Invasive Birds

Global Trends and Impacts

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CABI

5 Red-vented Bulbul (*Pycnonotus cafer* Linnaeus, 1766)

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5.1 Common Name

Red-vented Bulbul.

5.2 Nomenclature

The Red-vented Bulbul (*Pycnonotus cafer* Linnaeus, 1766) has eight subspecies (Table 5.1). These relate mostly to different geographical ranges, but some have morphologic differences (Dickinson *et al*., 2002).

5.3 Description

The Red-vented Bulbul measures approximately 21 cm in length (Berger, 1972) and its weight can vary between 26 and 45 g (Long, 1981). The morphometric parameters for this species are presented in Table 5.2. It may live for up to 11 years (Walker, 2008). Its feathers are predominantly dark brown (Fig. 5.1). Those on the back and breast have white tips. It has a distinctive erectile black crest on the top of the head, deep crimson subcaudal feathers, a white rump that is highly visible in flight, and a tail that is long and blackish with a prominent white tip (Berger, 1981; Pratt *et al*., 1987). The males tend to be slightly larger than the females but otherwise there is no sexual dimorphism (Stuart and Stuart, 1999). The immature bird looks like the adult but with paler feathering with some brownish edging, and an orange or pinkish, rather than red, vent. The morphological differences of the eight subspecies are presented in Table 5.1.

5.4 Distribution

The Red-vented Bulbul is native to the Indian subcontinent, South-east Asia and Malay Peninsula (Fig. 5.2) (Long, 1981). Its native range extends from eastern Pakistan to eastern China and Vietnam, and from northern India to Sri Lanka. Historically, the species was also present in Bangladesh, Bhutan, Myanmar and Nepal.

The Red-vented Bulbul was introduced into 19 countries and became established in 17 of them. This alien range comprises two main geographical areas: islands of the Pacific Ocean and littoral countries of the Middle East. There are also established populations in North America (e.g. Houston, Texas), in

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Table 5.1. The eight subspecies of *Pycnonotus cafer* and their native distributions and morphological characteristics.

Subspecies	Morphological characteristic	Distribution	Descriptor
P. c. humayuni	Pale brown	South-eastern Pakistan (Sind), north-western and north-central India	Deignan, 1951
P. c. intermedius	Black hood extending to mid-breast	Western Himalayas from Pakistan, Jammu and Kashmir east at least to Nepal	Blyth, 1846
P. c. bengalensis	Dark hood with brown auriculars	Central and eastern Himalayas and Gangetic Plain, and Bangladesh	Blyth, 1845
P. c. stanfordi	Black hood extending to breast	South Assam	Deignan, 1949
P. c. melanchimus	Black crown	South Myanmar	Deignan, 1949
P. c. wetmorei	Pale brown with dark hood	North-eastern Peninsular India	Deignan, 1960
P. c. cafer	Dark brown with scaly pattern, dark head	Southern India	Linnaeus, 1766
P. c. haemorrhousus	Dark mantle with narrow, pale edges	Sri Lanka	J.F. Gmelin, 1789

Table 5.2. Morphometric parameters of male and female *Pycnonotus cafer bengalensis*, measured on adults from an introduced population in New Caledonia. (Thibault *et al*., unpublished data.)

	Females			Males		
Character	Mean	SD	*n*	Mean	SD	*n*
Body mass (g)	38.05	4.54	27	43.69	5.01	31
Total length (cm)	19.75	0.97	13	19.98	0.87	18
Tail length (cm)	8.74	0.35	27	9.04	0.59	31
Head length (mm)	15.83	1.08	12	16.36	1.41	31
Crest length (mm)	18.01	0.87	12	18.02	2.59	18
Mandible length (mm)	12.15	1.20	27	12.50	0.87	31
Mandible width (mm)	5.65	0.27	13	5.70	0.31	18
Mandible height (mm)	5.61	0.24	13	5.98	0.31	18
Right wing length (cm)	9.31	0.25	27	9.63	0.57	30
Right tarsus length (mm)	24.66	2.31	27	24.92	2.11	30
Third digit length (mm)	16.71	1.66	13	17.87	1.52	17
Crimson patch length (cm)	4.00	0.40	13	3.91	0.47	17

Fig. 5.1. An adult Red-vented Bulbul. (©Photograph: Coralie Thouzeau-Fonseca, IAC.)

the Canary Islands (e.g. Fuerteventura) and in southern Spain (e.g. Malaga). It is now present on at least 37 islands and in seven continental locations, and is anticipated to continue its range expansion on several archipelagos (Thibault *et al*., 2018a).

5.5 Introduction and Invasion Pathways

5.5.1 Success of introductions

The Red-vented Bulbul is currently considered to be established in 38 of the 46 locations where it has been recorded historically (Table 5.3). Up-to-date information is lacking for islets of the Ailinglaplap archipelago (Marshall Islands) ('Eua, Savai'i and Ailinglaplap). Red-vented Bulbuls were reported in Melbourne in 1918 and 1942 (Lendon, 1952; Watling, 1978), but the species has not been reported there since and is considered 'eradicated' in Australia in the global invasive species database (www.issg.org/database). It was observed on five islands in the Hawaii Archipelago between 1982 and 1989, but it seems that it failed to establish beyond Oahu (Walker, 2008). It was eradicated from Auckland, New Zealand, in 1955 (Watling, 1978), 3 years after the first observation in 1952 (Turbott, 1956).

5.5.2 Introduction history

The oldest documented observation of *P. cafer* outside its native range is from Fiji, *c.*1903 (Parham, 1955; Watling, 1978). It is very likely that the dispersal of the species started with Indian workers who travelled from India to Fiji during this period (Ali and Ripley, 1996; Watling, 1978). A study conducted on Viti Levu between 1970 and 1973 revealed that the Red-vented Bulbul was already present in all major habitat types of the island, from sea level to 1320 m above sea level (Gorman, 1975). In 1978, it was also present at low densities on Ovalau, Wakaya and Beqa Islands, and on the western coast of Taveuni island (Watling, 1978). Today, the Red-vented Bulbul has spread to Vanua Levu, Gau, Kadavu, Nairi island, Waya islet, and recently to Fulaga islet.

