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New information on the distribution, status and conservation of terrestrial bird species in Grande Terre, New Caledonia

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Abstract. New Caledonia supports outstanding biological diversity, including many endemic bird species, some of which are threatened with extinction. The high levels of taxonomically unusual avian endemism make the islands one of the most urgent priorities for bird conservation in the Pacific region. We provide new data on the distribution of, and threats to, New Caledonian birds of conservation interest and provide a review of their status and requirements for conservation action. In addition, we report two rediscoveries: the first record of the New Caledonian Owllet-nightjar, *Aegotheles savesi*, since its description in 1880; and the only confirmed record of the Crow Honeyeater, *Gymnomyza aubryana*, in north New Caledonia during the twentieth century.

Introduction

The French overseas territory of New Caledonia comprises the main island of Grande Terre, the smaller Loyalty Islands (including Ouvéa, Lifou and Maré), the Ile des Pins and numerous smaller islets and reefs. New Caledonia is unique in the tropical south-west Pacific in that Grande Terre is not volcanic in origin, but is a fragment of the ancient super-continent of Gondwanaland.

The geological and tectonic history of Grande Terre has been a major influence in the evolution of the island's flora and fauna. It separated from Australia 65–80 million years ago (Coleman 1980), and such prolonged isolation, combined with highly unusual ultrabasic, peridotite-derived soils in the southern part of the island, have created a unique and exceptionally diverse flora that includes five endemic plant families (Morat 1993). Of the plant species restricted to southern ultrabasic soils, 98% are endemic to New Caledonia (Lowry 1998); for example, 19 of the world's 24 species of *Araucaria* are found only on these islands (Farjon *et al.* 1993), and 16 of the 17 palm genera so far described are endemic (Jaffré and Veillon 1988). Faunal endemism is similarly high: over 50 lizard species are known from New Caledonia, of which more than 80% are endemic (R. Sadlier, personal communication) including *Rhacodactylus leachianus*, the world's largest gecko. The biodiversity of these islands also extends to invertebrates, there being exceptional endemism in groups such as mayflies and land snails (Solem 1964; Chazeau 1993).

In total, 141 bird species have been recorded within the New Caledonian region (Barré and Dutson 2000). Of these, 73 are native terrestrial (i.e. not seabirds). There are 22 species listed as endemic to New Caledonia, of which 20 occur on Grande Terre, all of which are found, at least occasionally, in humid forest (Stattersfield *et al.* 1998; Barré and Dutson 2000). In addition, there are nine other 'restricted-range' bird species occurring in New Caledonia, seven of which occur on Grande Terre (Stattersfield *et al.* 1998). Of the endemic species, eight were listed as Threatened by Collar *et al.* (1994); this has been reduced to six, partly as a result of this survey (BirdLife International 2000). With the exception of Hawaii, Grande Terre is the smallest island in the world to which a family of birds is confined: the Kagu, *Rhynochetos jubatus*, is the only extant representative of the family Rhynochetidae. This extraordinary species is the official emblem of the islands.

The avifauna of New Caledonia is surprisingly poorly known. Until 1998 three species (the New Caledonian Rail, *Gallirallus lafresnayanus*, the New Caledonian Lorikeet, *Charmosyna diadema*, and the New Caledonian Owllet-nightjar, *Aegotheles savesi*) were known with certainty only from museum specimens or sightings prior to 1900. Moreover, no recent ornithological research had been undertaken in areas where these species were historically collected or where the last reported but unconfirmed sightings were made (A. Duncan, personal communication). There are two other endemic land-bird taxa of conservation interest: the Painted

Buttonquail, *Turnix (varia) novaecaledoniae*, and the White-throated Nightjar, *Eurostopodus (mystacalis) exul*. Both these endemic forms might prove sufficiently distinct to be treated as species in their own right (Debus 1996; Cleere 1999; BirdLife International 2000), but are known only from museum specimens and may be extinct.

Methods

We spent five months in nine forest sites across Grande Terre collecting data on the distribution, status and ecology of birds as part of a larger conservation research project called 'Project Diadema' (see Ekstrom *et al.* 2000). We compiled species inventories for each site and selected methods most likely to lead to the discovery of very rare species. We used sound recording and judicious playback of vocalisations where necessary. For threatened bird species, we also used simple two-belt point-count methods to provide approximate density estimations and to make the first population estimates for these species (see Ekstrom *et al.* 2000 for details). We did not use precise density-estimation techniques because of their unsuitability for surveys of species occurring at low densities (Marsden 1999) and the length of time required to fulfil the assumptions inherent in these methods (Bibby *et al.* 1992). During our work in tribal forests, we conducted informal interviews with guides and senior tribe members, using photographs and paintings of relevant bird species. This provided information on the local distribution of birds, as well as perceived changes in their occurrence and status over time.

Study sites

Nine humid forest sites were surveyed for 6–12 days each between July and November 1998 (see Fig. 1) by teams of 3–8 people. New Caledonia consists of three political units: the north province (Grande Terre), south province (Grande Terre) and the Loyalty Islands. The habitats of Grande Terre can be conveniently divided into five categories (Lowry 1998). (1) Maquis, a unique, heath-like evergreen scrub mainly found on highly ultrabasic soil. (2) Humid forest on ultrabasic soil and (3) humid forest on non-ultrabasic soil (these two together comprise 22% of the land area mainly on the east coast and central mountainous chain). (4) Sclerophyll forest, a highly threatened habitat, now comprising less than 3% of the land area. (5) *Melaleuca* woodland, a fire-maintained habitat mainly in the plains where indigenous forest has been burnt. We worked only in sites on Grande Terre, and only in humid forest and *Melaleuca* woodland. Four were in the south province: Rivière Bleue (Parc Provincial de la Rivière Bleue), Haute-Pourina valley (recently annexed to Parc Provincial de la Rivière Bleue), Ni-Kouakoué (Réserve Speciale de Faune et de Flore de la Ni-Kouakoué) and Nodela (Réserve Speciale de Faune et de Flore de la Nodela). All these sites are on ultrabasic soils. Five sites were selected in the north province: Néoua tribal forest, Tchamba tribal forest, Mt Panié (Réserve Speciale de Flore de Mt Panié), Mt Colnett and Mt Ignambi. All these sites are on non-ultrabasic soils, although Néoua and Tchamba border ultrabasic areas.

Results

The following accounts provide new information on, and review the distribution, status and conservation of, Grande Terre's endemic species listed as threatened by BirdLife International (2000); if this threat category has changed from that given in Collar *et al.* (1994), this is made clear in the text. This is followed by other species and subspecies of conservation interest.

