor* Photo: Ajith Kumar (CC BY 2.0)

Biology and Ecology

Identification

The Oriental garden lizard (*Calotes versicolor*) belongs to the family Agamidae, of which there are at least 82 species present in Australia (Cogger 2014; Uetz et al. 2017; Wilson and Swan 2017).

As the name suggests, the colouration is varied but is often described as olive green or greyish above and whitish below (Das 2015). The lizard exhibits obvious geographic variation in coloration, scalation, and size across its range (e.g., Bursey et al. 2012; Radder 2006). The average snout-vent length (SVL) is 100 mm, with a total body length (including tail) between 250–400 mm (Enge and Krysko 2004; Radder 2006). Neonates in India typically measure 25–28 mm SVL (Radder et al. 2001).

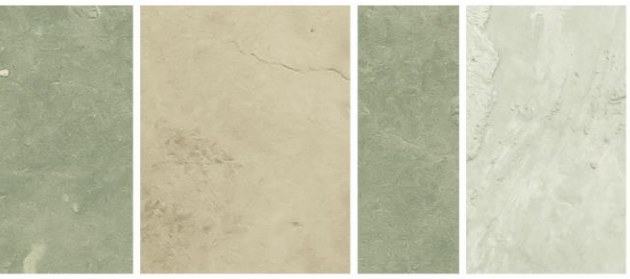
The Oriental garden lizard is distinguished from other *Calotes* by having lateral body scales that point backwards and upwards, two separated spines above the tympanum, and 35–52 scales around the body (Bomford 2008). The five fingers have long sharp pointed claws and the five toes have curved pointed claws.

The species is sexually dimorphic; adult males have a longer tail than females of the same SVL and adopt vibrant red colouring during the breeding season (Ji et al. 2002). Adult females usually have two pale yellow dorsal stripes. Although adult males are easily recognisable by

their seasonal red coloration and their spiny crest, females and juveniles are more difficult to distinguish from similar Australian native species. Moreover, juveniles have a cryptic coloration and manner making their detection problematic.

Figure 3. Male *C. versicolor*. Photo Raj (CC BY 2.0)

Figure 4. Female or juvenile *C. versicolor* can be difficult to identify. Photo: Rushen (CC BY-SA 2.0)



Behaviour and Traits

Oriental garden lizard is semi-arboreal and individuals are often found clinging to rocks, tree trunks, vines and low vegetation up to 9 m (Hasen Didi 1993). They typically live among leafy undergrowth and grass, particularly in open habitats. Males often display from fences and other conspicuous perches (Cox et al. 1998; Hasen Didi 1993).

Juveniles forage and bask mostly on the ground, whereas sub-adults and adults spend much of their time on tree trunks, frequently in a head-down posture surveying for prey (Diong et al. 1994). Adults roosting at night have been collected from May through October (summer to early autumn) in Florida (Enge and Krysko 2004).

Food and Foraging

The lizard seeks prey using a sit-and-wait strategy from a vantage point, such as tree trunks and fences. Females and juveniles typically seek prey from the ground (Diong et al. 1994).

Although predominately an insectivore, the lizard is opportunistically omnivorous, consuming a wide range of prey. In its native range, diet includes annelids, molluscs, insects, myriapods, arachnids, crustaceans, amphibians, reptiles, small birds and mammals as well as plant matter (Rao 1975; Sharma 1991). Adults occasionally prey on their own young (Diong 1994).

Predators of the oriental garden lizard are mammals and birds.

Reproduction and Lifecycle

This oviparous species (i.e., producing eggs that hatch outside the body) lays eggs in a hole in moist, shaded soil (Shanbhag 2003). The incubation period is around 40 to 60 days and hatchlings mature to adulthood in 9–12 months.

Oriental garden lizards lack sex chromosomes and female is the default sex; male development is influenced by testosterone levels (Ganesh and Raman 1995). Interestingly, gravid females can store viable sperm and retain viable eggs in the oviduct for up to six months when conditions are favourable (Radder et al. 1998). They do this by lowering their body temperature by about 3 to 5 $^{\circ}$C and halt the development of their embryos (Radder et al. 1998; Shanbhag 2003).

