The field discovery, ecology, monitoring and conservation of an enigma: Bruijn’s Brush-turkey *Aepypodius bruijnii* Oustalet 1880

**By Iwein Mauro**

Final report to *Van Tienhoven Foundation* for International Nature Protection and *WPA/BirdLife/SSC Megapode Specialist Group*
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1. Introduction | Bruijn’s Brush-turkey *Aepypodius bruijnii*, is endemic to the island of Waigeo (c. 3,100 km²; S 0°12’, E 130°45’; see Fig. 1) at the northern end of the Raja Ampat archipelago in Indonesian New Guinea. The species became known from 23 historical trade specimens that reached museum cabinets between 1880 and 1904, through the services of the Dutch merchant, A. A. Bruijn, and his indigenous collectors (Oustalet 1880; Jones *et al.* 1995; Voisin *et al.* 2000; Dekker 2000; Moeliker *et al.* 2003). Many of these specimens were labeled ‘Waigeo’ but subsequent authors (Rothschild *et al.* 1932; Peters 1934) queried whether this island was the species’ homeland. This doubt appeared justified considering that 15 ornithological expeditions between 1793–1937 failed to record the species on Waigeo (Rothschild *et al.* 1932; Rand and Gilliard 1967; Frith and Beehler 1998), and Bruijn was notorious for his inexact labeling practices (De Schauensee 1940a). However, Bruijn’s Brush-turkey was rediscovered on Waigeo in 1938 when J. Kakiaij — S. D. Ripley’s Misoolese field assistant, back from the days of the Denison-Crockett Expedition — collected a female specimen from Jeimon on the east side of Mayalibit Bay (see Fig. 1), at the behest of the Academy of Natural Sciences, Philadelphia (De Schauensee 1940a). Another six expeditions between 1948 and 2000 failed to record the species in the wild, despite prevailing confidence that Bruijn’s Brush-turkey still existed on the island (see e.g. Jones *et al.* 1995; Dekker *et al.* 2000; BirdLife International 2000). Finally, in February 2001, local hunters presented the head and gnawed bones of a female they had hunted and consumed to a local contact person working for the operation ‘Waigeo Expeditions’ (Heij and Post 2001). Subsequent searches at the locality where the bird had been hunted yielded no success: again Bruijn’s Brush-turkey could not be located in the wild.

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1 P.O. Box 289, 98401 Sorong, Indonesia, E-mail: iweinmauro@gmail.com
2 Bruijn’s Brush-turkey *Aepypodius bruijnii* was named after the immortal Dutch merchant of Ternate, Anton August Bruijn — a dealer in almost every product that the Moluccas and Vogelkop region had to offer, including natural history specimens — who’s indigenous collectors stood at the origin of the collection of likely all but one of a staggering 24 historical museum specimens known from this species.
3 Contrary to what Heij and Post (2001) appear to suggest, there has never been even the slightest subsequent doubt regarding the provenance of Kakiaij’s specimen, part of a collection of 268 skins that he personally secured from five traceable localities on Waigeo plus offshore Saonek I. (De Schauensee 1940ab).
4 The ‘Waigeo Expedition 2001’ gave up after a three days’ search of the exact spot where local hunters had previously caught the bird (Heij and Post 2001).
Figure 1. Waigeo and key localities.

Thus, 22 historical ornithological expeditions and modern reconnaissance visits, and two rediscoveries (De Schauensee 1940; Heij and Post 2001) in spite, Bruijn’s Brush-turkey remained entirely unknown in the living world during more than 120 years between its formal description and its ultimate field discovery by the author on Mount Nok in May 2002 (Anonymous 2002ab; Mauro 2002). Any comment on the species’ conservation status remained tentative in the absence of biological information hitherto. Its treatment was precautionary by default, varying primarily in response to ever more stringent evaluation criteria. Thus whereas a comfortable population surmise of 100–2,500 individuals sufficed to classify it as Endangered by the criteria of the Mace-Lande system (Mace and Lande 1991; Dekker and McGowan 1995), more stringent IUCN Red List criteria (IUCN 1994) later dictated that its population inference could no longer exceed 1,000 mature individuals in order to warrant precautionary listing as Vulnerable under criterion D1 (Dekker et al. 2000; BirdLife International 2000, 2001). Downgrading thus occurred due to semantic variance, not as a result of improved understanding of the species’ biology and population dynamics.

Here I report on the field discovery, ecology, monitoring and conservation of Bruijn’s Brush-turkey, following prolonged surveys in the previously ornithologically unexplored mountains of Waigeo. I describe its appearance, vocalizations and behavior in the field. Bruijn’s Brush-turkey belongs to the megapodes Megapodiidae, a family renowned for its exceptional incubation strategy, exploiting environmental heat sources and exhibiting no parental care (overview in Jones et al. 1995). Within the megapodes, the genus Aepypodius, which further only comprises one species, the Wattled Brush-turkey A. arfakianus of continental New Guinea and Misool, and the monotypic genus Alectura, erected for the Australian Brush-turkey A. lathami, are the most closely related genera (henceforth collectively called ‘the brush-turkeys’; Jones et al. 1995; Birks and Edwards 2002). Based on its generic affinities, Bruijn’s Brush-turkey had previously

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8 Mt. Nok, also known as Mt. Buffelhorn, is Waigeo’s third highest peak (see Table 3, Fig. 7; contra Post 2001, Heij and Post 2001, Moeliker 2002abc, Moeliker and Heij 2002, and Moeliker et al. 2003, who erroneously state this to be the highest point on the island.)
widely been speculated to build heaps of leaf litter and other organic material (henceforth called ‘incubation mounds’ or simply ‘mounds’), in which the heat produced by microbial decomposition incubates the eggs. Here I provide the first descriptions of its mounds at different stages of development. I further provide circumstantial evidence for its presumed male resource-defence polygyny and polyandry mating system, uniquely among the megapodes rooted within the closely allied New Guinean and Australian brush-turkey genera *Aepyprymnus* and *Alectura*. In the brush-turkeys, adult male territoriality is assumed to centre on the mound and vocal advertisement is restricted entirely to the mating season proper and may primarily be associated with sexual display on or in the immediate vicinity of the mound (Jones *et al.* 1995; Sinclair 2002; I.M. unpublished data). The number of reproductively mature males capable of permanently defending a mound is the single most relevant population unit to conservation assessment in a male resource-defending promiscuous megapode given that exactly these males secure virtually all copulations, and monopolize the chance of successful progeny (see Jones 1990ab). Here, I also assess this critical population parameter, and explore the conservation status and needs of this truly enigmatic taxon.

Table 1. Survey effort at key study sites on Waigeo.

<table>
<thead>
<tr>
<th>Study site</th>
<th>Camp altitude (m)</th>
<th>Camp coordinates (WGS ’84)</th>
<th>Study period</th>
<th># field days</th>
<th>Person-hour search effort</th>
<th>Altitude covered (m)</th>
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</thead>
<tbody>
<tr>
<td>Saporkren area</td>
<td>140</td>
<td>S 0°26’16” E 130°43’46”</td>
<td>09–21.04.02</td>
<td>10</td>
<td>160</td>
<td>0–235</td>
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<tr>
<td>Waifoi coastal forest</td>
<td>0</td>
<td>S 0°05’59” E 130°42’51”</td>
<td>31.05–02.06 / 17–18.11.02</td>
<td>5</td>
<td>200</td>
<td>0–100</td>
</tr>
<tr>
<td>Cempedak Camp</td>
<td>345</td>
<td>S 0°05’13” E 130°44’12”</td>
<td>29.04–12.05.02</td>
<td>14</td>
<td>560</td>
<td>280–665</td>
</tr>
<tr>
<td>Mt. Nok Base Camp</td>
<td>730</td>
<td>S 0°04’57” E 130°45’43”</td>
<td>14–28.05 / 05–16.11.02</td>
<td>27</td>
<td>944</td>
<td>465–880</td>
</tr>
<tr>
<td>Mangkawan Hills Camp</td>
<td>140</td>
<td>S 0°06’18” E 130°47’11”</td>
<td>21–26.10.02</td>
<td>7</td>
<td>280</td>
<td>140–340</td>
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<tr>
<td>Waremag River Camp</td>
<td>30</td>
<td>S 0°07’16” E 130°46’16”</td>
<td>27–28.10 / 04.11.02</td>
<td>3</td>
<td>120</td>
<td>30–60</td>
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<tr>
<td>Mobit Hills Camp</td>
<td>285</td>
<td>S 0°08’05” E 130°47’06”</td>
<td>29.10–03.11.02</td>
<td>6</td>
<td>240</td>
<td>285–560</td>
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<tr>
<td>Mt. Sau Lal Camp</td>
<td>780</td>
<td>S 0°02’34” E 130°50’45”</td>
<td>20.11–16.12.02 / 14–21.05.03</td>
<td>35</td>
<td>1,336</td>
<td>500–970</td>
</tr>
<tr>
<td>Wekabau Ridge Camp</td>
<td>780</td>
<td>S 0°02’55” E 130°51’49”</td>
<td>22.05.03–13.06.03</td>
<td>23</td>
<td>736</td>
<td>500–930</td>
</tr>
</tbody>
</table>

2. Methods

During a pilot survey of Mt. Nok, spanning the period 29 April–2 June 2002, I discovered an active incubation mound of Bruijn’s Brush-turkey. I monitored this mound from a well-concealed hide, erected 7.5 m distant, for a total of 91 hours spread over 13 consecutive mornings from 15 to 27 May (see Table 1; Fig. 1), standardized between first light 05:30 and 12:30. No significant rainfall occurred during this period. However, heavy and prolonged downpours had occurred daily between 6 and 11 May, before observations commenced. I further systematically searched cloud-forest in the summit area for additional mounds during 78 field hours between 14 and 28 May.