Species listed as threatened by BirdLife International (2000)

New Caledonian Rail, *Gallirallus lafresnayanus*
[BirdLife International 2000: Critical]

The 13 known specimens of this rail were taken between 1860 and 1890 in southern New Caledonia (Stokes 1978), although this probably represents a collecting bias as little ornithological exploration was conducted in the north. Moreover, fossil evidence suggests that the species was originally distributed over the entire island (Balouet and Olson 1989). The last confirmed records of the species were made by Layard and Layard (1882), who kept two individuals in captivity. Anecdotal evidence, however, suggests that the species survived into the twentieth century. Warner (1947), for example, received several reports of this rail from local people around Mt Mou, Mt Humbolt, Mt Panié, Bourail, La Foa and Canala (no date supplied). Stokes (1978) received reports from Mt Mou dating around 1910, from near the mouth of the Ouaième River below Mt Panié in 1960, and the southern

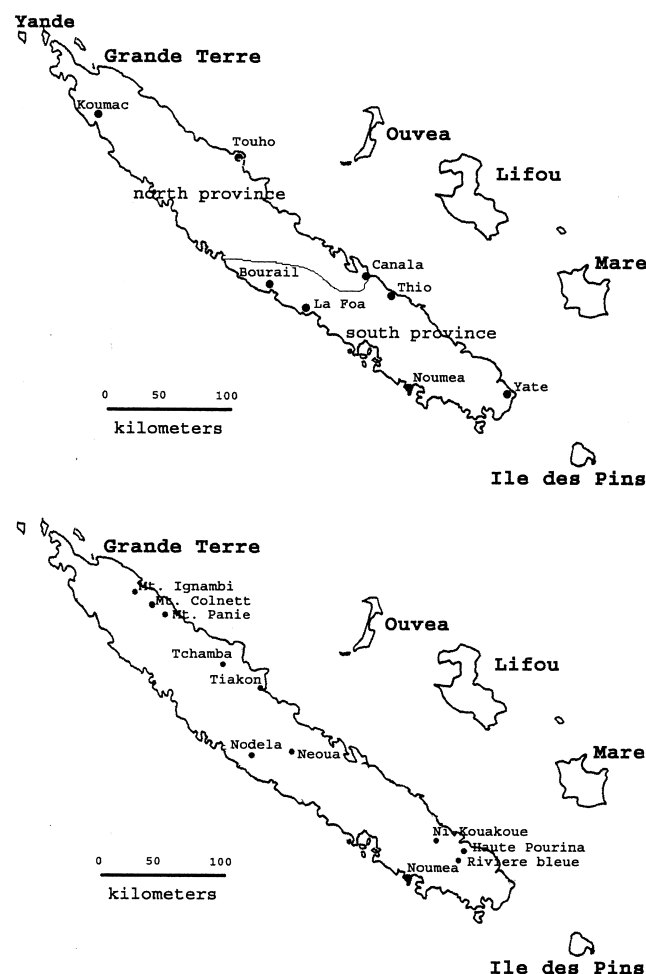


Fig. 1. New Caledonia, showing localities mentioned in the text (upper figure), and locations of humid forests visited during this study (lower figure).

ridge of the headwaters of the Rivière Blanche valley in the south of the island (no date supplied). Most recently, Balouet (1986) makes a surprisingly casual reference to an observation he made of a large brown rail on Mt Panié in November 1984 that he believed to be *G. lafresnayanus*, although he did not formally claim rediscovery of the species.

We did not record this species during fieldwork and no local people interviewed produced reliable reports, although there were a number of unsubstantiated recent records (see Ekstrom *et al.* 2000). Speculative broadcasting at all sites of the calls of Lord Howe Rail, *G. sylvestris*, the closest relative of *G. lafresnayanus*, failed to elicit any response. Nor was any remotely similar vocalisation heard in the forests of New Caledonia during fieldwork. It is difficult to draw any conclusions from this result as the species may be relatively silent or possess a completely different call to its congener.

Due to their terrestrial habits, rails appear to be particularly vulnerable to extinction and are among the thousands of bird species to have gone extinct from Pacific islands following the arrival of man and his commensal and domestic animals (Steadman 1995). *G. sylvestris*, a close relative of *G. lafresnayanus*, is endemic to Lord Howe Island and survived the anathema of man's arrival only in the forest of two mountain summits that were inaccessible to introduced pigs (Fullagar 1985; Miller and Mullette 1985). As feral pigs are found all over New Caledonia, *G. lafresnayanus* may have already been extirpated. However, its crepuscular habits and the lack of any vocal information make it highly cryptic and our failure to locate it should therefore not be taken as proof that it no longer survives.

Further research in steep mountainous regions (particularly those that retain good populations of Kagu, another ground nesting species) is required. These may yet reveal a small remnant population of *G. lafresnayanus*. If it is extant, control of introduced mammals such as pigs and feral dogs in particular areas would be likely to benefit the species.

Kagu, *Rhynochetos jubatus*
[BirdLife International 2000: Endangered]

This species, the sole representative of the endemic family Rhynochetidae, has already been the subject of considerable behavioural and ecological research (Hunt 1996; Hunt *et al.* 1996; Létocart and Salas 1997). Hunt (1996) gives a minimum total population estimate of 652 individuals for Grande Terre, though the true figure is likely to approach 1000 individuals (Y. Létocart, personal communication). It is well known and common in the lower forests of Rivière Bleue and Rivière Blanche (which make up the Parc Provincial de la Rivière Bleue), where numbers have increased markedly due to management, namely the eradication of dogs and cats and reintroduction of captive-bred individuals (Létocart 1992).

We recorded *R. jubatus* in humid forest at four of the nine sites surveyed: Nodela (400–1000 m), Haute-Pourina (250 m), Néoua tribal forest (250–500 m) and Tchamba tribal forest (300–400 m). Surprisingly, no records were made from the upper reaches of Rivière Bleue National Park, but studies by ornithologists for the provincial government (1991 and 1999) have demonstrated a healthy population from this area (Y. Létocart, personal communication).

Introduced mammals represent the greatest threat to this ground-nesting, and almost flightless, bird (Hunt *et al.* 1996; Y. Létocart, personal communication). In particular, feral and domestic dogs have been strongly implicated in the killing of many adult *R. jubatus* (Hunt *et al.* 1996). However, village-based hunting appears to be decreasing in the territory (e.g. Maruia/CI 1998; J. Manuaté, personal communication) and there is a net human emigration from the tribes into the capital (e.g. Ahmed-Michaux and Roos 1997), suggesting that the predation pressure imposed by domesticated dogs may be set to decline. However, most forests have feral dogs roaming free within them (Hunt *et al.* 1996), and the threat they carry is unlikely to diminish without active management. Pigs have been reported throughout Grande Terre (J. M. Thiollay, unpublished data; DDRP, personal communication) and were present in all forests visited during fieldwork; there is evidence that they opportunistically consume clutches of *R. jubatus* (Létocart, unpublished data). However, wild pigs co-exist with *R. jubatus* in the lower forests of Rivière Bleue, and *R. jubatus* populations were successfully augmented without control of pigs. This may indicate that pigs pose only a minor threat at low densities. Rats are also a threat to this species; in a recent study from Rivière Bleue Park, predation by rats is believed to account for 55% of nestling losses in *R. jubatus* (DRN, unpublished data).

In comparison to the threat from introduced species, deforestation and forest fragmentation are probably not significant threats to the species at present. The remaining habitat on Grande Terre is likely to be sufficient for the species' long-term survival, providing that other factors such as introduced predator pressure can be controlled. Hunt (1996) found that forest patch size was not well correlated with numbers of *R. jubatus*, other factors such as proximity to human settlements being more important. The species' large territory size of 10–30 ha (Hunt 1996; Létocart and Salas 1997) does presumably set limits on population viability in small forest patches. However, Y. Létocart (personal communication) reports that individuals can move at least 2 km through maquis between forest patches, an important consideration when estimating the future viability of populations.