In India, the lizard can lay multiple clutches over a long breeding season between May and October (Shanbhag 2003; Shanbhag and Prasad 1993). Clutch size depends on the season it is laid; larger in earlier breeders than late breeders of the same body size (Shanbhag et al. 2000). Typically, clutch size is positively correlated with SVL; the larger the female the larger the clutch size (Ji et al. 2002). The average is between 3 and 33 eggs (Ji et al. 2002; Shanbhag 2003; Shanbhag et al. 2000).

Habitat

The oriental garden lizard is considered the most widespread species of its genus, usually occurring at elevations of 600 to 1,000 m. It is commonly observed in open forests, parks, gardens, agricultural and disturbed areas (Cox et al. 1998). A very adaptable species, the garden lizard is often found in human-altered environments and survives in urban areas in Asia (Erdelen 1988). The species does not occur in closed canopy dense forest (Erdelen 1988).

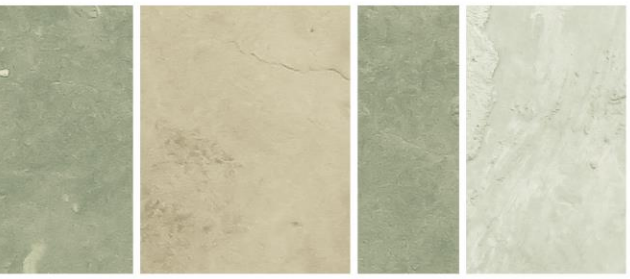
Global Range

Of the 21 recognised species of *Calotes* (Vindum et al., 2003), the Oriental garden lizard has the most widespread distribution (Enge and Krysko 2004) and can thrive in urban areas and other human-modified habitats.

The natural or native range (Figure 5) is from south-east Iran to Afghanistan, Pakistan, and Nepal, Bhutan, India (including Tamil Nadu, Assam, Gujarat, Maharashtra, Madhya Pradesh, Kerala, Himachal Pradesh, Mizoram, and the Andaman Islands), Sri Lanka, Bangladesh, Burma, Thailand, western Malaysia, Vietnam, Cambodia, southern China, to Sumatra in Indonesia (Boulenger 1912; Radder 2006; Smith 1935).

The lizard has introduced populations established in Celebes, Maldives, Seychelles, Florida USA, Guam, Mauritius, Oman and Borneo (Enge and Krysko 2004; Hasen Didi 1993; Matyot 2004). It was also introduced to Singapore in the 1980s (Chou 1994). No introduced population has ever been successfully eradicated following establishment.

Figure 5. Map showing general native range of *C. versicolor*. Image taken from The Reptile Database. August 2017.



Potential for Introduction

Oriental garden lizard is known to arrive in new locations via the transportation network. For example in the 1980s the species was introduced to Reunion Island as a stowaway in sugarcane cuttings from Java, where it rapidly established populations (Chou 1994; Matyot 2004). Although not yet established in Australia stowaways have been intercepted. Six individuals were detected between 2004 and 2011 in New South Wales, Queensland and Victoria (Henderson and Bomford 2011). A further four individuals were detected between 2012 and 2015 as stowaways associated with cargo arriving in Victoria (unpublished data). In fact, all 10 individuals were found in harbors or airports associated with the transport of goods and commodities into Australia. Thus it is most likely subsequent introductions will occur as a result of accidental import with goods as a stowaway on domestic and commercial shipping and air cargo (García-Díaz 2014b).

Because the species is known to be traded via legal and illegal pet trade, there is a possibility that a new incursion in Australia could result from intentional illegal import or by animals kept illegally by private collectors escaping or being deliberately released. Florida, USA first recorded the species in 1978 when several animals escaped from a reptile keeper (Enge and Krysko 2004). Subsequently, self-sustaining populations successfully established over 10 or more years.