Resulting novel insights into the species’ broad habitat requirements and conservation needs (Mauro 2002; Anonymous 2002a, 2002b) served as the basis for follow-up field work at the request of the WPA/BirdLife/SSC Megapode Specialist Group in October–December 2002, bringing to light the existence of a viable population of the species (Mauro 2003; Dekker 2003), and again in May–June 2003. I timed new field work based on: (1) Information that Waigeo receives an annual rainfall of 1,500–2,000 mm (van Royen 1960), most of which falls in a distinctive wet season from December through to May (local information). (2) The finding that elsewhere in seasonally humid environments the onset of breeding for mound-building megapodes is defined by local precipitation regimes (Jones *et al.* 1995). (3) My own observation that incubation was in progress on Mt. Nok in mid-May 2002 (Mauro 2002).
Severe drought conditions, exacerbated by the El Niño warm episode of an ENSO weather disturbance, however, afflicted the region during 14 consecutive months spanning June 2002 and July 2003. The vegetation of the entire Raja Ampat regency showed signs of drought stress by November–December 2002 (Takeuchi 2003), and I noted rainfall only on seven out of 87 field days during this period. At higher elevations, drinkable water was confined to localized stagnant pools, a condition which evidently determined our daily action radius.

Reproductive and vocal activity in the Bruijn’s Brush-turkey was not forthcoming hence I relied exclusively on qualitative mapping of its mounds to assess population status. Assisted by a variable team of local hunters, I performed a systematic and exhaustive search in the Mobit and Mangkawan Hills, on Mts. Nok and Sau Lal (see Table 1; Fig. 1). Except for the western slopes of Mt. Sau Lal, where post-fire successional low-stature scrub and pioneering woodland occur up to an elevation of 820 m locally, the predominant vegetation everywhere was multi-storied, closed-canopy primary forest, details of which will appear elsewhere. In total, inclusive of the pilot surveys, I searched 4,576 person-hour; initially within every altitudinal belt, later on mainly confined to the increasingly tested and confirmed altitudinal breeding distribution. I spot-mapped each mound using GPS and a barometric altimeter, concisely described (and, if deemed desirable, photographically documented) its main physical characteristics, and assigned it to one of four distinctive phases through which the mounds of this species normally pass: Construction Phase, Active Phase, Collapsed Phase and Spread-out Phase (see Chapters 3.2 and 4.2). By repeating this procedure over disjunct survey periods, I obtained static snapshots that provide insight into spatio-temporal distribution and utilization of incubation sites. I also described the main physical characteristics of mound sites, with special reference to distances from ridgetops and suspected permanent and temporary water sources, gradient, and aspect of the site. No further attempts were made to study individual mounds from a hide as had previously successfully been undertaken during the pilot surveys (Mauro 2002).

Incubation mounds are readily traceable for long periods of time beyond the mating season proper, likely the only time of year when mound-tending males of Bruijn’s Brush-turkey do become territorially vocal. Moreover, from the state in which a given mound is encountered, and through careful comparison to possibly others in its vicinity, much relevant information may still be retrieved. Furthermore, because it is the males that site, construct, tend and own the mounds in the Bruijn’s Brush-turkey, and a given mound can only reasonably have one owner at a time, and on the critical condition that the possibility of synchronically tended mounds by the same male can be reliably discounted, an opportunity emerges to arrive at a reasoned count of the total number of sexually mature males within that given subpopulation that are capable of permanently defending a mound (i.e. the single population unit most relevant to conservation assessment in a male resource-defending promiscuous megapode), and by inference the total world population. I used both Garmin® E-trex™ and E-trex Vista™ handheld units, which performed reasonably for the purpose of this study chiefly on heavy tree-covered ridges. By design, only WAAS-enabled data points (accuracy <3 meter, 95% typical with DGPS correction) and those with accuracy down to <15 meter (95% typical) were withheld. Elevation data were acquired through the barometric altimeter function provided on the E-trex Vista in combination with a barometric altimeter on the Casio 1470 PRT-40, initially calibrated at sea level before each climb, later recalibrated at mean camp elevation prior to each excursion. I averaged out barometric variation as much as possible by calculating the mean of multiple readings of both devices spread over different times of day, which further explains the slight discrepancy to previously stated preliminary data for Mt. Nok (Mauro 2002; Anonymous 2002ab).

In retrospect, such laborious qualitative limited resource mapping would anyhow have been desirable since: (1) both the population of Bruijn’s Brush-turkey and the extent of its breeding habitat are comparatively small and manageable with a group of motivated searchers; and (2) for reasons that we were unable to quantify within the given time-frame, the spatial distribution of its mounds was truncated in many seemingly suitable environments indicating that highly specialized ecological and behavioral requirements determine selection of incubation sites and associated establishment of adult male territories.
Descriptions of bare parts, vocalizations, body and locomotion postures, and general behavior result from both detailed observations at the mound under surveillance in May 2002 and casual encounters in the field during subsequent active searches.

Semi-structured interviews were taken from 53 local informants (questioned in Indonesian by I.M.) in order to gain insight into local knowledge about Bruijn’s Brush-turkey. Throughout, I have adopted Indonesian spelling for toponyms in the indigenous, spoken languages on Waigeo. Thus, it is Mayalibit instead of Majalibit Bay, Kabarei instead of Kabarai or Kabaray, and Manuram instead of Manoeram or Manooram I. for instance.

Sound recordings were produced using a Marantz PMD-222 conventional tape recorder with a Sennheiser ME-66 directional microphone. The mono analogue recordings subsequently were digitized in Adobe Audition 1.0 (© Adobe Systems Inc., 1992-2003) at a sample frequency of 96 kHz and a 24 bit resolution through an M-Audio Audiophile USB interface. Analysis was performed using Syrinx 2.3s (© J. Burt, 1995-2003).

Given that Bruijn’s Brush-turkey and the only other megapode on the island, Dusky Megapode Megapodius freycinet, breed in complete vertical parapatry (see Chapter 3.6), the issue of assigning mounds to species (e.g. Sinclair 2001, 2002) does not arise and mounds could thus be assigned to Bruijn’s Brush-turkey unambiguously. A nomenclatural problem does, however, pose itself with regard to the status of the incubation mound.9 Sinclair (2001, 2002) defined ‘active’ mounds broadly as ‘containing fresh organic material raked from the surrounding forest’, a condition under which incubation of eggs cannot expressly be inferred and indeed was not in progress during this study. Here I restrict the term ‘active’ mound to the period of thermal stability of the mound, recognizable on account of its characteristic plateau shape (cf. maintenance phase in Jones 1988b), during which incubation of eggs may take place. I further considered mounds to be ‘tended’ whenever there was evidence of them being manipulated, from the spreading out of the compacting material of a cooled mound onward.

The lowest altitude at which I recorded a mound of Bruijn’s Brush-turkey was 620 m (see Chapters 3.6 and 3.7). Adopting this as an altitudinal cut-off, I delineated in a Study Area (henceforth SA) for Mts. Nok and Sau Lal the external boundary of breeding habitat realistically suitable to the species through exclusion of geomorphologically unsuited terrain by means of combining GPS-waypoints, sketch-mapping and panoramic photography. Within the Mt. Sau Lal SA I also mapped broad habitat types. I applied Minimum Spanning Tree, Nearest Neighbor and Delaunay/Dirichlet (Voronoy Polygon) Tesselation connection schemes (Rosenberg 2001) to describe and analyse spatio-temporal distribution of incubation sites within the Mt. Sau Lal SA. Spatial analysis and visualization was performed using Passage 1.1.1.3 (© M. S. Rosenberg, 1998-2003) and Mapinfo Professional 6.0 (© Mapinfo Corp., 1985-2000). Quoted distances are spherical (geodesic) not taking into consideration slope.

I used the unedited NGA-NASA SRTM-3 three arc-second resolution digital elevation model to assess distribution and extent of land above 620 m elevation on

9 Because great discrepancies exist between the duration of mound attention and the actual period that sexual activity and egg-laying take place, and since incubation is inherently difficult to detect without proper in situ effort, the definition of the breeding season even in mound-building megapodes often is both arbitrary and pragmatic. As Jones et al. (1995) have pointed out, most literature references as to that indeed simply relate to sightings of birds at incubation sites, so that genuine breeding in fact largely remains unsubstantiated and quite possibly still considerably obscured in many species. Generally, the comparative study of all breeding-related aspects in mound-building megapodes would benefit from the implementation of a standard homologous terminology adequately dealing with the dichotomy of mound attendance versus sexual activity and incubation proper.
Waigeo, and estimate the species’ breeding range and total world population. However, SRTM-3 derived 620 m contour surfaces for Mts. Nok and Sau Lal exceeded their corresponding manually delineated SAs by factor 2.05 and 1.47 respectively, and application of SA densities to SRTM-3 surfaces would thus return grotesque population overestimates. Therefore, I applied correction factors C<2 km² = 0.49 to small relics <2 km² and C>2 km² = 0.68 for SRTM-3 surfaces >2 km² based on the proportional SA/SRTM-3 discrepancy for the relict Mt. Nok and the sizeable Mt. Sau Lal respectively. I calculated a single most parsimonious population estimate applying the observed mound-territory/km² density for Mt. Nok D<2 km² = 4.01 to SRTM-3 relics <2 km², and the mean for primary forest on Mt. Sau Lal D>2km² = 9.19 to surfaces >2 km². I removed from further analysis 20 SRTM-3 620 m relicts averaging 0.09 km² (± 0.1; 0.003–0.39 km²; n = 20) and totaling 1.78 km² that were too tiny to hold a single territory at the applicable D<2 km² density. Based on the mean impact of the most serious threatening process (see Chapter 4.11), I further considered separate 620 m contours <3.5 km apart and interconnected through a ridge not descending below 450 m as a single ‘location’ in the sense of the IUCN Red List categories and criteria (IUCN 2001), and throughout use the term only in this specific sense. Finally, I estimated extent of occurrence (EOO) by minimum convex polygon (MCP) around locations, and area of occupancy (AOO) by 4 km²-cell grid-mapping of known records excluding cases of vagrancy (IUCN 2001; 2003).

3. Results

3.1. The field discovery of Bruijn’s Brush-turkey

On 14 May 2002 at 13:20, just one hour after reaching cloud-forest on the eastern spine of Mt. Nok, I located an active incubation mound (see Fig. 2c) at 715 m elevation that I instantly recognized and pointed out to my unsuspecting local field assistants (contra Moeliker and Heij 2002) as pertaining to Bruijn’s Brush-turkey (Mauro 2002; Anonymous 2002ab) on the strength of previous personal field experience with the Wattled Brush-turkey (see Chapter 3.2). The mound in question was found in the distinctive conical steep-sided and flat-topped plateau shape (see Chapter 3.2), lacking central depression but with a fresh outside layer consisting mainly of leaf litter, lamped-down just recently, so that its immediate surroundings were entirely scraped bare (see Fig. 2c). There was a narrow, ill-defined trod-down path leading away from the mound for c. 8 m before petering out completely, near the beginning of which I picked up a freshly dropped chestnut contour-feather.
pertaining to the mound-owner’s rump. Of course, from such fortunate circumstances it was obvious at the double that it could only be a matter of time before I would feast my eyes on this nearly mythical species.