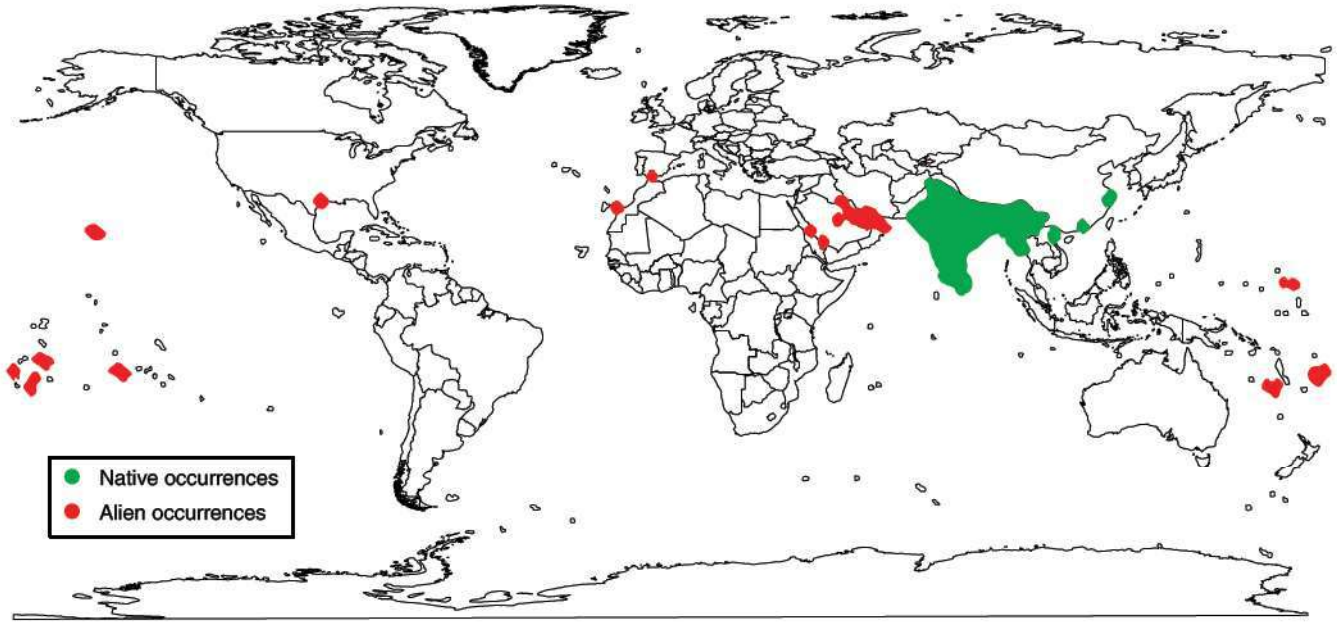

Fig. 5.2. Global distribution of the Red-vented Bulbul showing natural (green) and alien (red) distributions. (Adapted from Thibault *et al.*, 2018a.)

Table 5.3. Year of first observation of non-native populations of the Red-vented Bulbul.

Country	First observation	Reference(s)
Fiji	1903	Parham (1955); Watling (1978)
Tonga	1928	Watling (1978)
Western Samoa	1943	Watling (1978); Dhondt (1976a); DuPont (1972)
American Samoa	After 1957	Clapp and Sibley (1966)
USA (Hawaii)	1966	Berger (1975)
Qatar	1971	Nation *et al*. (1997); Warr (1986)
United Arab Emirates	1974	Pedersen and Aspinall (2015)
French Polynesia	1979	Meyer (1996)
Kuwait	1981	Gregory (2005)
New Caledonia	1983	Gill *et al*. (1995)
Bahrain	1986	Khamis (2010)
Oman	1987	J. Eriksen (personal communication)
Saudi Arabia	1980s	J. Babbington (personal communication)
USA (Texas)	1996	Brooks, 2013)
Spain	1998	Ministerio de Agricultura, Alimentacion y Medio Ambiente (2013)
Marshall Islands	2000	Vander Velde (2002)
Iran	2007	Azin *et al*. (2008)

According to Watling (1978), a pair of Red-vented Bulbuls was recorded on Niuafo'ou Island (Kingdom of Tonga) in 1928/1929. The species was then introduced on Tongatapu in the 1940s (Watling, 1978). It is assumed to have promptly spread from Tongatapu to 'Eua. It is now also present on Vava'u and Foa islands, where it was not recorded by the aforementioned authors. It was then recorded in Western Samoa in 1943 (Dhondt, 1976a), probably brought from Fiji (Watling, 1978). According to DuPont (1972), the first record of the species in Savai'i, the second main island of Western Samoa, was in 1970. In 1974, the species was widely distributed in Upolu and was observed in small numbers in two areas on Savai'i (Dhondt, 1976b). In 2005, McAllan and Hobcroft considered that the species had spread to all the inhabited areas of Upolu, Samoa, regardless of elevation or rainfall. Clapp and Sibley (1966) suspected that the Red-vented Bulbul was introduced on to Tutuila (American Samoa) around 1957, although the species was first officially recorded in Pago Pago in 1963. It appears to have arrived by aircraft and become established on the Tafuna Plain, a cultivated area next to the international airport (Freifeld, 1999). Soon after, in 1966, the Red-vented Bulbul was observed in Hawaii (Berger, 1975). It was first recorded in October 1966 near Waipahu, on O'ahu (Walker, 2008). Until 1982, the species was restricted to the south-east of the Island (Williams and Giddings, 1984). It arrived in French Polynesia in 1979, on Tahiti (Meyer, 1996). It quickly became abundant in coastal and lowland areas in the mainland and on the peninsula, even in areas up to 1500 m above sea level (Monnet *et al*., 1993). It is highly suspected that its introduction started with escaped or released caged birds. The species is now present in Bora-Bora, Moorea, Raiatea, Tahaa, Huahineiti and Huahine Nui, Tetiaroa, and is currently spreading to other islands and islets in the archipelago (T. Ghestemme, Société d'Ornithologie de Polynésie