Oriental garden lizard is not considered a food item, thus the potential for introduction for food is highly unlikely. However, it is possible the species may be accidently transported on produce, or vegetation used for landscaping.

Once escaped, the lizard has a high likelihood of establishment for a number of reasons (Diong et al. 1994; Radder et al. 1998; Radder 2006; Rao 1975; Shanbhag 2003; Shanbhag et al. 2000):

- Ability to adapt to new environments
- Capacity to thrive in highly urbanised areas
- Prolific breeding biology with an ability to store sperm and retain viable eggs.

Bomford (2008) evaluated the species as ‘extreme risk’ of spreading once established. However, there is evidence from its native range that the species may move relatively slowly over large distances (Erdelen 1988), so the invasion front may be relatively slow.

Potential for Eradication

In Australia, six incidents of single animal incursions have been successfully removed, although none of these were in the wild. Although eradication of an established, invasive population of oriental garden lizard has not been successful, an invasive population of Namib rock agama (*Agama planiceps*) was eradicated from a wood storage facility in the Canary Islands (Spain). The eradication took two years of manual removal of each individual (Mateo et al. 2011 in Garcia-Diaz (2014)). This indicates that available control methods may successfully eradicate an incipient population within two to four years, provided the species is detected early and the population is small and geographically contained (García-Díaz 2014d).

Once a breeding population establishes, there is no evidence to suggest whether or not it is possible to remove individuals at a rate faster than population growth (García-Díaz 2014d).

Considering the species' fecundity, it is likely population growth would be greater than removal once the species is established.

The oriental garden lizard should be detected visually and removed manually, although the use of net traps and/or pitfall traps has been moderately successful (Cogger 2014; Garden et al. 2007; Sutherland 2006). If traps are to be used, they must be augmented with visual surveys and manual removal to ensure full eradication (García-Díaz 2014d).

Since all Australian incursions of the lizard were found in harbors or airports by Customs and Biosecurity agencies during routine inspections, these pre-border and border inspections are considered an effective incursion prevention tool.

Impacts

The Oriental garden lizard is classified as moderate in terms of potential impact when considered at the family level, but high when considered at the genus level (García-Díaz 2014d).

Economic

No economic impact has been reported from the lizard's introduced range, although the species is widely used as a research specimen, particularly in Asia, as well as a traded species in the pet industry (García-Díaz 2014d).

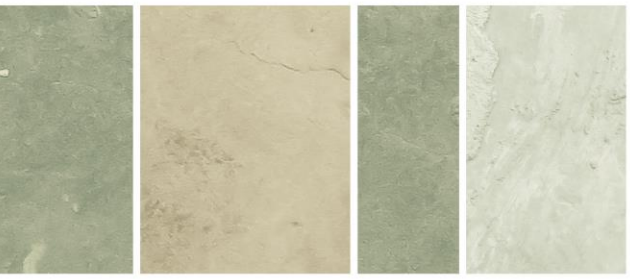
Environmental

Oriental garden lizards are known to out-compete other lizard species in the same geographical location. It has been linked to the decline of native reptiles in Singapore (e.g., green crested lizard, *Bronchocela cristatella*) as well as native geckos in Mauritius (Chou 1994). It is a voracious predator of invertebrates, with reports in Mauritius and Réunion of the species causing the disappearance or reduction of phasmids (Insecta: Phasmatodea).

Garden lizards are known to carry a variety of diseases that can be transmitted to other native reptiles (e.g., Bursey et al. 2012; Madhavi et al. 1998). The extent to which parasites harboured by the species are host-specific is unknown, or if native lizards like skinks and geckos would be susceptible to these.

Social

None reported.



Legislation

The high risk and potential pest status of the Oriental garden lizard is recognised throughout Australia, as indicated in Table 1.