The first sighting was made from the hide on 16 May at 06:38 when one Bruijn’s Brush-turkey walked into view along the path to my left, instantly noticed the hide and spent the next c. 30 seconds standing Alert (see Chapter 3.5) stock-still at point-blank range in front of it, closely observing the alien element whilst constantly uttering, at first relatively explosive, later on subdued, Anxiety Clucks (see Chapter 3.4), each time synchronically nodding its head forward. The bird was instantly identified as this species on account of its large body size, roughly 50% larger than Dusky Megapode (not seen in direct comparison), the powerful legs and very long tarsi, the long tail-projection, tail held level with horizontally kept body, its predominantly dusky brown plumage with contrasting maroon rump, the rounded nostril, the flesh- to pale-salmon-colored bare skin of face and neck, and the presence of a bright pink, protracted neck sack, comb and nape shield extending in a short lobe on each side of the neck (see Table 2). The presence of these structural head appendages readily identified the bird as an adult male (see e.g. Jones et al. 1995), these appendages being absent or minute in young males and females (henceforth collectively called female types). It then ran downhill out of sight, head and body dipped forward, Tail Spread (see Chapter 3.5), downhill to the left out of sight.

On 17 May the male appeared in front of the hide twice. It first walked in along the path at 06:40 and during the next c. 6 min alternated between silently standing still and sauntering to and fro in between the mound and the hide while constantly keeping an eye on the latter. It then slowly walked away downhill and reappeared from the same direction at 08:50. It now quietly and very slowly walked around the hide twice, and c. 5 min later disappeared again in the same direction it had come from at dawn, along its habitual path.
Field discovery of Bruijn's Brush-turkey Aepypodius bruijnii
The male did not visit the mound in the mornings of 18–19 May. On 20 May, however, I observed the male working on its mound for 23 minutes from 06:28 till 06:51. Again it arrived along the usual path but now seemingly unconcerned readily ascended the relatively steep and unstable sides of the mound with Wings Raised (see Chapter 3.5), presumably for stability. It slowly circled the rim of the mound’s plateau, its head down, while occasionally Scratching (see Chapter 3.5) the upper surface, stalking and pecking at small invertebrate items without swallowing them. It then suddenly halted and weakly flapped its wings without whirring during c. 3 seconds, simultaneously juddering its body and fanned tail laterally, presumably to shake off dew drops falling copiously from the canopy upon each gust of wind. Next it started to dig a hole in the center of the plateau, first by scraping backward from the center outward on all sides as to loosen and ripping the tamped-down litter open, subsequently by grasping the material in between the toes and in single rather stiff, mechanical, almost crane-like movements slowly hoisting and depositing this on the rim. The male then entered the test hole where its activities for the next c. 2 min took place imperceptibly from the position I was sitting, not so much due to the depth of the pit itself but simply because all this time the bird stood almost motionless, head down, wings held close to its body, and dorsum turned towards me. Promptly upon leaving the hole, the male proceeded to working removed material back into it, now reversing the modes just described. Subsequently it alternately circled and traversed the plateau in all directions for the next c. 5 min, in so doing gradually restoring the mound’s prior flat-topped, trod-down apex. Finally, the male descended the mound, Wings Raised briefly, and vacated the site right away to the left again. Here it returned briefly at 09:38, walking across in front of the mound once more, before disappearing again into the same direction along its usual path. This was the last observation of the male at the mound, despite seven subsequent standardized observation sessions.15

Observations of brush-turkeys away from the mound were made on 17 May at 15:09, when I disturbed a male at a distance of c. 120 m from the mound under surveillance, near a wallow of wild boar Sus scrofa. Also on the same day, I spotted a female type individual running away near camp at 18:09. On 18 and 19 May I also heard and glimpsed a single undetermined bird near camp toward dusk, in an area where I would later, in November, observe a male ascending its roosting tree (see Chapter 3.5). And on 25 May at 15:46, a female type individual was seen running away on its own near camp.

3.2. Description of incubation mounds

Figure 2a–e illustrates dissimilar incubation mounds of Bruijn’s Brush-turkey under varying conditions. Although not a single mound was actually observed to progress through the entire recycling process described below, the distinctive states through which the mounds of this species normally pass, were readily reconstructed from static snapshots obtained over disjunct survey periods and, by analogy, from an earlier account on the Australian Brush-turkey by Jones (1988b). The mounds of Bruijn’s Brush-turkey generally bore close resemblance to the corresponding phases of those constructed by its sister species, the Wattled Brush-
turkey, as known from the literature (Mayr 1930; Jones et al. 1995; Sinclair 2001) and from direct observations of the population inhabiting the Arfak Mountains on the Bird’s Head Peninsula of Indonesian New Guinea (I.M. unpublished data).

During initial construction (cf. construction phase in Jones 1988b), mounds of Bruijn’s Brush-turkey remain typically gently sloping, semi-elliptical to hemispherical, unstructured, loose piles of accumulating debris (Construction Phase; Fig. 2a). Measured mounds encountered in various stages of construction progress averaged 3.03 m (± 0.21; 1.9–4.1 m; n = 10) in basal length, 2.52 m (± 0.20; 1.8–3.6 m; n = 10) in basal width, and 0.52 m (± 0.05; 0.2–0.8 m; n = 10) in height. Assuming that these are spherical caps, mean volume was 1.81 m$^3$ (± 0.32; 0.38–3.6 m$^3$; n = 10). A compacted, decomposing mound, prematurely abandoned in its Construction Phase is presented in Figure 2b (see Fig. 2b).

Mounds subsequently change shape to a characteristic, relatively steep-sided, flat-topped or slightly concave, tamped-down plateau (cf. maintenance phase in Jones 1988b)14 preserved throughout incubation proper. Figure 2c shows the first mound of Bruijn’s Brush-turkey to be disclosed to science and, unfortunately, the only active mound found during the course of my work (Active Phase; see Fig. 2c). It reached a maximum height of 1.2 m on its round plateau 1.1 m in diameter and featured an elliptical basal area 2.1 m in width and 2.6 m in length. Assuming that it is a truncated cone, its volume is 2.93 m$^3$. Active Phase is characterized by regular mixing of litter into the mound or application of an exterior insular layer so that the mound’s surroundings are scraped clean.

Saturation and subsequent cooling of the mound lead to its abandonment, subsidence and collapse over time. Figure 2d presents the same mound as in Figure 2c but now in Collapsed Phase 184 days later (Collapsed Phase; see Fig. 2d). There was some evidence of continued sporadic low-level manipulation in all examined dilapidated mounds, ranging from occasional scraping to extensive digging, presumably to prevent vegetation from taking root in the compacted humificating mound. Consequently, incubation mounds became relatively messy, irregular-shaped, often with deep digging holes in their former plateaus, with a mean basal area 3.08 m (± 0.13; 2.5–3.5 m; n = 8) long and 2.61 m (± 0.14; 2.2–3.3 m; n = 8) wide, and a mean height of 0.58 m (± 0.05; 0.3–0.7 m; n = 8).

Finally, the largely decomposed material is entirely spread-out, causing the basal mound area to increase to 3.52 m (± 0.10; 2.7–4.7 m; n = 39) in length and 3.01 m (± 0.09; 1.9–4.3 m; n = 39) in width, with a thin 10–25-cm layer suffocating any sprouting vegetation (Spread-out Phase; Fig. 2e). Even such compacting bases were subject to occasional manipulation such as digging, gradual mixing of the remaining decaying material, and scraping, thereby exposing and damaging underground roots. Compacted earthen bases probably remain traceable in the landscape for several years.

In line with the Wattled Brush-turkey (Mayr 1930; Jones et al. 1995; Sinclair 2001), active and recently cooled incubation mounds of Bruijn’s Brush-turkey were primarily composed of leaves, with a secondary woody component of twigs, sticks and branches. Six out of a total of 78 incubation mounds had been sited over a sizeable decaying fallen log, and one was located at the base of a still standing rotten trunk of man’s height, together comprising 8.97 % of cases. Mounds were mainly freestanding though often supported by saplings, young trees and, rarely, palms protruding out of their basal edges, usually on the downhill side if built on sloping terrain. Curiously, in 11 out of 75 disclosed incubation sites on Mt. Sau Lal, or 14.67 % of considered cases, the mound was situated under lone, individual conifers, including but not restricted to a species of Dacrycarpus (cf. D. imbricatus; W. Vink in litt., 3 May 2004), with a high proportion of their decomposition-resistant litter mixed into the mound (see Chapter

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14 The term Maintenance Phase (Jones 1988b) appears redundant given that various sorts of maintenance and manipulative actions continue to be associated with mound recycling in the Bruijn’s Brush-turkey. The appellations Active or Thermally Stable Phase may better cover the overtones.
3.6. Mature conifers appeared to be absent from the cloud-forest on Mt. Nok (see Chapter 3.6).

The smallest active mounds of the Dusky Megapode on Waigeo, although approaching those of Brujin’s Brush-turkey in size and shape generally (cf. Dekker and Argeloo 1993), nevertheless do remain diagnosable on account of their predominant proportion of humus.

Table 2. Structure and coloration of bare parts in adult male type Bruijn’s Brush-turkey Aepyopus bruijnii.