(MANU), personal communication). In New Caledonia, intentional release of caged birds is strongly suspected to have occurred in 1983 in Nouméa to avoid prosecution for possession (Gill *et al.*, 1995). Nowadays, the species is still restricted to the mainland's southern province but continues to increase its range. Finally, in terms of Pacific Island occupation, the species was first observed in the Marshall Islands in 2000 by Vander Velde (2002). The species was initially restricted to urbanized areas in Majuro and then spread to agricultural areas of Laura (Vander Velde, 2002). It remains unknown exactly how the species got to Majuro, but it has been suggested that a pair built a nest in a container on a ship from Oahu (Vander Velde, 2002). The Red-vented Bulbul has since spread to Ailinglaplap Island (ebird, 2019: https://ebird.org, accessed 18 November 2019).

The species has also spread to the Arabian Peninsula, especially around the Persian Gulf. The Red-vented Bulbul was recorded in Qatar in 1971 (Nation *et al.*, 1997). It is suspected that there was more than one introduction event, possibly from birds escaping from cages. Two further inland occurrences were recorded – one in May 1992 and the other in March 1995 (Nation *et al.*, 1997). The species was then observed in Abu Dhabi in the United Arab Emirates in 1974 (Pedersen and Aspinall, 2015). Once again, its introduction was probably due to escaped or released caged birds (Khan, 1993). Local populations bred, and by 1996, a self-sustaining population of between 1000 and 5000 pairs had established (Jennings, 2010). The species is now present in many inland and coastal cities in the north of the country. During the spring of 1981, Red-vented Bulbuls were observed in the grounds of a hospital in the south of Kuwait City (Gregory, 2005). In 2003, the resident population was reported to comprise 100 breeding pairs (Jennings, 2010). This population appears to have decreased since then, and currently has a very restricted distribution (M. Pope, personal communication). The Red-vented Bulbul was first recorded in Bahrain in 1986 (Khamis, 2010), having probably escaped from cages. By 2003, the population comprised 250 pairs, was on the increase and was considered established. It was first observed in Saudi Arabia in the 1980s around the Riyadh Airbase (Jem Babbington, personal communication). Again, escaped caged birds were the likely source of this introduction. Additional introductions probably occurred because the bird is still sold in local markets. Anecdotal reports suggest that it was locally abundant near the airbase in the early 1990s, but it has since declined and today is considered to be a scarce breeding resident. The first record in Oman was an inland observation of a single bird on 2 January 1987 (J. Eriksen, personal communication). The species became increasingly common and dispersed across the capital, and some individuals were observed concurrently in northern Oman (J. Eriksen, personal communication). Ten to 12 Red-vented Bulbuls were observed on Kish Island, Iran, Persian Gulf, in March 2007 (Azin *et al.*, 2008). A survey was conducted immediately, revealing the presence of the species in two locations on the island, situated 2 km apart. As this is the only record on Iranian Islands and coastal areas, Azin *et al.* (2008) suggested that the introduction was human-induced.

In addition to the alien populations in the Pacific Islands and the Middle East, the Red-vented Bulbul has established in Houston, Texas. They were first observed in the Greenspoint area in the mid-1990s, having arrived as caged birds (Brooks, 2013). Two populations are recorded in Houston and have been monitored continuously since 2008.

Further afield, *P. cafer* has been present in Torremolinos, Malaga, Spain, since 1998 (Ministerio de Agricultura, Alimentacion y Medio Ambiente, 2013) and at Corralejo on the island of Fuerteventura, Canary Islands, where several ornithologists have recorded its presence since 2014 (ebird, 2019: https://ebird.org).

5.5.3 Suspected expansion along urban corridors

Monitoring of the expansion of the introduced population of Red-vented Bulbuls in New Caledonia over the past 10 years has provided reliable information on the dispersal strategy of this species on an oceanic island (Thibault *et al.*, 2019). First, the population established and started expanding into inhabited areas, apparently using urban corridors as major dispersal pathways. Three complementary research strategies were used to monitor their spread. The first involved constant monitoring at the edge of the distribution, data collection from community-participation point-count monitoring of terrestrial songbirds, and a survey conducted at borders between occupied areas and natural forests. Second, an important density gradient was described from the city centre (historical introduction) to rural habitats at the edge of the current distribution. Third, the distribution monitoring suggested that the expansion of the Red-vented Bulbul's range accelerated when the species started to disperse beyond city boundaries. It took 25 years for the Red-vented Bulbul to establish in Nouméa, the capital of New Caledonia, and to move 40 km north. In comparison, its range has expanded an additional 35 km in just 4 years (Thibault *et al.*, 2019). It is very likely that the species dispersal in Houston, Texas, is following a similar pattern (D. Brooks, personal communication).

5.6 Diet

5.6.1 Foraging behaviour

Foraging was the most frequent behavioural activity (33%) in an alien population of Red-vented Bulbuls, with perching/resting (22%) and calling (14%) accounting for an additional one-third of all activities (Brooks, 2013). The Red-vented Bulbul is one of the few animal species that cannot synthesize ascorbic acid and is thus susceptible to scurvy (Roy and Guha, 1958). This explains why it feeds mainly on fruit and berries (Islam and Williams, 2000; Brooks, 2013). Consumption of flowers, buds, insects and small reptiles is also reported (Vander Velde, 2002; Brooks, 2013). According to Bates' and co-workers (2014) study, the preferred foraging substrate for Red-vented Bulbuls is possibly related to its short slender legs that force it to hop from place to place. It is used to foraging in the presence of some conspecifics but with only a few heterospecifics around. Competitive interactions with heterospecific species was reported and could potentially pose a threat to some native frugivorous bird species (see section 5.10).