R. jubatus is well known and used as an emblem throughout New Caledonia for restaurants, hotels, shops and the national Post Office. However, despite conservation efforts and considerable research, its long-term survival in the wild is not yet assured. Active management, most importantly the

elimination of dogs, is required in forests that support populations outside Rivière Bleue. On the basis of our surveys we particularly recommend Nodela for priority management for this species due to the very important population of at least 53, and possibly up to 100, individuals at this site.

New Caledonian Lorikeet, *Charmosyna diadema*

[Collar *et al.* 1994: Endangered; BirdLife International 2000: Critical]

This lorikeet is known from two female co-types collected in 1859 from unknown locations in New Caledonia, and one individual collected (but not preserved) from Mt Ignambi in 1911 (Sarasin 1913).

We did not record *C. diadema* during fieldwork, despite 30 days of surveys on Mt Ignambi and other peaks in the north-east ranges. However, interviews revealed two relatively recent anecdotal reports of this species. S. Blancher, a forest warden (Direction des Ressources Naturelles), observed a small parrot, which may have been this species, near Aoupinié in the 1960s. He also told us about a similar report from the Néoua tribal forest area in the same decade.

The apparent disappearance of this species from New Caledonian forests is a mystery. It may have been particularly susceptible to predation by rats and have all but disappeared by the time Europeans arrived in New Caledonia to record its existence. Alternatively, it may have been dependant (as a seasonal migrant) on nectar sources in the sclerophyll forests of the west coast that have now been almost entirely destroyed (Lowry 1998). However, other rare *Charmosyna* lorikeets in Wallacea and the Pacific region are only sporadically recorded (White and Bruce 1991; Bregulla 1992; D. Watling, personal communication) so its continued existence on Grande Terre cannot be ruled out. In the recent reassessment of the world's threatened birds, this species has been upgraded from the IUCN category Endangered to that of Critical (BirdLife International 2000).

Horned Parakeet, *Eunymphicus cornutus*

[Collar *et al.* 1994: Vulnerable; BirdLife International 2000: Endangered]

The parrot genus *Eunymphicus*, endemic to New Caledonia, comprises two taxa, previously considered as subspecies but perhaps better treated as separate species (Juniper and Barr 1998; BirdLife International 2000). This account deals with the nominate subspecies found on Grande Terre (for details of the status and conservation of *E. c. uvaensis* see Robinet *et al.* 1995). The historical literature has been interpreted as providing evidence of a decline of this species (Collar *et al.* 1994). For example Layard and Layard (1882) refer to it as being found 'in all the forest-region' whereas today it appears to have a more restricted distribution (Barré and Dutson 2000).

We recorded the species at five out of nine sites surveyed, more frequently in the southern half of Grande Terre. It was common at Nodela (to 1100 m) and Rivière Pujémia (to

700 m). It was rare or uncommon at three other sites: Néoua (to 450 m), Mt Ignambi (to 1200 m) and Rivière Bleue. The species is reportedly common, but discreet, in both the lower and upper reaches of the Rivière Bleue (Y. Létocart, personal communication 1998). In all these sites humid forest predominates, with a canopy height of 10–30 m. Our observations and local reports suggest that *E. c. cornutus* is concentrated in the south of Grande Terre in forest on ultrabasic soil (although it is also found in some non-ultrabasic forests in the north). However, it is not found in all the southern ultrabasic forests, suggesting that more-specific habitat requirements are also important. Such basic ecological preferences have not been previously reported in the literature and it remains remarkably unstudied despite its prominence as a flagship species of taxonomic importance.

In all, 75 individuals of this species, originating from New Caledonia, were reported in trade between 1988 and 1998 and it has recently been promoted to CITES Appendix I (IUCN/SSC in litt. 2000). We did not encounter any firm evidence of current trapping for domestic or commercial purposes. However this parrot is quite common in captivity in New Caledonia, despite this being illegal. Therefore the newly introduced rules against domestic trade explicit in CITES I mean a requirement for closer enforcement of local trapping legislation by government authorities (i.e. Provinces Nord and Sud). As it breeds in terrestrial cavities (Hannecart and Létocart 1980, 1983; O. Robinet, personal communication), it may be vulnerable to introduced predators such as rats, as is the case for *Cyanoramphus* and *Vini* parrots on other Pacific islands (Seitre and Seitre 1992).

Nodela represents a key site for the conservation of this species and deserves effective protection, including the control of introduced mammals (especially rats and dogs). In addition, a full ecological study is required to clarify the factors underlying its distribution and possible decline.

New Caledonian Owlet-nightjar, *Aegotheles savesi*

[Collar *et al.* 1994: Endangered; BirdLife International: Critical]

The Owlet-nightjar family is very poorly known. It consists of 10 species from the forests of New Guinea, Halmahera and New Caledonia (Holyoak 1999; Pratt 2000). *A. savesi* was until recently known from only one 1880 specimen, from Tongué (near Nouméa). In addition, a specimen that may be of the same taxon has recently come to light in the Museo Civico di Zoologia, Rome, Italy (Carlo Violani in litt. 2000), a bird that was acquired in 1915.

Aegotheles savesi was observed for the only time in the 20th century during field work for this project. A single individual was observed at 1840 hours on 5 November 1998 in the Rivière Ni Valley at an altitude of 800 m, on the west of the Massif de Kouakoué in the South province. Further details are provided by Tobias and Ekstrom (2002). Owlet-nightjars are notoriously unobtrusive in nature (Beehler *et al.*

1986), but the single record in six months of field work, including 2350 nocturnal metre-net-hours, suggests that the species is very rare and/or very localised.

Although threats to this species are difficult to predict, rats are known predators of similar hole-nesting birds on Pacific islands (Seitre and Seitre 1992) and probably also of the Australian Owlet-nightjar, *A. cristatus* (Brigham and Geiser 1997). More information regarding the ecology and status of the species is urgently required to allow the formulation of appropriate management proposals. Large areas of unexplored riverine forest exist on the Kouakoué massif and should be searched for the species. *A. savesi* was recently upgraded from Endangered (Collar *et al.* 1994) to Critical in the recent reassessment of the world's threatened birds (BirdLife International 2000).

Crow Honeyeater, *Gymnomyza aubryana*

[Collar *et al.* 2000: Vulnerable; BirdLife International 2000: Endangered]

All recent records of *G. aubryana* are from the southern forests and its stronghold appears to be Rivière Bleue (Y. Létocart, unpublished data). It did occur in the North Province during the 19th century, as evidenced by specimens marked 'Mt Panié' in the Museum National d'Histoire Naturelle, Paris. There are also recent anecdotal records of the species from Mt Panié in 1997 (Flannery, unpublished data) and Mt Colnett and Mt Ignambi (tribes of Colnett and Paimboas, personal communication).