<table>
<thead>
<tr>
<th>Bare parts</th>
<th>Adult male type Bruijn’s Brush-turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>Dark brown, paler greish on tip, along culmen and mandibular tomium; entirely greyish-brown; entirely dark brown; nostril rounded; (n=10).</td>
</tr>
<tr>
<td>Mandible</td>
<td>Entirely dark brown; dark brown with paler greish mandibular tomium and gonys (n=10).</td>
</tr>
<tr>
<td>Iris</td>
<td>Hazel; light brown; dark brown; orangey; (n=6).</td>
</tr>
<tr>
<td>Orbital ring</td>
<td>Grey; olive-grey; brownish-grey; (n=5).</td>
</tr>
<tr>
<td>Legs</td>
<td>Dark brownish-green or greyish-green often gradually becoming brighter yellowish-green along rear edge of tarsus and sometimes on tibio-tarsal joint; (n=8).</td>
</tr>
<tr>
<td>Facial skin</td>
<td>Flesh-colored; pale salmon-colored; (n=16).</td>
</tr>
<tr>
<td>Neck skin</td>
<td>Flesh-colored; pale salmon-colored; (n=16).</td>
</tr>
<tr>
<td>Neck sack</td>
<td>Bright pink; invariably protracted and usually concealed by feathering of upper breast; (n=5).</td>
</tr>
<tr>
<td>Comb</td>
<td>Upper surface densely covered with bright pink wart-like papillae; comb widest but relatively lower on central forehead and gradually narrowing and becoming higher above and behind eye where merging with nape shield; (n=16).</td>
</tr>
<tr>
<td>Nape shield</td>
<td>Upper surface densely covered with bright pink wart-like papillae; when relaxed flattening and widening nape shield extends in short lobe on each side of neck; (n=16).</td>
</tr>
</tbody>
</table>

3.3. Bare parts of the adult male

When on 16, 18 and 20 May 2002 I watched a male Bruijn’s Brush-turkey at its incubation mound on Mt. Nok from a well-concealed hide for a total of 34 minutes at a distance ranging between 1.5–7.5 m, I was in fact the first observer to make detailed notes on the bare parts coloration and structural head appendages of a living individual of this species (contra Moeliker 2002bc and Moeliker and Heij 2002). Table 2 gives a detailed description of the bare parts of adult males, resulting from 16 sightings of at least seven different adult male-type individuals during the course of my work (see Table 2). These observations lasted up to 23 minutes and the birds were 1.5–25 m close. I found no difference in appearance during observations spread over three separate survey periods. This strongly suggests that there is no seasonal variation in coloration. Nor were there any apparent differences in facial tissue coloration in response to anxiety or stress (so-called ‘blushing’), suggesting that both pigmentation and capillary blood flow contribute to the unusual pink coloration of the bare head and its structural appendages.

3.4. Vocalizations

In conformity with its congener (e.g. Kloska 1986; Kloska and Nicolai 1988; Jones et al. 1995; I.M. unpublished data), Bruijn’s Brush-turkey proved to be ordinarily silent. Two different types of vocalizations recorded, were however directly associated with anxiety and distress. Most frequently uttered, was a short, weak to rather explosive, single cluck, lasting c. 0.1 seconds within the 0.51–4.7 kHz range, infrequently to constantly repeated, depending upon level of anxiety. Such Anxiety Clucks bore some resemblance, in tonal quality, to both nocturnal clucking of Red-
necked Crake *Rallina tricolor*, and aerial calls of Gurney’s Eagle *Aquila gurneyi*. In addition, a short c. 2 seconds series of loud Raucous Cackles twice accompanied a sudden, explosive whirring take-off from the forest floor, and may primarily be linked to conditions of extreme distress.

As with the other brush-turkeys, adult male territorial advertisement in the Bruijn’s Brush-turkey is likely restricted entirely to the mating season and may primarily be associated with sexual display on or in the immediate vicinity of an incubation mound. Unfortunately, since prolonged drought conditions caused complete cessation of breeding activities during my work, these territorial vocalizations and displays remain to be witnessed and adequately described.

### 3.5. Behavioral ecology

All visual and aural contacts with Bruijn’s Brush-turkey during the course of my work (*n* = 34) were of single individuals, which suggests that sexes live independently and solitarily, with no evidence of pair-bonds. Out of 25 closely observed birds, 23 were adult males and only two were female types. Nine contacts were either merely aural (*n* = 4) or too brief to ascertain presence/absence of structural head appendages (*n* = 5).

Contrary to the Wattled Brush-turkey, which readily flushes into trees upon disturbance (e.g. *Jones* *et al.* 1995; I.M. unpublished data), all casual encounters with Bruijn’s Brush-turkey on Mt. Nok during the pilot survey (*n* = 5) referred to solitary birds scurrying away on the forest floor, even when taken by surprise at very close range. Birds typically took to their heels head and body dipped forward, Neck Normal, slightly retracted up, or Semi-extended Horizontally, Tail Spread (see below). This striking deviation from the expected pattern led to the ‘merely speculative’ query in *Mauro* (2002) ‘whether the species might perhaps have evolved to a flightless form’. Subsequent observations, however, have revealed that, although the species is technically capable of short, labored flights, such an escape mode appears to be employed by means of last resort only and is generally inherently unpredictable. Out of 24 casual encounters, only in nine instances – seven of which determinably involved adult males – did birds disturbed from a distance of 7–25 m flush low, straight out, slightly downhill over a short distance of 15–30 m, once *c*. 80 m, typically ending up in trees 8–12 m above ground. The species’ flight invariably was labored, with rapid, powerful, whirring wingbeats, rather clumsy, sometimes momentarily dropping height simultaneously juddering its body as if struggling to gain height, and in all cases without glides even when flying down along the most precipitous of slopes. Subdued Anxiety Clucks sometimes preceded the sudden explosive whirring take-off from the forest floor, which twice was also accompanied by Raucous Cackles (see Chapter 3.4). In five instances it was possible to creep up on birds that had landed in trees, and note their demeanors. First, they pondered the situation from behind denser foliage, neck retracted up or semi-outstretched vertically, Tail Spread or Raised (see below). Next, they rather clumsily leaped upward along branches into the open, balancing their bodies with Wings Raised (see below), Tail Raised, occasionally still uttering anxiety calls, and finally flying out of sight, manoeuvring in between the myriad of gnarled branches that make up the canopy, not to be relocated subsequently.

The species roosts nocturnally in trees, solitarily as judged from the modest quantity of dropped faeces. Roosting trees (*n* = 5) stood in the vicinity (<40 m) of the incubation mound, once just above it. Monitoring from a hide on two consecutive evenings of one roosting tree, under which fresh excrements were found, failed to produce any sightings, suggesting that the species perhaps utilizes more than one tree. I found no evidence of diurnal roosting in trees.

The following preliminary general notes may be distilled regarding body and locomotion postures (cf. *Marchant* and *Higgins* 1993; *Jones* *et al.* 1995). Neck Normal: at rest, semi-outstretched or slightly retracted up vertically, neck sack invariably heavily
protracted and concealed by the feathering of upper breast. Neck Extended Vertically: if anxious or investigative, neck fully outstretched vertically, neck sack invariably heavily protracted though ordinarily visible. Neck Semi-extended Horizontally: in escape run, neck usually half-outstretched horizontally or slightly c. 5–10° below horizontal. Neck Down: in digging, head and neck retracted down c. 45° below horizontal. Wings Normal: at rest, held close to body. Wings Out: in escape run, closed wings sometimes held slightly out from body, carpal area lowered so that wing tips protrude above bodyline, which may be either horizontal or inclined forward (see below). Wings Raised: apparently to control equilibrium when leaping upward in trees or negotiating unstable sides of incubation mound, wings briefly raised 45–70° above the horizontal and half stretched. Tail postures as in the Australian Brush-turkey, apparently related to level of anxiety. Tail Normal: at rest, held level in line with horizontally kept body or very slightly c. 5° dipped down ventrally, rectrices folded together horizontally or very slightly fanned laterally. Tail Spread: if anxious or running away, tail raised very slightly c. 5–10° up from horizontal, rectrices widely spread out laterally. Tail Raised: in extreme distress, usually when alighted in trees upon disturbance but occasionally noticed also in birds running off, tail held c. 25–35° up from body, widely fanned dorsally. Standing: body horizontal or slightly inclined upwards, Neck, Wings and Tail Normal. Walking: as standing generally but body slightly dipped forward. Alert: when suspicious of danger or anxious, stands stock-still, body horizontal and erect, Neck Extended Vertically, Tail Spread ordinarily but Raised in case of extreme distress, and sometimes emitting clucks concurrently nodding its head forward (see Chapter 3.4). Escape Run: head and body dipped forward, Neck Normal slightly retracted up or Semi-extended Horizontally, Tail Spread or Raised presumably depending on level of anxiety. Scratching (when digging hole in mound): scratches off surface material by scraping and grasping material between toes and carefully inverting it backwards while continually changing direction, body tilted forward, Neck, Wings and Tail Normal. Digging (of hole in mound): grasps refashioned material between toes and in single rather stiff, mechanical, almost crane-like movements slowly hoists and deposits this toward the apex rim, body dipped forward, Neck continually alternating between Down and Normal, whereas Wings and Tail Normal.

3.6. Altitudinal distribution and habitat preferences | I found incubation sites of Brujin’s Brush-turkey only on Mts. Nok (n = 3) and Sau Lal (n = 75) at an average altitude of 769 m (± 92.8; 620–930 m; n = 78), along an ecological gradient above 620 m elevation, where a structurally distinctive, wind-sheared and possibly locally edaphically controlled, stunted cloud-forest grows on infertile ultramafic rocks. Such ‘Kruppelholz’ formations typically were thin-stemmed, rarely exceeding 20 cm dbh, grew c. 7–25 m tall, with occasional emergents in sheltered valleys up to c. 18 m (contra Moeliker and Heij 2002, who reported trees c. 40 m in height from the summit area of Mt. Nok), and featured gnarled trunks and branches heavily draped in epiphytic moss and ferns, and a dense understorey of seedlings, saplings and palms (particularly Pandanus). On the relict Mt. Nok (see Table 3) all three incubation sites were located at 705–730 m within a very restricted area around the summit that is shrouded in clouds during parts of most days. I did not record the species below 620 m in spite of having devoted in excess of 1,940 person-hour or 42.4 % of search effort there. Moreover, I took down merely three credible testimonies of brush-turkeys, each involving solitary, apparently female types, having been hunted within recent living memory from low-lying sectors of Mts. Nok and Sau Lal exploited by humans on a regular basis. One was snared close to the village grounds of Waifoi near sea level c. 1986, another captured by dogs along the Apiap R. at c. 30 m near S 0°02'56", E 130°48'34" in the early nineties, and the last individual equally taken by dogs in the mid-nineties was along a small tributary of the Wai Paley R. near S 0°5'43", E 130°45'44" at c. 110 m elevation in the general area locally known as Katotara (see Fig. 7).
Field discovery of Bruijn's Brush-turkey *Aepypodius bruijnii*
Dusky Megapode was found to occur principally in flat alluvial lowland forests along the broader river valleys between sea level and c. 100 m. Here its huge mounds typically were being maintained communally. Once beyond the foothill boundary proper, incubation sites of Dusky Megapode were confined to patchily distributed relatively extensive expanses of flat or only slightly undulating terrain, and were being tended by solitary territorial pairs. I found such isolated incubation sites locally at 230 m in limestone karst country in the Saporkren area, at 260 m in hill forest on ultramafics along the western spine of Mt. Nok and at a maximum elevation of 285 m in limestone karst country in the Mobit Hills (see Table 1; Fig. 1). In November 2002 I observed silent, solitary individuals at 465, 625, and 730 m on Mt. Nok.18

I conclude that the two species breed in complete vertical parapatry, separated by an altitudinal gap exceeding 300 m, set against a maximum elevation of 970 m available for the island.