5.6.2 Colour preference

In a study in French Polynesia, the authors concluded that fruit selection in some species of birds, including Red-vented Bulbuls, might be driven more by colour preference than by fruit abundance (Spotswood *et al.*, 2013). A food colour-preference experiment showed that they significantly preferred red fruits over yellow, green and a control colour (Thouzeau-Fonseca, 2013; Thibault *et al.*, 2019).

5.6.3 Diet composition

A quantitative assessment of the diet of Red-vented Bulbuls was conducted recently following the classical method of gut content analysis (Thibault *et al.*, 2019). As suspected according to the literature, the diet mostly comprises plant items, which were found in 92% of the cadavers analysed (n = 134). Animal remains were found in 50% of the digestive tracts of Red-vented Bulbuls examined. This study contributed to the list of both plant and animal species known to be consumed by the species (Thibault *et al.*, 2018a). Seeds and entire fruits accounted for more than 70% of plant remains found, and most could be identified to species level. The 134 individuals analysed had consumed more than 16 plant species belonging to 14 families. Among these, only two were native and one endemic; the rest (80%) were introduced species, and five of these were considered invasive. Moreover, 31% of the species of fruit consumed by the Red-vented Bulbuls that were found around the city of Nouméa were cultivated plants. The maximum length of the largest seed swallowed by bulbuls was 14 mm.

All identified animals in the digestive tracts of Red-vented Bulbuls in this study were arthropods (Thibault *et al.*, 2018a). A total of 22 families belonging to ten orders were identified from chitin remains. Functionally, 88% of the insects consumed were primary consumers. Seasonal variation in the annual diet of the Red-vented Bulbul is highly suspected but has not been assessed specifically. The consumption of small skinks (e.g. *Emoia cyanura* and *Caledoniscincus* spp.) and geckos (e.g. *Hemidactylus frenatus*) has been reported in the literature and observed in the field, but no corresponding remains were found in this study.

Similarly, in the Houston population of Red-vented Bulbuls, 45% of the 20 species of identified plants consumed were exotic species found within the native range of the bulbul, whereas six (30%) were exotic species found outside the native range and five (25%) were native Texas plants (Brooks, 2013).

5.7 Breeding Behaviour

The breeding characteristics of the Red-vented Bulbul are summarized in Table 5.4. The observed number of clutches per year is generally one, although a second may be possible if the first clutch fails early in the season (Watling, 1983). Both sexes take part in nest construction (Prajapati *et al.*, 2011). The nest is cup-shaped (Vander Velde, 2002) and made of plant matter (Brooks, 2013) and spider webs. Sometimes, they will nest in plastic dishes. Nests are constructed about 3 m above ground

Table 5.4. Descriptive and breeding traits of Red-vented Bulbuls.

Characteristic	Value	Reference
Adult height (cm)	21	Berger (1972)
Adult weight (g)	26–45	Long (1981)
Lifespan (years)	≤11	Walker (2008)
Clutches per year	1	Watling (1983)
Clutch size (mean ± SD)	3 ± 1	Zia *et al.* (2014)
Incubation length (days; mean ± SD)	13 ± 1	Watling (1983)
Incubation success (%)	28	Watling (1983)
Days as nestling	12	Watling (1983)
Nestling survival rate (%)	50	Watling (1983)
Fledging (days)	14	Watling (1983)
No. fledged per pair	0.33	Watling (1983)
Flocks of young	Yes	Watling (1983)
Sexual dimorphism	No	Watling (1983)
Parental investment	Both	Watling (1983)

Fig. 5.3. A nest and eggs of Red-vented Bulbuls. (©Photograph: Fabrice Brescia, IAC.)

(Vijayan, 1980; Watling, 1983; Brooks, 2013), often in forks of branches of shrubs (Vijayan, 1980; Zia *et al.*, 2014). The nest is about 10 cm wide, 6 cm height and 5 cm deep (Vijayan, 1980; Watling, 1983; Prajapati *et al.*, 2011). The eggs of the Red-vented Bulbul are oval shaped and pinkish-white with small red-brown dots, and the mean clutch size is three (Fig. 5.3) (Zia *et al.*, 2014). The incubation period is around 12–14 days (Berger, 1981; Watling, 1983; Duncan *et al.*, 2001). Chicks stay in the nest for approximately 12 days and remain around the nest for about 2 weeks after fledging. The mean number of fledglings produced per nesting attempt was estimated to be 0.33 in Fiji, with an incubation success rate of 28% and a nestling survival rate of about 50% (Watling, 1983).

5.8 Habitat

The Red-vented Bulbul can live in diverse habitat types. It is found in open areas, dry scrub, forest (natural or plantation),

plains and cropland, as well as urban areas (Vander Velde, 2002). It is preferentially present in anthropogenic environments (urban areas, gardens, parks, farms), savannah areas, shrub vegetation, and more rarely on the edge of forest (Vander Velde, 2002). Virtually all (96%) of the alien bulbuls in Houston were found in residential suburbs, often with well-planted gardens (Brooks, 2013). In this study, bulbuls perched in 36 different species of plants: 44% were native to Texas, 42% were exotic plants found within the native range of bulbuls and 14% were exotic plants found outside their native range (Brooks, 2013). Tree species that alien bulbuls most frequently used for perching were bamboo (*Bambusa* spp.) and crepe myrtle (*Lagerstroemia indica*), along with edible fig (*Ficus carica*) and tallow (*Sapium sebiferum*) (Brooks, 2013). Bulbuls also perched on abiotic anthropogenic structures, especially telephone and utility wires, along with bird baths and water fountains (Brooks, 2013).

Bird densities across habitats

In New Caledonia, Red-vented Bulbuls are extremely abundant in Nouméa (over 200 birds/km²) and present in much lower densities (30 birds/km²) 50 km away. Together with these estimates of bird densities at different distances from Nouméa, a detection probability curve is presented for the species in inhabited contexts (Fig. 5.4). This curve shows that the probability of detecting a Red-vented Bulbul falls to 50% when the individual is 25 m from the observer.