We recorded *G. aubryana* at four out of nine forest sites but it was rare at three of these. The species was most common in the Ni-Kouakoué reserve (700–850 m) where several pairs were located. Elsewhere in the southern province, a single individual or pair was recorded in upper Rivière Bleue (100–350 m), Rivière Pujémia (500 m) and Rivière Pourina (200 m), these three sites being one contiguous forested area. More recent studies (Y. Létocart, personal communication 2001) suggest a population density of 2 territories per 100 ha in the upper Rivière Bleue. In the northern province, a single individual was recorded on Mt Panié at 400 m. Elder members of Haut Coulna, Tchamba and Paimboas tribes (all in the North Province) are familiar with and have local names for the species, and gave good descriptions of its call (Ekstrom *et al.* 2000). The observation of a single individual at 400 m on the western slopes of Mt Panié near Haut Coulna tribal settlement confirmed the persistence of this species in the North Province. This disjunct population is apparently small given the paucity of sightings in these forests during prolonged fieldwork despite the use of tape playback, to which it usually responds well. On the basis of an estimated territory size of 0.5–0.75 km² (Ekstrom *et al.* 2000; Y. Létocart, personal communication 2001) and habitat availability (Jaffre *et al.* 1997) we estimate global population size at roughly 1000–3000 individuals (see

Ekstrom *et al.* 2000). It is important to note that the species is inconspicuous and is therefore likely to go under-recorded.

Gymnomyza aubryana is thinly and patchily distributed, its apparent absence from many humid forest sites implying some form of specialisation that is incompletely understood. It has been recorded deep inside continuous humid forest but also in small forest patches amongst scrubland on ultrabasic soil. These latter sites are particularly vulnerable to bushfire damage and the species, in general, is threatened by both habitat loss and possibly predation by rats. It is interesting to note, however, that the related Fijian endemic Giant Forest Honeyeater, *Gymnomyza viridis*, is threatened by habitat loss but appears unaffected by rats (BirdLife International 2000). A study investigating the ecology of *G. aubryana* in Rivière Bleue has been initiated by the government of the South Province (Y. Létocart and C. Lambert, personal communication) and will hopefully increase our understanding of the threats to this species.

Our observations suggest that *G. aubryana* is uncommon throughout the island and largely restricted to humid ultrabasic forests of southern Grande Terre. However, the record from the north implies that it may still be more widespread than previously suggested (Chardonnet and Lartiges, personal communication). Populations may be declining in Rivière Bleue (Y. Létocart, personal communication). In recognition of its scarcity and restricted habitat requirements, we recommended it be raised in status to Endangered. This is reflected in the recent IUCN listing (BirdLife International 2000).

Other species of conservation interest

Australasian Bittern, *Botaurus poiciloptilus*

[Collar *et al.* 1994: Endangered; BirdLife International 2000: Vulnerable]

This species is found in wetlands in southern Australia and New Zealand as well as in New Caledonia (Sibley and Monroe 1990). It is classified as Endangered and is threatened by habitat destruction and the world population may number less than 1000 individuals (Collar *et al.* 1994). It was considered 'très rares' [very rare] by Layard and Layard (1882), Mayr (1945) and Hannecart and Létocart (1983) and there have been few recent records.

One possible aural record was made during field work: a booming call similar to recordings of *B. poiciloptilus* was heard on two occasions around 1130 hours in October 1998 in an area of wetland close to Le Cap river on the west coast of Grande Terre north of Bourail. A total of five further nights were spent in wetland habitat, such as near Tiakan on the east coast, with no other records. However, significant areas of wetland habitat remain unsurveyed in New Caledonia, such as the Plaine des Lacs.

This species is threatened in Australia and New Zealand by drainage of its habitat for agriculture and salinisation of

swamps (Garnett and Crowley 2000). Further research is necessary to identify the status and distribution in New Caledonia.

New Caledonian Imperial Pigeon, Ducula goliath

[Collar *et al.* 1994: Vulnerable; BirdLife International 2000: Near Threatened]

This species is the world's largest living arboreal pigeon (Goodwin 1970). It is endemic to Grande Terre, where it is a very popular game species. Historical literature (e.g. Warner 1947) provides some evidence that commercial harvesting (which is now illegal) has led to major population declines. S. Grillet used a point-count method to estimate the population size of *D. goliath* in Rivière Bleue National Park in June and July 1995, which revealed a figure of 6600–7600 individuals. However, these numbers cannot be extrapolated to provide a population estimate for Grande Terre as they probably include a positive seasonal bias, because many *D. goliath* migrate to the park at this time of year (Y. Létocart, personal communication).

We found *D. goliath* to be common or fairly common in most humid forest sites visited. It was most common below 1000 m and apparently rarer in forests on ultrabasic substrates such as in the valleys of the Ni, Pourina and Pujémia. Our subjective measures of abundance suggested that it has a degree of tolerance to habitat disturbance, being equally common in some selectively logged areas. Using a simple two-belt point-count method (Bibby *et al.* 1992) over a range of months (July to November) we were able to extrapolate our figures to the amount of humid forest available on Grande Terre (Lowry 1998). This analysis suggested an approximate total population estimate of 100000 individuals for Grande Terre (see Ekstrom *et al.* 2000).

The species is hunted in all tribal forests, but appears to be resilient to this pressure as it remains common at many of these sites (Ekstrom *et al.* 2000). Regulation of cartridges, emigration of rural populations into Nouméa (Ahmed-Michaux and Roos 1997) and increased poultry consumption (J. Manauté, personal communication) are leading to reduced hunting in the tribal forests. Indeed, our qualitative measures of densities in tribal forests were not significantly lower than those in managed reserves such as Rivière Bleue and Nodela, sites that probably suffer lower levels of hunting (Ekstrom *et al.* 2000). These data tentatively suggest that hunting of *D. goliath* does not threaten the species with local extinctions in tribal forests. This is not the case in 'commons' (or 'open access' forests) with good road access, such as the Col des Roussettes. Here, populations of *D. goliath* are very low due to hunting pressure from major towns nearby (F. Devinck, personal communication).

The current hunting law is specific: hunting is allowed only during weekends in April with a limitation of five birds per hunter per day. Hunting is allowed in this month because the pigeons form part of the traditional Kanak Yam Feast in April or May. In addition, the birds are not believed to breed

during this period (Létocart 1998; Barré and Garine-Wichatitsky 2001). These laws are not effectively enforced at present (J. Manauté, personal communication) and our observations suggested that hunting continues throughout the year (Ekstrom *et al.* 2000). To tackle this, the Direction des Ressources Naturelles are publishing a booklet and starting an education scheme for hunters both from towns and in traditional tribes. An anthropological study of the relative importance of *D. goliath* and introduced deer for tribe-based hunters is presently being conducted by the Institut Agronomique néo-Calédonien (IAC). These projects are likely to improve hunting practices and similar projects are required in Province Nord.

In summary, despite the serious threat of hunting in some areas, the species is widespread and remains common in many areas and appears under no immediate threat of extinction. It has therefore been down-listed from Vulnerable to Near Threatened in the recent reassessment of the world's threatened birds (BirdLife International 2000).

Cloven-feathered Dove, Drepanoptila holosericea

[Collar *et al.* 1994: Vulnerable; BirdLife International 2000: Near Threatened]

Drepanoptila holosericea is an endemic pigeon, evolutionarily derived from the Fruit-doves, *Ptilinopus*, but highly divergent morphologically (Landoldt 1987). It was previously considered fairly common in most humid forests of Grande Terre (Layard and Layard 1882). It lays two eggs per brood (Beland 1975) compared with the single egg typical of most *Ptilinopus* spp. (Goodwin 1970), a factor that may facilitate recovery from population crashes. Toone *et al.* (1993) estimated the total population to be greater than 5000 individuals, but this estimate had no basis in fieldwork.