The spatial distribution of incubation mounds of Bruijn’s Brush-turkey was truncated in many seemingly suitable environments, indicating that highly specialized ecological and behavioral requirements determine selection of incubation sites and associated establishment of adult male territories/home-ranges (Mauro 2002). The present surveys were far too restricted in time to allow for enough environmental variables to be reliably quantified in order to warrant a comprehensive analysis of habitat characteristics here. However, some general tendencies may reasonably be formulated.

17 ‘Ultramafic’ is roughly synonymous with ‘ultrabasic’ or ‘serpentine’, and is an adjective used to describe igneous or metamorphic rocks which comprise less than 45 % silica (SiO2) and have high concentrations of Mg, Fe, Cr, Co and Ni, and low concentrations of P, K and Ca (Proctor 2003).

18 On 10 and 11 November 2002 I observed a silent solitary Dusky Megapode within a territory of Bruijn’s Brush-turkey at 730 m elevation on Mt. Nok. Single, seemingly unpaired silent Dusky Megapodes were also repeatedly observed at 465 m elevation near permanent waterholes in a stream and at 625 m elevation, both on the eastern slopes of Mt. Nok on 12–13 November 2002. Quite possibly these observations relate to local displacement due to prolonged drought reigning at the time (see Chapter 2), post-juvenile dispersal or merely opportunistic seasonal foraging behavior. In any case this typically vocal species did not establish territories on site. During a total of 26 field days on Mt. Nok, spread over two disjunct study visits, I never heard this typically vocal species calling. Furthermore, none were detected visually nor aurally during 58 field days on Mt. Sau Lal spread over two separate survey periods.
Adult males of Bruijn’s Brush-turkey selected relatively steep versants, sloping on average 24.3 % (± 13.6; 0–60 %; n = 70), to establish incubation sites. The spatial distribution of incubation sites overwhelmingly was concentrated along the main crests and buttressed ridgetops, harboring 88.46 % of cases (n = 69) within the immediate vicinity of the apices and supporting flanks. The remaining 11.54 % (n = 9) were located within valleys near permanent water holes in dry stream beds. Of 71 mounds, 45 (63.4 %) were on east to south facing slopes [25.4 % (n = 18) faced E, 22.5 % (n = 16) S, 15.5 % (n = 11) SE, 11.3 % (n = 8) N, 9.9 % (n = 7) NE, 8.5 % (n = 6) SW, and 7 % (n = 5) W]. Of 78 mounds, 61 (78.21 %) were located in multi-layered primary forest with a closed canopy generally comprised of multiple dense, broadleaf crowns c. 10–18 m in height. Eleven (14.10 %; 14.67 % if only Mt. Sau Lal is considered; see Chapter 3.2) were within multi-storied, closed-canopy forest but directly below individual, often emergent conifers c. 9–15 m tall, featuring a comparatively open crown. Four (5.13 %) were in what appeared to be genuinely edaphically controlled dwarfish primary formations, typically virtually unlayered and densely stocked with c. 5–7 m thin-stemmed, dead-straight tree-poles. Finally, the remaining two (2.56 %) stood in low-stature <5 m tall, generally open, completely unlayered secondary, pioneering woodland, recovering from wild fires in 1982–83. In each of the latter three distinctive environmental circumstances, combining to 22 % of cases (n = 17), solar radiation on the mounds in question was high. Whereas secondary, pioneering woodland comprised 18 % of the Mt Sau Lal SA, only two mounds (2.7 %), were located within such woodland.19 20

3.7. Spatio-temporal use of incubation sites and population densities | Average distance between simultaneously tended mounds on Mt. Sau Lal was 243.8 m (± 110.59; 141.7–702.4 m; n = 44) in a Minimum Spanning Tree, and 204 m (± 47.3; 141.7–346.7 m; n = 44) in a Nearest Neighbor connection scheme. The two concurrently active mounds on Mt. Nok were 399 m distant. Average population density at the Mt. Sau Lal SA was estimated to be 8.2 mound-territories/km². However, density varied considerably across broad habitat types: from 2 mound-territories/km² in post-fire successional woodland, over 8 in edaphically controlled, pole-stemmed primary tracts, finally to 10.4 in multi-layered, closed-canopy primary forest. Mean density for primary formations thus was 9.2 mound territories/km² (= D >2 km²; see Chapter 2; Table 3). Tentative delineation of mound-territories for the Mt. Sau Lal SA applying Delaunay/Dirichlet Tessellation of points representing simultaneously tended mounds (Fig. 6) yields a mean mound-territory area of 0.08 km² (± 0.04; 0.04–0.22 km²; n = 14) for interlocked points and 0.14 km² (± 0.1; 0.04–0.53 km²; n = 31) for outlying spots. For the relict Mt. Nok SA mean territory was 0.25 km² (n = 2), i.e. a population density of 4 mound-territories/km² (= D<2 km²; see Chapter 2; Table 3).

In 57.8 % (n = 26) of the 45 delineated mound-territories above, only a single incubation site was found, i.e. the mound constituting the centroid of the tessellation delineating each territory. Respectively two, three, four and five successively used incubation sites were found in 26.7 % (n = 12), 8.9 % (n = 4), 4.4 % (n = 2) and 2.2 % (n = 1) of cases. Mean distances between up to four disused incubation sites within a territory and the centroid tended mound that defines it, comprised 82.49 m (± 30.08; 31.8–153.2 m; n = 30). Comparison of the status of 28 incubation sites that could be followed over both survey periods yields the following: (1) Out of 24 that were tended in late 2002, 15 or 62.5 % showed evidence of an intermittent abortive start of renovation and of ongoing

19 Interestingly, both incubation sites in secondary woodland were respectively 70 and 110 m distant from a 0.095 km² primary fragment, which in itself curiously was unexploited as nesting habitat.
20 One of the tenders in regrowth was flushed from its mound on two occasions and proved to be a typical adult male, featuring well-developed comb, nape-shield lobes, and neck-sack (see Table 2; Chapters 3.3 and 4.2).

20
manipulation in mid-2003. (2) Nine mounds or 37.5 % showed no further evidence of manipulation. (3) Only one of these had been abandoned in favor of a novel half-finished construction 36 m away, and curiously now located right on a transect cut in 2002.

### 3.8. Core breeding zones and world population estimate

Cloud-forest covers 61.9 km² or 2 % of Waigeo’s land area. Excluding the 1.78 km² scattered over 20 relicts too tiny to support even a single territory (see Chapter 2), it is estimated that breeding habitat of Bruijn’s Brush-turkey comprises just 60.1 km² or 1.9 % of the island’s area. Based on habitat extent and observed mound-territory densities a global population of 349 sexually mature mound-owning males is estimated (see Table 3). This pinpoints Bruijn’s Brush-turkey among Indonesia’s most restricted-range and rarer bird species (Stattersfield et al. 1998; BirdLife International 2000, 2001).

Three mountain systems in the eastern sector of Waigeo together contain 94 % of breeding habitat and 98 % of the total inferred world population of Bruijn’s Brush-turkey (see Table 3; Fig. 7). Mt. Danai alone contains 60 % of breeding habitat and 65 % of total population. The Mnier–Werar Hills contain 19 % of habitat and 20 % of population, and Mts. Sau Lal–Waimila 15 % of habitat and 13 % of the population. The remaining 5.6 % of breeding habitat and 2 % of inferred global population are being contained within three locations ranging between 0.68 and 1.85 km².

#### Table 3. Locations of Bruijn’s Brush-turkey *Aepypodius bruijnii* on Waigeo ranked in declining order of importance.

<table>
<thead>
<tr>
<th>Location</th>
<th>Summit altitude (m)</th>
<th>Summit coordinates (WGS ’84)</th>
<th>SRTM-3 620 m contour area (km²)</th>
<th>Inferred # mound-owning males¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt. Danai</td>
<td>950</td>
<td>S 00°12’08’’ E 131°00’53’’</td>
<td>36.19</td>
<td>226.4</td>
</tr>
<tr>
<td>Mnier–Werar Hills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mnier Hills</td>
<td>870</td>
<td>S 00°10’04’’ E 131°07’54’’</td>
<td>10.717</td>
<td>67</td>
</tr>
<tr>
<td>Werar Hills</td>
<td>760</td>
<td>S 00°11’31’’ E 131°11’07’’</td>
<td>0.823</td>
<td>1.6</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td>11.539</td>
<td>68.6</td>
</tr>
<tr>
<td>Mts. Sau Lal–Waimila</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt. Sau Lal</td>
<td>970</td>
<td>S 00°02’29’’ E 130°51’05’’</td>
<td>8.038</td>
<td>45²</td>
</tr>
<tr>
<td>Mt. Waimila</td>
<td>710</td>
<td>S 00°02’29’’ E 130°51’05’’</td>
<td>0.974</td>
<td>1.9</td>
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<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td>9.012</td>
<td>46.9</td>
</tr>
<tr>
<td>Rabia Hills</td>
<td>720</td>
<td>S 00°15’45’’ E 130°55’04’’</td>
<td>1.852</td>
<td>3.6</td>
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<td>Mt. Nok</td>
<td>880</td>
<td>S 00°04’54’’ E 130°45’17’’</td>
<td>0.864</td>
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<tr>
<td>Mt. Abaipap</td>
<td>700</td>
<td>S 00°06’13’’ E 130°30’55’’</td>
<td>0.676</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>60.135</td>
<td>348.8</td>
</tr>
</tbody>
</table>

¹ Correction factor C <2 km² = 0.4883 and density factor D <2 km² = 4.01 for small relicts <2 km²; C >2 km² = 0.681 and D >2 km² = 9.185 for SRTM-3 620 m surfaces >2 km² (see Chapter 2). ² For Mts. Sau Lal and Nok observed values are presented.