5.9 Impacts

The Red-vented Bulbul is commonly blamed for three categories of negative impacts (described below), mostly related to its diverse diet comprising fruits and berries (Islam and Williams, 2000; Brooks, 2013), and flowers, buds, insects and small reptiles (Vander Velde, 2002; Brooks, 2013). Of the 165 reports of plants eaten by the Red-vented Bulbul in the literature, 50% concern the degradation of cultivated plants and 35% relate to seed dispersal (Thibault *et al.*, 2018a). The remaining 17% (26 species from 17 families) were reports of consumption without consideration of the impacts.

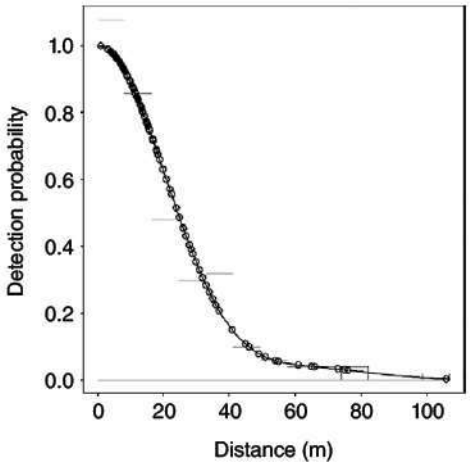

Fig. 5.4. Probability of detecting a Red-vented Bulbul individual as a function of distance (m) from the transect in inhabited areas. (From Thibault *et al.*, 2019.)

Damage to cultivated plants is the most frequently reported impact of the Red-vented Bulbul, within both its native and alien ranges (Fig. 5.5). However, information from its alien range comes from just four locations. In contrast, the references reporting the Red-vented Bulbul as a problematic seed disperser come from eight locations in six countries, and negative interactions with local fauna are reported for 17 species from 11 locations.

In 2018, a review of the literature on alien Red-vented Bulbul populations, their impacts, population trends and management found no quantitative support for considering this species in the '100 world's worst invasive species list' (Thibault *et al.*, 2018a). Indeed, applying the available quantitative information from the literature to the Environmental Impact Classification of Alien Taxa would have led to classifying the species as 'data deficient', 'minimal concern' or 'minor concern', depending on the alien location considered. This is due to the lack of quantitative evaluations of impacts caused by Red-vented Bulbuls in their alien range.

A risk assessment was conducted in 2019 regarding the rencent entry of the Red-vented Bulbul within the European territory. Following a framework proposed by the European Commission's section dedicated to biological invasions, the assessment concluded in a "moderate overall risk with medium confidence". Once again, the medium confidence level attributed to this conclusion was attributed to a lack of quantitative evaluations of both the impacts of and habitat suitability for the species.

5.9.1 Damage to cultivated plants

When reviewing the literature on consumption of cultivated plant species by the Red-vented Bulbul, 52 plant species belonging to 25 families were identified (Thibault *et al.*, 2018a). Among these, 67% (35 species) were cultivated for food production and 33% (17 species) for ornamental purposes.

The location where alien Red-vented Bulbuls have been blamed for the most significant damage to cultivated plants is Oahu, Hawaii, where Walker (2008) reported them consuming several species of fruits, vegetables and flowers, leading to considerable economic losses. The estimated value of the damage to Oahu's orchid industry in one year (1989) was US$300,000 (Fox, 2011) when the Red-vented Bulbul, together with the Warbling or Japanese White-eye (*Zosterops japonicus*), reportedly destroyed up to 75% of Hawaiian orchid and *Anthurium* plantations (Cummings *et al.*, 1994). In New Caledonia, significant impacts have been recorded for some crops and plant nurseries (Metzdorf and Brescia, 2008) with up to 35% losses (Caplong and Barjon, 2010). An open-field experiment suggested that the Red-vented Bulbul was responsible for nearly 18% loss of tomato crops (Thibault *et al.*, 2019). Pecked fruits were generally medium-sized (50–70 mm width), orange to red in colour (Fig. 5.6) and had relatively high sugar concentrations (4–6°Bx). The Red-vented Bulbul is not considered an agricultural pest in Fiji (Watling, 1979) or in Houston, Texas, where it was found to consume mainly introduced tropical plant species (Brooks, 2013).