We encountered this species frequently in humid forest between 100 and 1000 m, and also in *Melaleuca* savanna within *c.* 100 m of humid forest. The species was common or fairly common at most sites visited in the North Province. It was notably less common in some ultrabasic forests such as the valleys of the Bleue, Pourina, Pujémia and Ni rivers. In Rivière Bleue the species is attracted to a small (*c.* 2 ha) dense stand of *Elaeocarpus angustifolius* trees and is difficult to find elsewhere in the park (Y. Létocart, personal communication), suggesting that it has quite specific dietary requirements. Using a simple two-belt point-count method (Bibby *et al.* 1992), and extrapolating to the amount of humid forest available (Lowry 1998), we obtained an approximate total population estimate of 140000 individuals for the humid forests of Grande Terre.

This species appears under no immediate threat. It is tolerant of relatively disturbed habitat and is rarely hunted due to its small size. Only Tchamba and Néoua tribes reported occasionally taking the species for food; the New Caledonian Imperial Pigeon is generally sufficiently abundant to discourage any hunting of the smaller *D. holosericea*.

Given the species' relative abundance, and the fact that it is neither targeted by hunters nor intolerant of habitat degradation, we do not consider it to be under immediate threat of extinction. It requires no specific conservation measures to ensure its survival and we recommended that it be downgraded from the IUCN Threatened category. This is recognised in the recent reassessment of the world's threatened birds (BirdLife International 2000) where *D. hollosericea* is removed from the Vulnerable category to Near Threatened.

New Caledonian Grassbird, *Megalurulus mariei*

[Collar *et al.* 1994: not listed; BirdLife International 2000: Data Deficient]

This secretive passerine is endemic to Grande Terre where it inhabits thick vegetation, generally outside humid forest, particularly clumps of *Lantana* and also *Melaleuca* woodland and dense scrub (Layard and Layard 1882; Stokes 1979; Barré and Dutson 2000), including that degraded by fire (Ekstrom *et al.* 2000). It occurs sporadically throughout New Caledonia (Barré and Dutson 2000), possibly most frequently in the north and east (Y. Létocart, personal communication). It may prefer ferns and scrubs at higher altitudes, but grasses at lower elevations.

We observed *M. mariei* in *Lantana*, stunted *Melaleuca* scrub and maquis at Nodela, Néoua and Mt Ignambi. It was once observed in the undergrowth of humid forest at Mt Ignambi. At all three sites it appeared rare.

M. mariei lives and nests in fire-maintained habitats and could be threatened by the anthropogenic increase in fire frequency. Its distribution and status are poorly known; in recognition of this it has been moved from Least Concern into the Data Deficient category of the recently updated IUCN list (BirdLife International 2000).

Subspecies of conservation interest

Painted Button-Quail, *Turnix varia novaecaledoniae*

The nominate subspecies is found in Australia, while the subspecies *Turnix v. novaecaledoniae* is endemic to Grande Terre and Ile des Pins (Sibley and Monroe 1990) and is possibly worthy of specific rank (Debus 1996). It has been suggested that the species was, in fact, introduced to the island (Bruce 1985), but the existence of (sometimes locally abundant) fossil remains at several locations on Grande Terre (Balouet and Olson 1989) and the distinctiveness of the taxa confirms that it is native. There are reports from the Népoui (sclerophyll forest, west coast) region in the 20th century, and also from Touha (Delacour 1966), probably referring to Touho on the east coast (Hannecart and Létocart 1980–83). Balouet and Olson (1989) refer to this taxon as 'nearly, if not quite, extinct' and BirdLife International include it in their list of extinct taxa (Brooks 2000).

We did not record this bird during fieldwork, and interviews with local people revealed no evidence of its presence.

It may, however, survive in open grassy *Melaleuca* woodland or sclerophyll forest. These habitats were barely surveyed by our project and the latter is extremely limited in extent in New Caledonia – an estimated 2% of the original area remains (Lowry 1998).

The reasons for the taxon's rarity (or possible extinction) are unclear. The anthropogenic increase in fire frequency, loss of habitat or exploitation for meat or eggs may have all been factors. Button-quails are furtive in habits, meaning that we cannot conclude that it is extinct without considerable further directed research.

Red-fronted Parakeet, *Cyanoramphus novaehollandiae saisseti*

This parrot is found in New Caledonia, Lord Howe Island and New Zealand (Sibley and Monroe 1990). However, a recent review suggests that the subspecies endemic to Grande Terre, *C. n. saisseti*, qualifies for full species status (Juniper and Parr 1998).

We observed this taxon in seven out of nine of our humid-forest field sites where it was generally recorded as fairly common or uncommon between 400 and 1500 m. However, we also recorded it down to lower altitudes and even sea level in very small (to 0.5 ha), scrubby and disturbed forest patches amongst maquis. These observations indicate a broader habitat tolerance than 'indigenous montane forest', as was suggested by Juniper and Parr (1998).

Although relatively widespread and tolerating disturbed and patchy habitat, it is always found at low density and the situation should be monitored, and it does not appear to require conservation action at present. However, other surveys have found *C. novaehollandiae* to be rarer than *E. cornutus* (N. Barré, unpublished data 1999–2000) and continued monitoring will be important.

New Caledonian White-throated Nightjar, *Eurostopodus (mystacalis) exul*

This taxon is usually considered a subspecies of *Eurostopodus mystacalis* (e.g. Hannecart and Létocart 1980–83; Cleere 1998) but may be better treated a separate species (Cleere 1999). No records have been reported since Macmillan collected the type from long grass in *Melaleuca* woodland near Tao on the north-west coast of Grande Terre in 1939 (Mayr 1941). The specimen was in egg-laying condition, suggesting that it was unlikely to have been a vagrant or migrating individual from nearby Australian populations.

We did not record this species, despite a total of 2350 nocturnal metre-net-hours and 200 nocturnal observation hours in, and on the edge of, humid forest. Nor did we uncover any anecdotal reports of a nightjar-like bird. Nightjars reflect conspicuous eye-shine in torchlight and tend to have distinctive vocalisations. The lack of records or familiarity with the species thus suggests that it is very rare or possibly extinct.

However, we cannot yet rule out the possibility that it is highly cryptic, and survives in remote unsurveyed forests.

Bush fires affect large areas of *Melaleuca* savanna each year and may threaten the feeding or nesting habitats of this species. Feral cats and dogs may prey upon adults and chicks, as is suspected for *E. mystacalis mystacalis* in Australia (Cleere 1998). Nestlings may be threatened by the fire ants *Wasmannia auropunctata* that have spread rapidly since their introduction in 1972 and are now rife in many areas of savanna and some forests (Jourdan 1997). Further research is required to identify the status of this species. We recommend intensive nocturnal surveys on the edge of, and within, the humid forests of the north-east ranges of Grande Terre.