2¹ Bruijn’s Brush-turkey is often stated to inhabit rugged limestone karst (e.g. Stattersfield et al. 1998; Dekker et al. 2000; BirdLife International 2000, 2001). However, the entire currently known population is being contained within ultramafic outcrops on Mts. Nok and Sau Lal, and hence the species’ plight there is perhaps inextricably linked to the general need to conserve vegetation over ultramafic rocks as a potential source of important chemicals for medicinal and other uses, and in particular the advanced stages and closed forest in terms of a very poorly described and taxonomically understood endemism component (Van Balgooy and Tantra 1986; Proctor 2003; Takeuchi 2003).
4. Discussion

4.1. The field discovery of Bruijn’s Brush-turkey

In 1985 J. M. Diamond pointed out that it remained unknown whether any ornithological collectors had reached Waigeo’s summits (Diamond 1985). Moreover, the idea first introduced by Dekker and Argeloo (1993) that Bruijn’s Brush-turkey, by analogy with the Wattled Brush-turkey, presumably inhabited the mountains of Waigeo, became the dominant view by the turn of the century (see e.g. Jones et al. 1995; Dekker et al. 2000; BirdLife International 2000). Nevertheless, the long-awaited decisive assault on the island’s peaks did not occur during three consecutive ‘Waigeo Expeditions’ in 1999, 2000 and 2001, devoted primarily to rediscovering Bruijn’s Brush-turkey (Heij and Post 2001).

This neglect of the island’s summits, which can now be identified as the major flaw in the hunt for Bruijn’s Brush-turkey, was probably due to a combination of three factors. First, and foremost perhaps, the possibility that the island could harbor strictly montane bird populations may have been deemed unrealistic in view of its modest topography not exceeding 1,000 m in elevation and effectively lacking significantly large areas above the 900 m contour where montane conditions normally set in on New Guinea (Paijmans 1976). What is more, the sole locality-specific historical specimen of Bruijn’s Brush-turkey, definitely collected below 640 m elevation from Jeimon in the Siam R. valley in 1938 (De Schauensee 1940a), gave rise to the common misconception, most recently perpetuated by Moeliker (2002abc), that the species is rare but widely distributed across Waigeo. Second, virtually all historical collecting and modern reconnaissance took place in coastal, rugged limestone karst country where higher elevations may be impossible and certainly very difficult to reach (cf. Dekker and...
McGowan 1995). Conversely, the only ornithologist having searched the more accessible ultramafics, G. Stein, rather discouragingly tagged this zone an ‘überhaupt auffallend tierarm Gebiet’ (‘a generally strikingly animal-poor region’; Rothschild et al. 1932). Third, Waigeo’s interior remained preponderantly uncharted until long after World War II, and its crucial montane sites were not appreciated until the advent of high-resolution DEM’s like SRTM-3 (see Chapter 2).

Finally, transfer of local knowledge ordinarily proves crucial in tracking-down little-known species. However, in the particular case of Bruijn’s Brush-turkey, I found that information provided by local respondents rested almost entirely on tribal oral lore and narration, an increasingly fragmented, decaying ‘collective memory’, which albeit riveting by no means is necessarily true and accurate, and which in the overall absence of counterevidence from the field unfortunately was all too credulously embraced hitherto. That the species appears to be known and goes by its own local name in certain villages, as various sources report (Diamond 1986; Dekker and Argeloo 1993; Post 2001), cannot be considered proof that it occurs, not even incidentally, in the wider vicinity as both Megapode Action Plans (Dekker and McGowan 1995; Dekker et al. 2000) appear to suggest. The fact that none of the respondents recognized the species as a mound builder in the first place, quite understandably rather perceiving it as a kind of fowl, to me suggests that the inhabitants of Waigeo perhaps always have possessed merely casual knowledge of the species and never entered its secluded breeding habitat. In any case, the method of extensive village interviewing in order to gather presence/absence data recommended in the last Megapode Action Plan (Dekker et al. 2000), especially as executed by the ‘Waigeo Expeditions’ of NMR without earnest ground-truthing, proved immensely ineffective and to generate merely secondary, ambiguous information prone to considerable misinterpretation.

23 What little appears to be known about the brush-turkey locally is being interwoven with lore about small hominoids that live in the interior of the island (or in another version a sort of evil, fading demons that are the spirits of the earliest inhabitants of Waigeo driven into the interior by the invading Biak tribe), testimonies about a sizeable lake in the center of the island’s eastern half, and stories about the four giant eggs from which the four kings of the Raja Ampat hatched and a fifth egg still being guarded somewhere along the Raja R. in Kabui Bay.

24 Occurrence near Selpele where villagers in 1986 appeared to recognize the species (Diamond 1986; in litt. to Jones et al. 1995) seems rather unlikely in view of the comparatively open, low-stature vegetation on the inhospitable limestone bedrock of the narrow peninsula on which the village sits, and its isolation from the nearest inferred breeding locations (see Fig. 7). This is not to say, of course, that at the time of Diamond’s visit to Selpele none of its inhabitants might have been genuinely cognisant of the species’ existence but merely that such awareness could just as well have originated elsewhere. In fact, this possibility is extremely likely when considering that customary law and tradition of the Kavee people native to Selpele, strictly dictate that male outsiders desiring to marry a Selpele woman must reside on site for life. Whilst the 25th specimen from Mumes likely proves earlier circumstantial evidence (Diamond 1986; in litt. to Jones et al. 1995) from nearby Warsambin just across the Rabia Strait entirely correct, I would still like to make the point that the garden and hunting areas of the village traditionally lie on the east bank at Mumes, which in all likelihood therefore constitutes the genuine area from which its inhabitants gained acquaintance with the species (see Fig. 7).

25 That a species as striking in external morphology as this one managed to remain virtually unknown, even to the island’s indigenous inhabitants, in retrospect may be understood in terms of its secluded montane habitat versus the lifestyle of ‘water and shore people’. Ironically, the cloud-forest zone on Mt. Nok and Sau Lal had remained as much a terra incognita to myself, the first-time overseas visitor, as to my local assistants who, so to speak, grew up in the shadows of these peaks, and our ascent, due to the mutual unfamiliarity with the unforgiving terrain, as much a hardship and adventure. This merely serves to rebut the such-and-such allusion by Moeliker and Heij (2003) that I was ‘also’ just ‘brought’ to the incubation mounds on Mt. Nok as these authors were so fortunate to get done later (see Chapter 3.1).

26 For instance, the views expressed by Moeliker (2002bc) that ‘this new locality [referring to Mumes] in the relatively low southern part of Waigeo indicates that Bruijn’s Brush-turkey is not confined to the higher altitude forest of the island’ and that ‘the species is probably less vulnerable’
4.2. Description of incubation mounds | Jones et al. (1995) suspected that the confusingly diverse descriptions of the incubation mounds of the Wattled Brush-turkey may be attributable to mounds in differing phases. In the Australian Brush-turkey, the marked change in appearance from spherical during the Construction Phase to conical in the Active Phase, is known to result from gradual shifting of the male’s construction activities at the base and sides of the mound to maintenance activities on the apex in order to mediate thermal stability, and from subsequent laying activities of females (Jones 1988b). However, I had noticed previously that incubation mounds of Wattled Brush-turkeys in the Arfak Mountains had attained such a distinctive shape even before males had started vocal advertisement (I.M. unpublished data), indicating that a firm, stamped-down plateau may be a prerequisite for optimal performance of their display and hence deliberately laid out by the male. As in the Wattled Brush-turkey (I.M. unpublished data), it is likely that a definite rim and crater on the apex will be present only during the onset and early stages of the breeding season in the Brujin’s Brush-turkey, when females are still actively laying; hence it was not observed during my work.

The construction of 14.7% of incubation mounds beneath single conifers is noteworthy, considering that the Australian Brush-turkey avoids areas dominated by eucalypts, which similarly drop decomposition-resistant litter (Jones 1988a). These conifers feature a comparatively open canopy so that solar radiation on the mounds at their feet was visibly high. The potential contribution of solar radiation to the production of sufficient incubation heat merits further investigation.

4.3. Bare parts of the adult male | The renderings of the bare parts’ coloration of Brujin’s Brush-turkey in the ornithological literature (Oustalet 1880, 1881; Ogilvie-Grant 1897; Rand and Gilliard 1967; Beehler et al. 1986; Jones et al. 1995) are not supported by specimen label data or other secondary sources. These appear to have been in fact entirely speculative, founded on color states in dried-out specimens and partly rooted in analogy with the Wattled Brush-turkey. Although few reliably internally sexed specimens are to be found among the Brujin material, there can be no reasonable doubt as to the pronounced sexual dimorphism in adult Brujin’s Brush-turkeys. Since all my close observations relate to adult male type individuals, however, I cannot at present specifically comment on this topic. As observed in this study, bare parts’ coloration in the species appears to remain permanent once developed. This is in agreement with what little is known about various populations of its congener and the comparatively well-studied Australian Brush-turkey (Marchant and Higgins 1993; Jones et al. 1995).