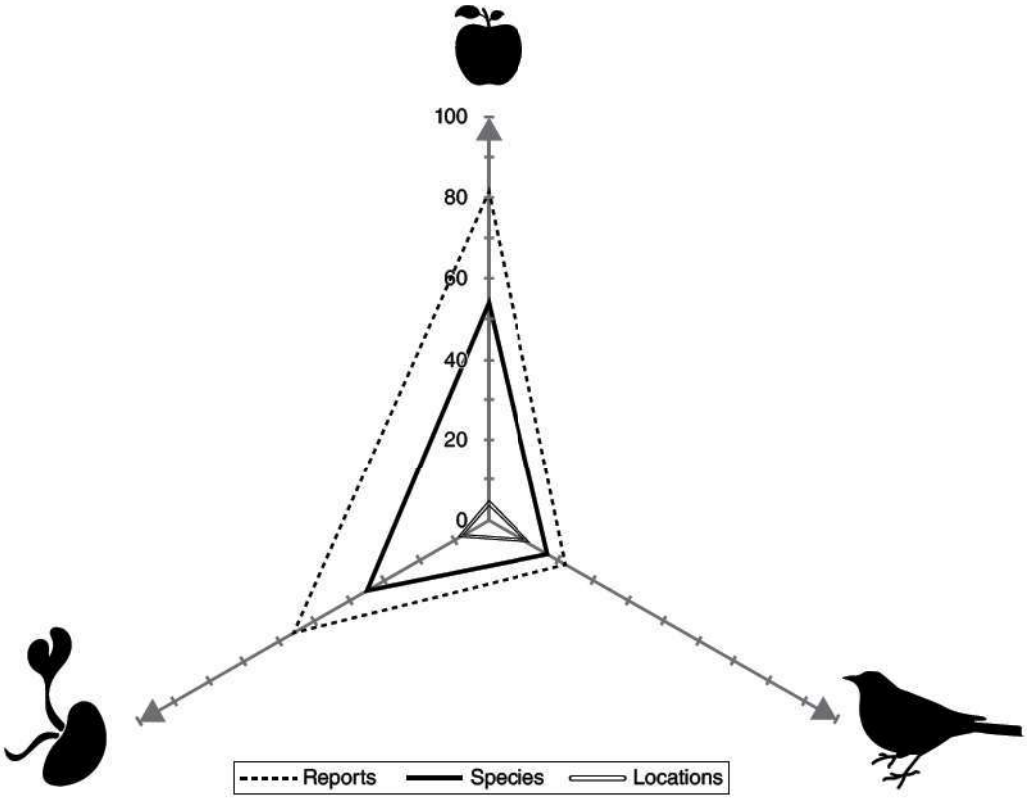

Fig. 5.5. Numbers of reports in the literature, species and location associated with three categories of impact from introduced Red-vented Bulbuls: damage to fruit production, disturbance of native fauna and dispersal of noxious plant seeds. (Adapted from Thibault *et al.*, 2018a.)

Fig. 5.6. A) Cultivated tomato pecked by Red-vented Bulbuls. B) An individual feeding on a cultivated papaya. (©Photographs: (A) Martin Thibault, IAC and (B) Coralie Thouzeau-Fonseca, IAC.)

5.9.2 Dispersal of noxious plant seeds

Thibault *et al.* (2018a) found 56 reports of problematic seed dispersal by the Red-vented Bulbul from six countries inside its alien range. The Red-vented Bulbul can spread the seeds of at least 33 plant species from 25 families. Among these species, 30% were considered non-native (ten species) and 42% invasive (14 species) in the places where the corresponding studies were conducted. They found records of only one endemic (*Coprosma taitensis*, Tahiti) and eight native species that were spread by bulbuls (Spotswood *et al.*, 2012).

The Red-vented Bulbul is considered a major vector of the invasive tree *Miconia calvescens* in Tahiti (Meyer, 1996) and can potentially disperse seven other alien plant species in French Polynesia, including *Lantana camara* (Spotswood *et al*., 2012, 2013). Its ability to disperse *M. calvescens* and *L. camara* is not unique to the Red-vented Bulbul, as many other avian species, both alien and native, also disperse seeds of these plants. The propensity of the Red-vented Bulbul to disperse seeds of these plants varies from island to island and generally depends on the community of introduced plants and bird species present. For example, the introduced Silvereye (*Zosterops lateralis*) also disperses these seeds in Tahiti, but in Moorea, the endemic Fruit Dove (*Ptilinopus purpuralis*) predominantly disperses seeds of these alien plants. In Fiji, the Red-vented Bulbul contributes to the spread of primary colonist weeds (Watling, 1979). In New Caledonia, the Red-vented Bulbul spreads seeds of another invasive species, *Schinus terebinthifolius* and is often observed feeding on its fruits (Fig. 5.7).

A recent study in New Caledonia was dedicated to describing the seed disperser effectiveness of the Red-vented Bulbul (Thibault *et al*., 2018c). Their mean gut passage time of a fruit consumed was between 20 and 30 min. When coupled with bird movement data, this corresponded to a median dispersal distance of approximately 100 m around a tree. Germination experiments conducted on both the endemic *Myrtastrum rufopunctata* and the invasive *S. terebinthifolius* showed contradicting trends. Consumption by the Red-vented Bulbul accelerated the germination speed and enhanced the germination rate of *S. terebinthifolius* but lowered the germination capacity of the endemic *M. rufopunctatum*. Even if this observation could be partly explained by differences in fruit characteristics, such effects of favouring an invasive species could drive an 'invasional meltdown' and should be described in depth (Thibault *et al*., 2018c).

5.9.3 Interactions with native fauna

According to Thibault *et al*. (2018a), 15 species of bird, one reptile and one insect suffer negative interactions with alien Red-vented Bulbuls. Only one study has addressed the issue of how the aggressive behaviour of the Red-vented Bulbul affected other bird species (Pernetta and Watling, 1978). In Fiji, several authors have reported Red-vented Bulbuls displaying aggressive behaviour and competition for food resources towards other passerine species (Clunie, 1976; Pernetta and Watling, 1978; Williams, 2011). However, Watling (1979) suspected that the observed association of native bird species with forest was mainly due to habitat loss rather than the aggressive behaviour of the Red-vented Bulbul in Fiji. Similarly, alien bulbuls in Houston, Texas, showed limited agonistic behaviour towards smaller more passive species when foraging, whereas larger species too close to nesting bulbuls stimulated mobbing behaviour; overall bulbuls showed little aggression towards native birds (Brooks, 2013).

Fig. 5.7. A Red-vented Bulbul feeding on the red berries of the invasive *Schinus terebinthifolius* in New Caledonia. (©Photograph: Coralie Thouzeau-Fonseca, IAC.)

In New Caledonia, the presence and abundance of Red-vented Bulbuls in inhabited areas was correlated with a lower abundance of nine native songbird species but had no effect on the three introduced species that were tested (Fig. 5.8) (Thibault *et al*., 2018b). In this study, the temporal trend in the abundance of native songbirds suggested that the Red-vented Bulbul contributed to a niche contraction rather than a direct depletion of these species. On Tutuila, American Samoa, Sherman and Fall (2010) observed that bulbuls competed for access to food resources with two passerine species.

Insect and skink predation by Red-vented Bulbuls is mentioned in several studies (Vander Velde, 2002; Walker, 2008; Brooks, 2013). On Oahu, Hawaii, direct predation of the monarch butterfly (*Danaus plexippus*) by the Red-vented Bulbul led to an induced colour selection against the orange morph in the monarch (Stimson and Berman, 1990). After 10 years, the same authors reported a predation transfer to the larvae, leading to an overall decline in abundance of the butterfly (Stimson and Kasuya, 2000). In Tahiti, Red-vented Bulbuls are considered a threat to the Tahiti Monarch (*Pomarea nigra*), an endemic and critically endangered passerine, through competition for nest sites and territory (Blanvillain *et al*., 2003).