Island Thrush, Turdus poliocephalus

There are three subspecies of *T. poliocephalus* known from New Caledonia. *Turdus p. xanthopus* was thought to be endemic to Grande Terre (Hannecart and Létocart 1980–83), where it is now very rare or extinct (Warner 1947). However, a population was recently found on the islet of Yandé to the north of Grande Terre; this is estimated to support a minimum of 100 individuals (de Naurois 1982). *Turdus p. marensis* (endemic to Maré) was last collected in 1912 (Sarasin 1913) and there have been no recent records (Barré and Dutson 2000). *Turdus p. pritzbueri* (found on Lifou, New Caledonia and Tanna, Vanuatu) was regarded as ‘nearly extinct’ on Lifou by Macmillan (1939); G. Dutson found it to be surviving on Tanna in 1998.

We did not record this species in any of the sites visited on Grande Terre or during visits to Lifou. Similarly, a more recent 3-month survey of Lifou failed to find the subspecies there (N. Barré, unpublished data 2000).

All three subspecies in New Caledonia appear to be close to extinction or already extinct. The reasons behind this decline throughout the territory are unclear. The islet of Yandé provides the only potential for a viable ecological study. The introduction of Black Rats, *Rattus rattus*, has been implicated in the extinction of other subspecies on Norfolk and Lord Howe islands (Garnett and Crowley 2000), so it is likely that control of rats on Yandé would protect the small remaining population of *T. p. xanthopus*.

Discussion

Bird conservation in New Caledonia within a global context

Most of New Caledonia’s birds of conservation interest occur primarily in humid forest. This is fortunate given the near total destruction of the sclerophyll forest on the west coast (Lowry 1998). Grande Terre contains approximately 3000 km² of humid forest, located mainly in the east and on the central mountainous chain (Lowry 1998). Large areas of lowland humid forest have been destroyed by bush fires (e.g. Morat *et al.* 1981; Maruia/CI 1998) and smaller patches by open-cast nickel mining (Dupon 1986; Mittermeier *et al.*

1996) and logging (Lowry 1998). The lighting of bush fires is an ancestral Kanak practice, and has led to the creation of large areas of *Melaleuca* savanna. These fires continue to eat into humid forest edge and degrade remaining gallery forest within savannas (J. Manauté, personal communication). Fortunately, logging is on the decline in New Caledonia today (Dupon 1986; Mittermeier *et al.* 1996), but at least two new mine-product factories are planned for the next few years in both the north and south provinces (N. Barré, in litt. 2001). New mining activities pose their greatest threat to maquis flora, which shows precarious patterns of micro-endemism.

Despite the significant habitat losses, the present day threats to humid forest in New Caledonia may be less serious than in most other high-biodiversity countries, which tend to have lower GDPs. Such ‘developing’ countries suffer the drastic and destructive combinations of high population growth, great poverty and poor governmental institutions. New Caledonia is unusual in that it has a very low rural population density (c. 8 per km²: UN figures 1990), with relatively few people dependant on local forest resources for livelihood (Ahmed-Michaux and Roos 1997). In addition to this, the islands have the infrastructural and financial advantages of being an overseas territory of France and also benefit from the growing cultural awareness of the significance of ‘biodiversity’. These factors act to reduce the pressure on general forest resources in New Caledonia and make successful conservation management more promising than in other high-biodiversity countries.

The growing threat of introduced species

We consider that the most immediate threats to the conservation of New Caledonia’s threatened birds are posed by introduced species. The wide ranges occupied by New Caledonia’s threatened birds mean that localised logging or mining operations are unlikely to threaten individual bird species with extinction. However, Grande Terre is an ancient island, and isolated evolution has resulted in an ecologically naïve fauna that is vulnerable to predation and competition from alien species brought in accidentally or intentionally. This conclusion is not without its precedents. Human exploration resulting in the movement of species has been disastrous for the survival of island endemics across the planet (e.g. Diamond 1984). In the Pacific, for example, at least 2000 species of bird may have become extinct since the arrival of humans on the oceanic archipelagos (Steadman 1995). The New Caledonian fossil record bears scars from the same story: up to 40% of non-passerine birds appear to have gone extinct since the arrival of man, including species such as a giant galliform *Sylviornis neocaledoniae* and a giant megapode *Megapodius molistructor* (Balouet and Olson 1989).

The introduced species that potentially threaten forest birds and the integrity of their habitat include dogs, rats, cats, pigs, deer, cows and fire ants, *Wasmannia auropunctata*. The

mammal species are found throughout the humid forests of Grande Terre (Hunt *et al.* 1996; Mauria/CI 1998; Ekstrom *et al.* 2000), whereas fire ants have at present only invaded certain forests but are present in most *Melaleuca* savannas (Jourdan 1997). Management decisions about these introduced species must be prioritised on the timescale of the threats they pose. In the short term, predation appears the most detrimental. Predation of populations of *R. jubatus* by dogs (Hunt *et al.* 1996), cats and rats (DRN, unpublished data) has been well documented. Other than in the only properly managed protected area, Rivière Bleue Provincial Park, Kagu are likely to be decreasing due to continued uncontrolled predation by these introduced mammals. Introduced pigs appear responsible for the near extinction of a species of *Gallirallus* rail on nearby Lord Howe island (Disney 1974; Miller and Mullete 1985), so pigs are seriously implicated in the disappearance of *G. lafresnayanus* on Grande Terre. Cats and rats are known predators of hole-nesting birds in the Pacific (Steadman 1995) and possibly Owllet-nightjars in Australia (Brigham and Geiser 1997), and therefore may be responsible for the present rarity of *A. savesi*: rats have been present in its only known habitat for at least 100 years. The effects of fire-ants on the survival of bird nestlings is not yet known but may be serious (J. Chazeau, personal communication). These threats are operating now, and all require immediate active management.

In short, the primary management action for bird conservation is the control of introduced mammals, particularly dogs, cats and rats. Action is required in forests other than Rivière Bleue Provincial Park. These measures should have immediate positive effects for the survival of *R. jubatus*, *G. lafresnayanus*, *E. cornutus*, *A. savesi* and *G. aubryanus*, all of which are considered globally threatened (BirdLife International 2000).

The damaging effects of introduced herbivores act in the longer term. Deer, pigs and cows are widespread across New Caledonia, being found to the summits of the highest mountains. These mammals may have serious consequences for general forest structure and regeneration through their foraging, browsing and rooting behaviour. Such effects are already very obvious in some areas, such as in the Rivière Tchamba valley and Mt Panié, where large areas of bare soil denuded of leaf litter and young plants can be seen inside closed forest. Pavlov *et al.* (1992) have demonstrated the negative impacts of introduced pigs in Australia's humid forest. A major aim of the French governmental agency, Institut Agronomique neo-Calédonien, IAC (formerly CIRAD), is to investigate the effects of introduced species on wildlife. At present they focus on the negative influence of deer, such as on forest regeneration, which is expected to provide valuable information on the magnitude of these longer-term effects of introduced species. Subjectively, this study found the understorey depleted in pig- and deer-

populated forests. A dearth of new saplings will cause major problems for forest regeneration in the medium to long term.