Adult males of the brush-turkeys feature conspicuous fleshy ornamental head and neck appendages that are grotesquely enlarged only during territorial vocal advertisement and sexual display (Jones et al. 1995). In the absence of such behavior during my work, much remains to be learned about the exact structure and function of these appendages in Brujin’s Brush-turkey. From my field observations, it became obvious, however, that the diagnostic long pendulous nape wattles attributed to the adult male (cf. Jones et al. 1995) either represent inflated extensions of the nape shield exclusively associated with courtship display or are an artifact of preparation. In live birds at rest these parts invariably featured as a small lobe slightly protruding over the dorsal area of the neck and continuous with the widening and flattening nape shield connected to the comb. Whatever the case, the interpretation by Beehler et al. (1986), recently reinstated by BirdLife International (2000; contra Jones et al. 1995), that the two elongated pendulous wattles actually are attached to the side-neck, must have arisen either from erroneous perception or deformation in examined material (e.g. the specimen in the Smithsonian Institution, National Museum of Natural History, Washington, because ‘the three localities known thus far [referring to Yenbekaki, Mt. Nok and Mumes] lie 30–50 km apart and represent three different habitats’, clearly are a gross caricature of the reality.
USNM 146767), and should be dismissed. The pendulous wattle of the foreneck (Jones et al. 1995), taken here to be a true neck sack as in the Wattled Brush-turkey, invariably was heavily protracted in live birds and nearly constantly concealed by the feathering of the upper breast, protruding only when birds were Alert, with Neck Extended Vertically (see Chapter 3.5).

If the seemingly enlarged head and neck ornaments exhibited by a fine mounted male among the Bruijn trade series (Muséum national d’Histoire naturelle, Paris, MNHN G.C. 1887–416; see plate 1 in Voisin et al. 2000) are not attributable to post-mortem preparation, this may be regarded as conclusive proof that at the very least the specimen in question, and likely all the Bruijn material, was secured within the species’ montane breeding zones. Congruent with such supposition is the incidental occurrence of Bruijn’s Brush-turkey in lowlands today (see Chapter 4.8), rendering inconceivable that as many as 23 historical specimens could have been randomly collected here. Moreover, my work strongly indicates that adult mound-tending males – and a number of Bruijn’s skins are fine males – remain on territory throughout the year, indeed enduring even prolonged drought conditions. The remarkable extensiveness of the Bruijn material cannot, therefore, be considered suggestive of a historical decline in the species.

Finally, the bright pink coloration of neck sack, comb and nape shield in adult male Bruijn’s Brush-turkey (see Table 2) appears to be a relatively unique event both in terms of its general rarity in avian skin, and the key role such ornaments undoubtedly play in intersexual selection as the driving force to evolutionary adaptation in a promiscuous megapode. Investigations into the physiology, anatomy and nanostructure of these appendages and the color producing mechanisms they support, including ultraviolet reflectance, remain a promising field for further research.

4.4. Vocalizations | There is an intriguing potential similarity between the Raucous Cackling I recorded, and the onomatopoetic name Mangwap, originally reported by Dekker and Argeloo (1993) to be reserved for Bruijn’s Brush-turkey within the locally spoken dialect of the Biak language at Urbinasopen (S 0°22’25”, E 131°15’7”; Fig. 1), man invariably denoting ‘bird’ in Biak and the qualifier gwap reportedly referring to the sound it makes (Dekker and Argeloo 1993; Argeloo 2001). However, the same name evidently was not consistently being applied to the species at Yenbekaki (S 0°12’10”, E 131°18’40”; Fig. 1) c. 18 km to the North. Here, Heij and Post (2001) reported on nocturnal calls that were pointed out to them as pertaining to the Mangwap by the very islanders, who two months earlier had hunted and partaken of a female Bruijn’s Brush-turkey. The call was transcribed as ‘first a series of three guttural calls ough, ough, ough, followed by a descending trill of about five seconds, ending with a sharp tick’, without further comment on its distinction from the vocalizations of the Dusky Megapode, described in the same account as present ‘in large numbers’ in the area. Indeed, this published transcription conceivably may only refer to the typical territorial duet of Dusky Megapode itself: the introductory guttural series most likely is initiated by the female, its partner joining in with the long descending trill (I.M. unpublished data). Whereas many Megapodius species and the three Talegalla species are well known frequently to vocalize at night, the brush-turkeys clearly do not (see e.g. Jones et al. 1995; I.M. unpublished data).

27 Against this perhaps pleads the fact that Bruijn’s hunters apparently did not secure any of the other bird species that are largely confined to higher elevations on Waigeo such as e.g. the gerygone Gerygone chloronota meisai, and honeyeaters Myzomela [nigrita] steini and Meliphaga orientalis facialis. However, these collectors evidently operated on commercial terms, not out of a vested scientific necessity to obtain an exhaustively representative collection, thus likely targeting valuable birds of paradise rather than such small jobs, which moreover were technically difficult to secure those days.
4.5. **Behavioral ecology** | Observations of the male manipulating its active mound on Mt. Nok, and the lack of evidence of pair bonds – all casual encounters involved solitary, territorially non-vocal individuals – strongly suggest a male resource-defence polygyny and polyandry mating system, which, uniquely among the megapodes, is rooted within the brush-turkeys.

Waigeo receives an annual rainfall of 1,500–2,000 mm (van Royen 1960), most of which falls in a distinctive wet season from December through to May (local information). Elsewhere in seasonally humid environments the onset of breeding for mound-building megapodes has been found to be defined by local precipitation regimes (Jones et al. 1995). Incubation evidently was in progress on Mt. Nok in mid-May 2002 following normal rainfall in the year 2001 and the first quarter of 2002, as inferred from neutral or La Niña cold phase Sea Surface Temperature conditions at the time. Hence, the best available evidence currently identifies the species’ habitual breeding season as unfolding in the March–May (second half) of the normal wet season on the island.

The virtual lack of female birds in this study (see Chapter 3.5) may be explained by two factors, or a combination of them. First, the sexes may segregate temporarily, e.g. in response to environmental perturbation such as drought, or seasonally by altitude, whereby only mound-tending adult males remain in their territory in cloud-forest, while female types disperse into the lowlands. Two out of five casual sightings away from the mound under surveillance on Mt. Nok at the very onset of an El Niño warm episode in mid-May 2002 were of female types, whereas all determinable subsequent observations \((n = 17)\) during the follow-up field work, when drought conditions became increasingly severe, were of adult males (see Chapter 4.6). Second, it is likely that female types are much more difficult to detect: (1) because they likely live much more secretively and are warier, being constantly prone to a varying degree of agonistic behavior displayed by mound-tending territorial adult males; and (2) because they have no resource to defend, females may more readily temporarily vacate sectors which, ad interim, are being intensively trespassed by humans, such as during my work.

4.6. **Altitudinal distribution and habitat preferences** | The transition to montane conditions gradually sets in at c. 500 m elevation on Waigeo (van Royen 1960, I.M. unpublished data) but the lower edge and extent of optimum cloud-forest at any given locality on Waigeo presumably depends on its capacity to capture the environmental conditions that mould cloud-forests, which in turn may be expressed in terms of its specific position and aspect, summit elevation and amount of land at higher altitudes. Along New Guinea’s central cordillera such cloud-forests ordinarily are encountered from 2,100–2,400 m upwards only, though compression of the altitudinal vegetation belts on low and exposed mountains as on Waigeo, the so-called ‘Massenerhebung’ effect, has long been documented for many Wallacean and Northern Melanesian islands (Mayr and Diamond 2001). Conversely, it remains possible that a shortage of one or more macronutrients (except Mg), very high soil Mg/Ca quotients or high soil Ni concentrations contribute to the dwarfed nature of forests growing on ultramafic outcrops (Proctor 2003). Unfortunately, almost nothing is presently known about the taxonomic composition of this forest type on Waigeo, particularly with respect to the pedogenesis of the ultramafic outcrops that virtually enclose it (see Chapters 3.6 and 4.11). Van Royen (1960) termed it a shadow of continental New Guinea submontane forests though this may perhaps at least partly be explained in terms of his observations pertaining to a tiny relictual patch on Mt. Nok (see Table 3), which in itself likely already is considerably impoverished compared to more extensive stands elsewhere on the island.\(^{28}\) For instance, Mt. Sau Lal cloud-forests featured scattered sizeable patches of

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\(^{28}\) Dominant trees presently known from cloud-forest on Mt. Nok are *Rhododendron cornubovis*, *Rapanea* sp., *Pouteria firma*, *Dillenia ovalifolia*, *Podocarpus* sp., *Drimys piperita*, *Elaeocarpus sepikanus*, *Melastoma* sp., *Evodia* sp., *Rhodomyrtus trineura*, and *Hibbertia scandens*. In the undergrowth...
climbing bamboo, and numerous emergent conifers including a *Dacrycarpus* (cf. *D. imbricatus*; W. Vink *in litt.*, 3 May 2004), both of which appeared to be absent from Mt. Nok. Undoubtedly, there is substantial prospect for future taxonomic discovery in the Waigeo ultramafic cloud-forest zone.

In addition to Bruijn’s Brush-turkey I found the owlet-nightjar *Aegotheles wallacii*, the scrubwren *Sericornis beccarii*, and the honeyeaters *Meliphaga orientalis facialis* and *Myzomela nigrita steini* to be normally confined to the cloud-forest on Waigeo. The exact taxonomic affinities of the novel populations of the owlet-nightjar and scrubwren, recorded for the first time on the island during this study, are under systematic investigation currently, whereas the morphologically highly distinctive *steini*-subspecies of the Black Myzomela certainly qualifies as an endemic allospecies. The restriction to cloud-forest of taxa distinct at the species and allospecies level, and the complete dissimilarity between the mix of montane populations on Waigeo and Batanta (see Chapter 4.9), are testimony to the potential even minor ecological gradients can exercise to isolate taxa and sustain speciation across Pleistocene land-bridge islands.

The rarity of Bruijn’s Brush-turkey has been linked to potential competitive exclusion by the ecologically similar Dusky Megapode (Dekker and Argeloo 1993; BirdLife International 2001; cf. Ripley 1960), considered a more recent arrival on Waigeo. However, my work reveals that the two breed in complete vertical parapatry, separated by an altitudinal gap exceeding 300 m, set against a maximum elevation of 970 m available for the island. Moreover, these mutually exclusive breeding ranges are mirrored by a comparable occupancy pattern of Dusky Megapode on neighboring Batanta (I.M. unpublished data), where *Aepypodius* is absent till further notice (see Chapter 4.9). All this suggests that the brush-turkey’s isolated montane breeding distribution may be better explained in terms of the unique evolutionary adaptation to upland forests of the genus *Aepypodius*. Recent molecular work by Birks and Edwards (2002) brought to light that Dusky Megapode may be paraphyletic, *M. f. quoyii* and nominate *freycinet* each clustering with other species rather than as sisters in their ND2 mitochondrial gene tree. Such a relatively steep phylogenetic gap within Dusky Megapode suggests that *Megapodius* also has an ancient history on Waigeo and that the disjunct breeding zones both species maintain are a result of a long-term and stable evolutionary *status quo*.  