Table 1: Current status of the Oriental garden lizard under jurisdictional legislation

Jurisdiction	Legislation	Status
Australia	Biosecurity Act 2015	included
Australia	List of specimens taken to be suitable for live import	not listed
Western Australia	Biosecurity and Agriculture Management Act 2007	prohibited
South Australia	Natural Resources Management Act 2004	prohibited
New South Wales	Non-Indigenous Animals Regulation	high risk
Queensland	Land Protection (Pest and Stock Route Management) Act 2002	Class 1 declared animal
Victoria	Catchment and Land Protection Act 1994	prohibited

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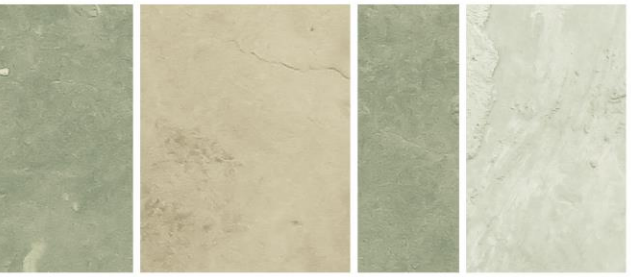

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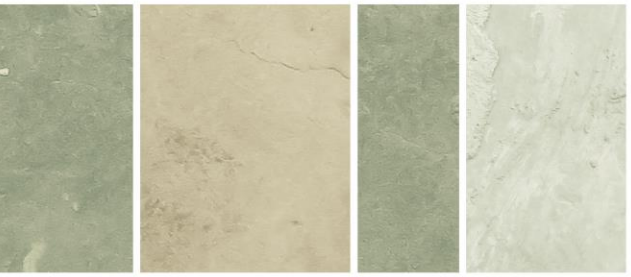

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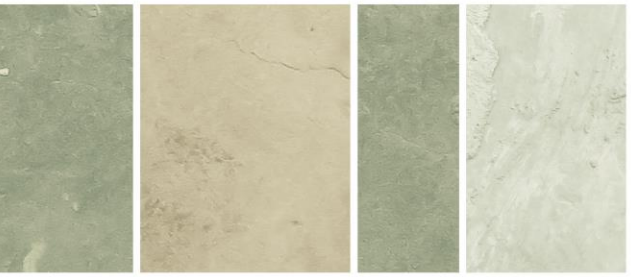

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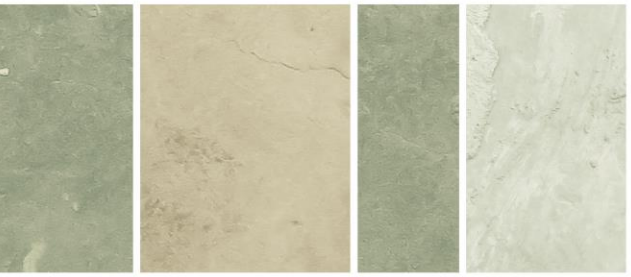

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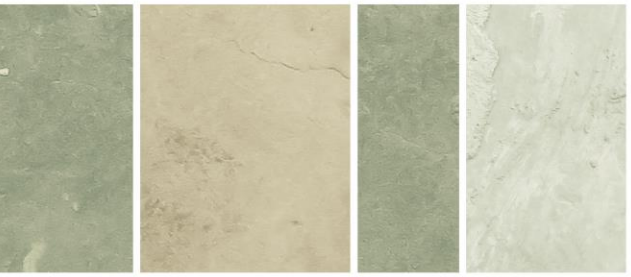

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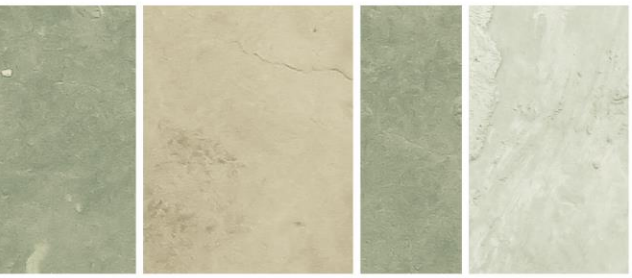

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