Conclusion and outlook

Despite the threats outlined above, the outlook for the conservation of forest birds in New Caledonia may be bright. Most birds of conservation interest are dependant on humid forest, and large areas of this habitat still remain on the islands. The international conservation community is reviving interest in this global biodiversity hotspot (Mittermeier *et al.* 1996; Jaffré *et al.* 1998; Olson and Dinerstein 1998). This interest has sparked a number of surveys (e.g. Mauria/CI 1998; this study), resulting in an increase in our understanding of the terrestrial biodiversity of the territory. For conservation purposes, our knowledge of the distribution and status of threatened birds is now well enough understood that all species known to be extant (except the elusive *A. savesi*) can be protected if the political will exists. The increased global conservation interest in New Caledonia is catalysing a number of research and management initiatives amongst both local and international NGOs. The Société Calédonienne d'Ornithologie has recently reformed and is developing an excellent programme of collaborative activities with local and international NGOs, and governmental bodies in both provinces. Helped by international expertise, there are new conservation projects in the sclerophyll forest of the west coast initiated by WWF (France) in collaboration with the Province Nord government. Province Nord is also involved with Conservation International setting up a community reserve in the Mont Panié forests. Similar projects are in preparation by BirdLife International in collaboration with the South Pacific Regional Environment Programme (SPREP). These diverse activities are the start of effective conservation in New Caledonia with a commitment to improving the protected-areas system, plus active enforcement and management of these reserves in association with local communities. Our inspiration is that these are achievable aims in collaboration with the people of the islands, reflecting realisation of our mutual responsibility for ensuring conservation of New Caledonia's irreplaceable biodiversity.

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References

- Ahmed-Michaux, P., and Roos, W. (1997). Images de la population de la Nouvelle-Calédonie. *Demographie Société* **55**, 31–35.
- Balouet, J.-C. (1986). Premiers colons de Nouvelle-Calédonie. *L'Univers du Vivant* **7**, 35–47.
- Balouet, J.-C., and Olson, S. L. (1989). Fossil birds from late Quaternary deposits in New Caledonia. *Smithsonian Contributions to Zoology* **469**, 1–7.
- Barré, N., and Dutson, G. (2000). Liste commentée des oiseaux de Nouvelle-Calédonie. *Alauda* **68**, 1–48.
- Barré, N., and Garine-Wichatitsky, M. de (2001). Analyse de données biométriques de d'alimentation sur des oiseaux collectés à Forêt Plate (Pouémbout). Polycopié, IAC, New Caledonia.
- Beehler, B. M., Pratt, T. K., and Zimmerman, D. A. (1986). 'Birds of New Guinea.' (Princeton University Press: Princeton.)
- Bibby, C. J., Burgess, N., and Hill, D. A. (1992). 'Bird Census Techniques.' (Academic Press: London.)
- BirdLife International (2000). 'Threatened Birds of the World.' (Eds A. J. Stattersfield and D. R. Capper.) (Lynx Edicions & BirdLife International: Barcelona & Cambridge.)
- Brooks, T. (2000). Other categories: Extinct. In 'Threatened Birds of the World'. (Eds A. J. Stattersfield and D. R. Capper.) pp. 701–708. (Lynx Edicions & BirdLife International: Barcelona & Cambridge.)
- Bregulla, H. L. (1992). 'Birds of Vanuatu.' (Anthony Nelson: Oswestry, UK.)
- Brigham, R. M., and Geiser, F. (1997). Breeding biology of Australian Owllet-nightjars *Aegotheles cristatus* in *Eucalyptus* woodland. *Emu* **97**, 316–321.
- Bruce, M. D. (1985). Reviews (Oiseaux de Nouvelle-Calédonie et des Loyauté) New Caledonian Birds. *Emu* **85**, 275–276.
- Chazeau, J. (1993). Research on New Caledonian terrestrial fauna: achievements and prospects. *Biodiversity Letters* **1**, 123–129.
- Christidis, L., and Boles, W. E. (1994). 'The Taxonomy and Species of Birds of Australia and its Territories.' RAOU Monograph No. 2. (RAOU: Melbourne.)
- Cleere, N. (1998). 'Nightjars: a Guide to Nightjars and Related Nightbirds.' (Pica Press: Robertsbridge, UK.)
- Cleere, N. (1999). Family Caprimulgidae (Nightjars). In 'Handbook of the Birds of the World. Vol. 5. Barn Owls to Hummingbirds'. (Eds J. del Hoyo, A. Elliot, and J. Sargatal.) pp. 302–386. (Eds Linx Edicions: Barcelona.)
- Coleman, P. J. (1980). Plate tectonic background to biogeographic development in the south-west Pacific over the last 100 million years. *Paleogeography, Paleoclimate and Paleoecology* **31**, 105–121.
- Collar, N. J., Crosby, M. J., and Stattersfield, A. J. (1994). 'Birds to Watch 2: the World List of Threatened Birds.' (BirdLife International: Cambridge, UK.)
- Debus, S. J. S. (1996). Family Turnicidae (Buttonquails). In 'Handbook of the Birds of the World. Vol. 3. Hoatzin to Auks'. (Eds J. del Hoyo, A. Elliot, and J. Sargatal.) pp. 44–59. (Lynx Edicions: Barcelona.)
- Delacour, J. (1966). 'Guide des Oiseaux de la Nouvelle Calédonie.' (Delachaux et Nestlé: Neufchâtel.)
- Diamond, J. H. (1984). Historic extinctions: a Rosetta stone for understanding prehistoric extinctions. In 'Quaternary Extinctions'. (Eds P. S. Martin and R. G. Klein.) pp. 824–862. (University of Arizona Press: Tucson.)
- Disney, H. J. (1974). Survey of the Woodhen. In 'Environmental Survey of Lord Howe Island'. (Eds H. F. Recher and S. S. Clark.) Appendix G. (Government Printer: Sydney.)
- Dupon, J. F. (1986). The effect of mining on the environment of high islands: case study of nickel mining. In 'New Caledonian Environmental Case Studies, South Pacific Study'. (SPREP: Nouméa.)
- Ekstrom, J. M. M., Jones, J. P. G., Willis, J., and Isherwood, I. (2000). Humid forests of New Caledonia: biological research and conservation recommendations for the vertebrate fauna of Grande Terre. CSB Conservation Publications, Cambridge, UK.
- Farjon, A., Page, C. N., and Schellevis, N. (1993). A preliminary world list of threatened conifer taxa. *Biodiversity and Conservation* **2**, 304–326.
- Fullagar, P. J. (1985). The woodhen of Lord Howe Island. *Avicultural Magazine* **92**, 15–30.
- Garnett, S. T., and Crowley, G. M. (2000). 'The Action Plan for Australian Birds 2000.' (Environment Australia: Canberra.)
- Goodwin, D. (1970). 'Pigeons and Doves of the World.' (British Museum (Natural History): London.)
- Hannecart, F., and Létocart, Y. (1980–83). 'Oiseaux de Nouvelle Calédonie et des Loyautés.' (Editions Cardinalis: Nouméa.)
- Holyoak, D. T. (1999). Family Aegothelidae (Owllet-nightjars). In 'Handbook of the Birds of the World. Vol. 5. Barn-owls to Hummingbirds'. (Eds J. del Hoyo, A. Elliott and J. Sargatal.) pp. 266–265. (Lynx Edicions: Barcelona.)
- Hunt, G. R. (1996). Environmental variables associated with population patterns of the Kagu *Rhynochetos jubatus* of New Caledonia. *Ibis* **138**, 778–785.
- Hunt, G. R., Hay, R., and Veltman, C. J. (1996). Multiple Kagu *Rhynochetos jubatus* deaths caused by dog attacks at a high-altitude study site on Pic Ningua, New Caledonia. *Bird Conservation International* **6**, 295–306.
- Jaffré, T., and Veillon, J.-M. (1988). Morphologie, distribution et ecologie des palmiers de Nouvelle Calédonie. Rapports Scientifiques et Techniques (Sciences de la Vie: Botanique), 2. ORSTOM, Nouméa.
- Jaffré, T., Veillon, J. M., and Pintaud, J. C. (1997). Comparaison de la diversité floristique des forêts denses humides sur roches ultramaïques et sur substrats différents en Nouvelle-Calédonie. In 'Ecologie des Milieux sur Roches Ultramaïques et des Sols Metalifères'. (Eds T. Jaffré, R. D. Reeves and T. Becquer.) pp. 163–170. (ORSTOM: Nouméa.)
- Jourdan, H. (1997). Threats on Pacific islands: the spread of the tramp ant *Wasmannia auropunctatus* (Hymenoptera: formicidae). *Pacific Conservation Biology* **3**, 61–64.
- Juniper, T., and Parr, M. (1998). 'Parrots: A Guide to the Parrots of the World.' (Pica Press: Robertsbridge, UK.)
- Landolt, R. (1987). Comparative functional morphology of the intestinal tract in pigeons with special reference to the adaptive radiation of the fruit pigeons. Part I. *Zoologische Jahrbücher* **116**, 169–215.
- Layard, E. L., and Layard, E. L. C. (1882). Notes on the avifauna of New Caledonia, a catalogue of the birds of the island with remarks by the Rev. Canon Tristram. *Ibis* (4th series) **6**, 493–546.
- Létocart, Y. (1998). Observations par radio-tracking des comportements du Notou dans le parc de la Rivière Bleue. Polycopié, Province Sud, DRN.
- Létocart, Y., and Salas, M. (1997). Spatial organisation and breeding of Kagu *Rhynochetos jubatus* in Rivière Bleue Park, New Caledonia. *Emu* **97**, 97–107.
- Lowry, P. P. (1998). Diversity, endemism and extinction in the flora of New Caledonia: a review. In 'Rare, Threatened and Endangered Floras of Asia and the Pacific Rim'. (Eds C.-I. Peng and P. P. Lowry.) Institute of Botany, Academia Sinica Monograph Series **16**, 181–206.
- Marsden, S. J. (1999). Estimation of parrot and hornbill density using a point count distance sampling method. *Ibis* **141**, 377–390.
- Macmillan, L. (1939). Notes sur les oiseaux des Iles Loyauté. *Bulletin Periodicale Société Melanesienne* **2**, 30–41.