In the Middle East, cross-breeding between the exotic Red-vented Bulbul and the three closely related native species (White-cheeked Bulbul (*Pycnonotus leucogenys*), White-eared Bulbul (*P. leucotis*) and Yellow-vented Bulbul (*P. xanthopygos*)) is often reported as a potential threat for native bulbuls (Khan, 1993; Nation *et al*., 1997; Gregory, 2005; Azin *et al*., 2008; Khamis, 2010).

5.9.4 Positive effects

Red-vented Bulbuls feed on a variety of native plant species (Trail, 1994; Sherman and Fall, 2010), and dispersal of native seeds is the only service that has been explored in the Red-vented Bulbul's alien range (Spotswood *et al*., 2012). As an example, the endemic *M. rufopunctatum* was found to be among the most frequently consumed species in New Caledonia during the study of Thibault *et al*. (2018c). Interestingly, in a village-scale survey led by Daigneault and Brown (2013) in Viti Levu, Fiji, 47% of the respondents reported that the Red-vented Bulbul was good for their community for three main

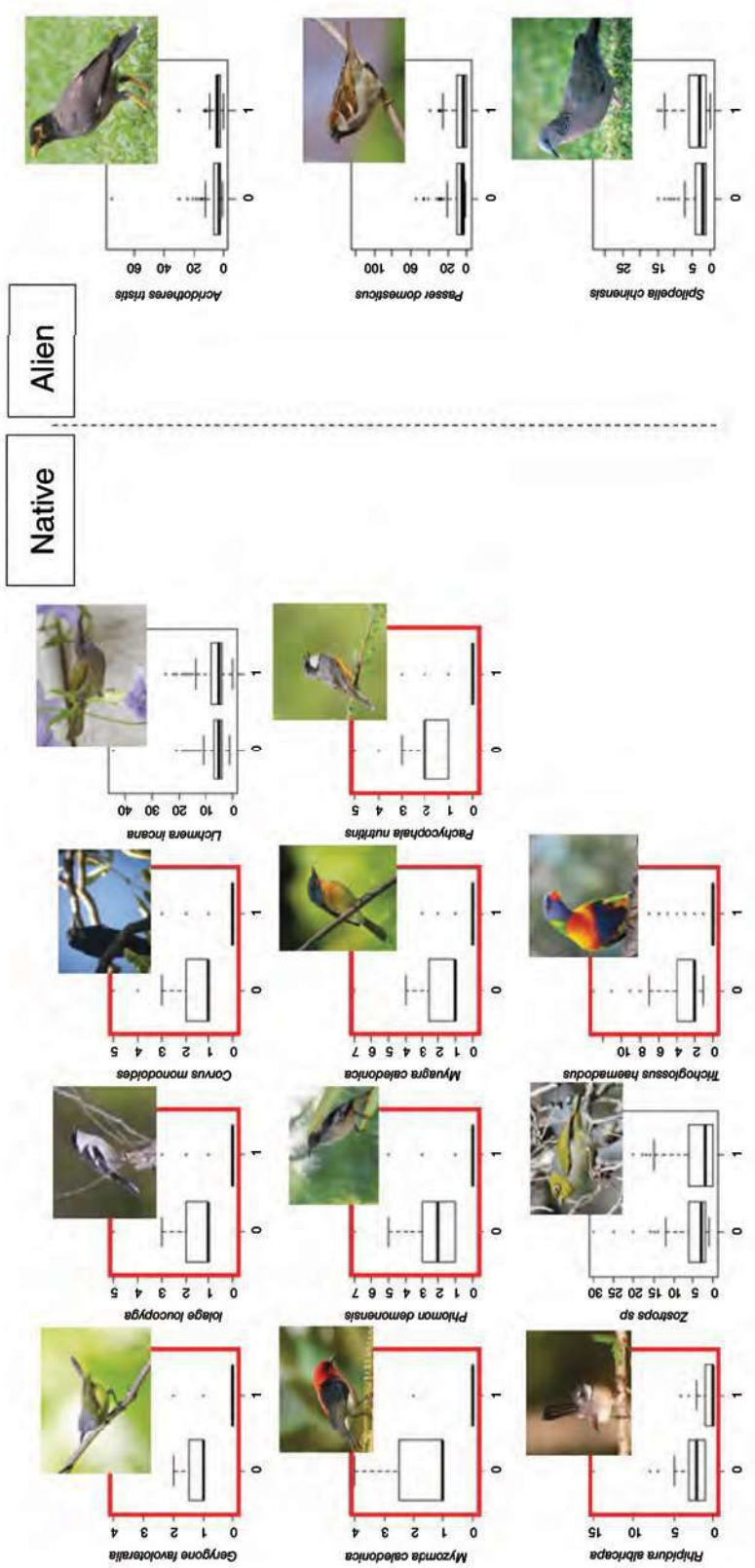

Fig. 5.8. Mean abundance of 14 songbirds in inhabited areas of New Caledonia, depending on whether the Red-vented Bulbul was present or not. Species highlighted in red were less abundant when the Red-vented Bulbul was present. (Adapted from Thibault *et al.*, 2018b.)

reasons: (i) it was effective at insect control; (ii) it reduced mongoose attacks on chickens as a result of the chickens eavesdropping on bulbul alarm calls; and (iii) village focus groups responded that Red-vented Bulbuls were occasionally eaten by villagers.

5.10 Control

To the best of our knowledge, predation of Red-vented Bulbuls has not been studied specifically. Predation by domestic and feral cats (*Felis catus*) is very likely, considering both the low height at which the Red-vented Bulbul nest is built (3 m on average) and their preferred habitat. Raptors are also suspected to prey on Red-vented Bulbuls. During a trapping experiment in New Caledonia, a Swamp Harrier (*Circus approximans*) was recorded by a camera trap while attempting to catch Red-vented Bulbuls (M. Thibault, personal communication).

The Red-vented Bulbul is considered an invasive species and environmental pest under the law in Australia (Tasmanian Government, 2010), Fiji (Minister of Primary Industries, 1985), French Polynesia (Direction de l'Environnement de la Polynésie Française, 2017), Hawaii (Division of Forestry and Wildlife, 2014), New Caledonia (Direction du Développement Economique et de l'Environnement de la Province Nord, 2008; Direction de l'Environnement de la Province Sud, 2016), New Zealand (Ministry of Primary Industries, 2017), South Africa (Department of Environmental Affairs, 2016) and Spain (Ministerio de Agricultura, Alimentacion y Medio Ambiente, 2013). In these countries, transportation, trade and possession of this species are forbidden, and hunting is authorized. No mention of this species as a pest or an invasive species is available from other countries.

Thibault *et al.* (2018a) listed only three examples of management action taken against the Red-vented Bulbul in its alien range documented in the published scientific literature. The first was the successful eradication programme implemented in New Zealand between 1952 and 1955 (Turbott, 1956). This programme allowed the early detection and shooting of bulbuls due to a reward associated with a call for information, and led to an announcement of eradication in 1955 (Watling, 1978). This management strategy remains in place in New Zealand and helped prevent establishment after three more recent introduction events (September 2006, February 2013 and May 2016).

The second location where management actions have been implemented against the Red-vented Bulbul is the island of Tahiti, French Polynesia. In Tahiti, an experimental management programme that was not focused on Red-vented Bulbul management specifically but rather on Tahiti Monarch conservation aimed to control alien birds. Control campaigns were implemented twice, in 2012 and 2013 (Saavedra, 2012, 2013), against the Red-vented Bulbul and the Common Myna (*Acridotheres tristis*). For these, poisoning, shooting and trapping were used simultaneously. These actions resulted in the extermination of 1035 Red-vented Bulbuls in 2012 and 849 in 2013, and led to an increase in the breeding success of the Tahiti Monarch (Saavedra, 2013). Elsewhere in the French Polynesian Archipelago, Red-vented Bulbul removal programmes are in progress in Bora-Bora, Makatea and Nuku Hiva, three islands where the species is still rare but that are located near uninvaded parts of the archipelago.

Third, a test conducted in Hawaii on bird repellent showed that ziram (zinc dimethyldithiocarbamate), methiocarb and methyl anthranilate reduced the consumption of treated papaya mash by Red-vented Bulbuls (Cummings *et al.*, 1994). In an open-field test, the same authors showed that methiocarb significantly reduced damage on orchids.

In contrast, a cost–benefit analysis conducted in Fiji on controlling the Red-vented Bulbul recommended 'taking no action against the bulbul until such time as other benefits and/or means of control have been field tested' (Daigneault and Brown, 2013). This response could be considered a fourth management option.

Nevertheless, locally, unpublished actions exist. In New Caledonia, where expansion of the bulbul population is ongoing, birds are shot, where possible, when they are detected in new areas. In 2016, a Red-vented Bulbul was located at 'La Foa, Pocquereux' by the Institut Agronomique néo-Calédonien (IAC), in the current northern edge of their distribution, resulting in the very first official control action organized in New Caledonia. Following this, a collaboration was established between several institutions to implement a 'quick reaction' protocol that aims to locate and shoot Red-vented Bulbuls that are observed near or beyond the edge of the current distribution range.

In order to reduce the increasing levels of crop damage, and to meet a social demand reported by New Caledonian farmers, locals and agriculture authorities, a management method inspired by the example of Red-whiskered Bulbul (*Pycnonotus jocosus*) control in La Réunion was investigated by the IAC (Thouzeau-Fonseca, 2013). The method consisted of using magpie-type traps and decoys to capture bulbuls. The results show that reddish fruit baits attract Red-vented Bulbuls efficiently. The use of a decoy bird is essential to enhance trapping success, but frequent accidental releases by inadequately trained users should be avoided when trapping outside the actual distributional range to prevent any release in the field.

5.11 Uses

In Assam in north-eastern India, Red-vented Bulbul fights were part of a traditional and religious annual celebration (Fig. 5.9) until this was banned in January 2016. Wild bulbuls were trapped, kept in cages and prepared for the fights, and were finally released if they won (Shalet, 2016).

Red-vented Bulbuls are in high demand for the Asian songbird trade, both in Asia and in many places where people from this region have emigrated. When the captive birds held in other countries escape, this is probably the primary source of introduced birds. This is the case in several countries of the Arabian Peninsula, where bulbuls are sold as cage birds in local markets (J. Baddington, personal communication) and on the internet, as well as in Houston, Texas (Brooks, 2013), where they are also believed to have arrived on large cargo barges travelling from Asia.

Fig. 5.9. A Red-vented Bulbul fight in Assam, India. (©Photograph: Manash Pratim Gogoi.)

5.12 Notes

Dispersal of the Red-vented Bulbul is strongly linked to human activities. The long and close relationship with humans certainly fostered bulbul range expansion at both global and local scales. It led to the transportation of caged individuals across the Pacific Ocean by Indian migrants from the early 20th century first, then by boat and airplane during the 1950s. Within invaded territories such as the New Caledonia mainland, it is assumed that human transportation of caged birds accelerates the dispersal rate of the species.

Part of the information presented here comes from a PhD thesis published recently (Thibault, 2018). In this thesis, an attempt was made to model the potential global distribution of the Red-vented Bulbul according to available distribution and climate data (Thibault *et al.*, unpublished data). The preliminary results of this study suggest that many tropical and subtropical islands (e.g. Mayotte, Madagascar, Indian Ocean Islands) appear to be climatically suitable for the species. When applying Intergovernmental Panel on Climate Change (IPCC) climate change scenarios for 2050 to this potential global distribution, two results are causes for alarm. First, two locations could become climatically suitable for Red-vented Bulbuls in the future (Guinea Gulf and South America). Second, the climate requirements of the Red-vented Bulbul overlap those of other invasive bird species native to the same area (e.g. Common Myna, Red-whiskered Bulbul). Therefore, expected climate change may increase the overlap of invasive bird species that tolerate specific climate parameters. This could favour the establishment and multi-invasion of several territories.

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