- Maruia, C. I. (1998). 'Conserving Biodiversity in Province Nord, New Caledonia.' (Conservation International and Maruia Society: Washington, DC.)
- Mayr, E. (1941). Birds of the Whitney Expedition: a new nightjar from New Caledonia. *American Museum Novitates* **47**, 1152.
- Mayr, E. (1945). 'Birds of the Southwest Pacific.' (MacMillan: New York.)
- Miller, B., and Mulleter, K. J. (1985). Rehabilitation of an endangered Australian bird: the Lord Howe Island Woodhen *Tricholimnas sylvestris* (Sclater). *Biological Conservation* **34**, 55–95.
- Mittermeier, R. A., Werner, T. B., and Lees, A. (1996). New Caledonia — a conservation imperative for an ancient land. *Oryx* **30**, 104–112.
- Morat, P. (1993). Our knowledge of the flora of New Caledonia: endemism and diversity in relation to vegetation types and substrates. *Biodiversity Letters* **1**, 72–81.
- Morat, P., Jaffré, T., Veillon, J. M., and Mackee, H. S. (1981). 'Végétation. Atlas de la Nouvelle-Calédonie et Dépendances.' (ORSTOM: Paris.)
- de Naurois, R. (1982). Sur le statut passé et present des merles (*Turdus poliocephalus*) de Nouvelle-Calédonie et îles voisines. *Revue Française d'Ornithologie* **52**, 153–170.
- Olson, D. M., and Dinerstein, E. (1998). The Global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. *Conservation Biology* **12**, 502–515.
- Pratt, T. K. (2000). Evidence of a previously unrecognized species of owl-nightjar. *The Auk* **17**, 1–11.
- Pavlov, P. M., Crome, F. H. J. and Moore, L. A. (1992). Feral pigs, rainforest conservation and exotic diseases in North Queensland. *Wildlife Research* **19**, 179–193.
- Robinet, O., Beugnet, F., Dulieu, D., and Chardonnet, P. (1995). The Ouvéa parakeet – state of knowledge and conservation status. *Oryx* **29**, 143–150.
- Sarasin, F. (1913). Die Vogel Neu-Caledoniens und der Loyalty inseln. In 'Forschungen in Neu-Caledonien und auf den Loyalty Inseln'. (Eds F. Sarasin and J. Roux.) pp. 1–78. [Nova Caledonia (A), Zoologie. Vol. 1.] (CW Kriedets Verlag: Berlin.)
- Seitre, R., and Seitre, J. (1992). Causes of landbird extinctions in French Polynesia. *Oryx* **26**, 215–222.
- Sibley, C. G., and Monroe, B. L. (1990). 'Distribution and Taxonomy of Birds of the World.' (Yale University Press: New Haven.)
- Solem, A. (1964). New records of New Caledonian non-marine mollusks and analysis of the introduced mollusks. *Pacific Science* **18**, 130–137.
- Stattersfield, A. J., Crosby, M. J., Long, A. J., and Wrege, D. C. (1998). 'Endemic Bird Areas of the World: Priorities for Biodiversity Conservation.' (BirdLife International: Cambridge, UK.)
- Steadman, D. W. (1995). Prehistoric extinctions of Pacific Island birds: biodiversity meets prehistory. *Science* **267**, 1123–1131.
- Stokes, T. (1978). On the possible existence of the New Caledonian Wood Rail *Tricholimnas lafresnayanus*. *Bulletin of the British Ornithological Club* **99**, 47–54.
- Stokes, T. (1979). Notes on the landbirds of New Caledonia. *Emu* **80**, 81–86.
- Tobias, J., and Ekstrom J. M. M. (2002). The New Caledonian Owllet-nightjar *Aegotheles savesi* rediscovered? *Bulletin of the British Ornithologists Club*, in press.
- Toone, B., Ellis, J. S., Wirth, R., and Seal, U. S. (1993). Conservation assessment and management plan for pigeons and doves: report from a workshop, 10–13 March 1993, San Diego, CA. ICBP Pigeon and Dove Specialist Group and IUCN/SSC Captive Breeding Specialist Group.
- White, C. M. N., and Bruce, M. D. (1991). 'The Birds of Wallacea.' (Checklist No. 7.) (The British Ornithological Union.: London.)
- Warner, D. W. (1947). The ornithology of New Caledonia and the Loyalty Islands. Ph.D. Thesis, Cornell University, USA.

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