I did not record Bruijn’s Brush-turkey below 620 m in spite of having invested in excess of 1,940 person-hour there. Moreover, a conservative estimate of previous scientific ornithological field effort below 500 m on Waigeo easily arrives at 23,300 person-hour with only a single specimen record for the species (De Schauensee 1940). However, two permanent records now exist for the true lowlands of Waigeo, in addition
to three credible local testimonies I report on above. The infamous preserved head and gnawed bones acquisitioned by the Natuurmuseum Rotterdam [NMR # 9989–01605] pertained to a female taken in late November 2000 by local hunters within ultramafic xerophytic scrub and woodland at 150 m elevation along a tributary of the Werar R. c. 4 km inland from Yenbekaki on Waigeo’s north-eastern tip (Anonymous 2000; Post 2001; Heij and Post 2001; see Fig. 7). The first specimen in-the-flesh [NMR # 9989–01606] equally was a female, with well-developed ovary; it was snared in mid-July 2002 within internally degraded mature foothill forest at c. 80 m elevation in limestone country c. 3 km due east of Mumes (see Fig. 7) on the eastern shores of Mayalibit Bay’s mouth. In addition, the 1938 female [ANSP # 140581] from Jeimon (De Schauensee 1940) certainly originated from outside the species’ breeding habitat and was definitely collected below 640 m.

Four respondents who had first-hand experience of Bruijn’s Brush-turkey, simply because they had eaten it one day, associated its occurrence with prolonged periods of drought, and the circumstances of the specimen from Mumes are consistent with a presumed drought etiology. My work revealed that adult mound-tending males endured extreme drought conditions on territory, whereas female types appeared to have completely vacated optimum cloud-forest habitat (see Chapter 4.5), and all lowland records to date involve female type individuals. However, the species ranks as technically undetectable when dispersed in small numbers across vast lowlands hence the possibility looms that such apparent altitudinal shifting of female types extends far beyond the casual disturbance-response, and obscures juvenile dispersal and/or genetically strategic interchange of adults between isolated breeding habitats. As a matter of reasonable precaution, any in-situ conservation initiative for the species should therefore soundly consider this potential temporal dependency upon lowlands of at least a subset of the population.

I conclude that the best available evidence suggests that lowland occurrences are incidental (contra Moeliker 2002ab), and recommend these be treated as cases of vagrancy with regard to applying criterion B of the IUCN Red List criteria (IUCN 2001; see Chapter 4.13). All traceable positions of lowland records were on average only 5.9 km (± 3.88; 1.1–10.3 km; n = 6) distant from the nearest known or inferred breeding habitat and lie east of Mayalibit Bay.

Clear biological explanations ordinarily underpin recorded habitat characteristics of megapode incubation sites (e.g. Jones 1988a; Sinclair 2002). With 89 % of cases concentrated along the main crests and buttressed ridgetops, it seems plausible that Bruijn’s Brush-turkey primarily selects incubation sites in function of an optimal projection along declivities of male advertising calls, which likely are delivered from the mound’s apex as in the Wattled Brush-turkey (see also Sinclair 2002; I.M. unpublished data). That east to south facing slopes appeared to be favored, may further be interrelated with these receiving sunlight during presumed morning sexual display, though the amount of suitable land on west and north facing slopes was also disproportionately restricted. Characteristics related to provisioning of organic material and protection of the mound from desiccation, as advanced in other megapode studies (Jones 1988a; Sinclair 2002), probably determined 78 % of disclosed incubation sites that promoted a stable microhabitat. The likelihood that a combination of solar and microbial heat nurtures incubation in the remaining 22 % of cases (cf. Palmer et al. 2000), constitutes a confounding factor with respect to site selection. Finally, more than 20 years after the last fire event on Mt. Sau Lal, the species’ population density in areas of post-fire succession there was still 4.5 times lower than in adjacent primary tracts.

This locality’s published coordinates (Moeliker and Heij 2002; Moeliker et al. 2002) appear to be GPS-default decimal minute notations (hddd°mm.mmm’’) directly rewritten as degrees-minutes-seconds (hddd°mm’ss.s’‘); the correct notation after conversion used here is S 0°20’36”, E 130°58’49”.

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4.7. Spatio-temporal use of incubation sites and population densities | Sinclair (2001) demonstrated disadvantages of mound renovation over novel construction in terms of thermal conductivity. However, I consider it impossible that additional disused mounds could have been systematically overlooked in 58 % of delineated mound-territories at the Mt. Sau Lal SA that held only a single incubation site. Therefore, I advance recurrent utilization of these sites over successive breeding seasons as the most parsimonious explanation. A comparison of the status of 28 incubation sites that could be followed over both survey periods is consistent with such recurrent use over consecutive years. However, out of 24 mounds tended in late 2002, there were only ten cases where successful incubation during the previous breeding season could be positively inferred either from the Collapsed Phase of a mound or the fact that it constituted the centroid of the territory it defines. Conversely, occurrence of up to five successively used incubation sites in the remaining 42 % of mound-territories, is in agreement with rotational usage of incubation sites over successive breeding seasons as described e.g. by Jones (1988ab, 1990ab) for the Australian Brush-turkey.

On present evidence territorial adult males ordinarily tend a single mound only during a breeding season. However, since construction of a second mound may be expected to commence only after the first reaches thermal stability (Jones 1988b), and this particular condition was evidently being impeded by ongoing drought conditions during this study (see Chapter 2), synchronic attendance of two mounds by a same territorial male may have gone largely unnoticed. Nevertheless, whilst for 42 % of territories the possibility of concurrent utilization cannot be ruled-out, such occurrence due to the extreme density of the favored breeding habitat was especially conceivable in only three cases where presumed doublets were separated 32, 36 and 42 m respectively, and showed evidence of recent manipulation.

Little comparable published information exists on population densities in megapodes derived from qualitative mapping of mounds. However, with an observed 4–8 mound-territories/km², Bruijn’s Brush-turkey probably ranks as a low-density species. In comparison, Australian Brush-turkey in the wild occurs at densities of 22.2 mound-territories/km² (Marchant and Higgins 1993), an order of magnitude 2.4–5.5 times greater.

4.8. Core breeding zones and world population estimate | The lack of information on sex-ratio and turnover rate of breeding individuals in the Bruijn’s Brush-turkey, dictates that numerical quantification of its total reproductively mature population (IUCN 2001) can only be achieved through inference by analogy with closely allied taxa.31 In three studies of the Australian Brush-turkey (Jones 1990b; D.N. Jones in litt., August 2004), soliciting sexually mature females outnumbered mound-owning males by factor 1.8 on average (±0.05; 1.75–1.85; n = 3). If this figure is applied to the estimated number of mound-owning
males in Bruijn’s Brush-turkey (see Table 3), a global population of 977 mature individuals is estimated. This score does not take into consideration an inestimable pool of recently sexually mature but still reproductively suppressed individuals that depend on demographic turnover to become actively procreative. In captivity, female A. a. misoliensis may produce eggs c. 1 year after hatching (R. W. R. J. Dekker in litt., 22 June 2004), while female Australian Brush-turkey is known to have bred in the wild at <1 year of age, and commonly breeds in its second year (Jones 1987; Marchant and Higgins 1993). By analogy young females of Bruijn’s Brush-turkey probably rather quickly become part of the actively propagating population. In contrast, the majority of immature males, whilst likely sexually mature at one year, conceivably require several years before becoming capable of permanently defending an incubation mound from older, dominant males, and securing copulations as in the Australian Brush-turkey (Jones 1987; Marchant and Higgins 1993).32

Out of six locations identified (see Table 3; Fig. 7), Bruijn’s Brush-turkey presently is confirmed to breed on Mts. Sau Lal and Nok only, and the known population totals 47 mound-owning males. All available evidence suggests that forests remain in pristine condition in the Mt. Danai area. In contrast, sizeable tracts in the Mnier Hills appeared to be covered with low-stature scrub and anthropogenic grasslands hence the population estimate for the Mnier–Werar Hills is almost certainly too high. Additional work may well bring to light that a number of the selected relicts do not support a breeding population after all. This possibility seems particularly plausible for Mt. Abaipap west of Mayalibit Bay, given its comparatively higher degree of isolation from viable recruitment sources, and the complete lack of reliable records for the species this side of the bay.33 The critically low population ceilings of all relicts moreover suggest an imminent risk of at least temporary extirpation.

I conclude that only the three principal locations, together containing 98 % of the world population, are meaningful for the long-term survival of Bruijn’s Brush-turkey, and until a population is proven extant west of Mayalibit Bay, recommend querying its occurrence there. This reduces the species’ EOO to 1,734 km² if the entire eastern part of the island up to the Goh-Puan bottleneck is considered. An MCP around the five locations that side of the bay yields an EOO of 751 km². Present AOO tallies six 4 km²-cells or 24 km². Moreover, even if future field work should prove all locations within its EOO to be fully saturated at the IUCN 4 km²-griddcell reference scale, AOO still could not exceed 192 km².

32 The expected biased sex-ratio in Bruijn’s Brush-turkey could be socially mediated in response to lingering suppression of young sexually mature males, in combination with male-biased mortality as a direct consequence of the stresses, reduced fitness, and increased predation risk incurred through mound construction and defense. However, recent research on the Australian Brush-turkey by Göth revealed that sex ratios at hatching are being determined by incubation temperature, with more females hatching at the higher end of the scale (A. Göth in litt., 18 August 2004). In turn this begs the question whether a relation may exist with recurrent ENSO-induced drought episodes.

33 Mt. Abaipap is the unique locality in the island’s western sector to conceivably harbor a tiny population of Bruijn’s Brush-turkey (see Table 3; Fig. 7). Traveling in a longboat along the north coast on 14 June 2003 I was at least able to confirm local reports that the forests in this area remain entirely intact. However, in view of this population’s exceedingly low ceiling, and especially its comparatively higher degree of isolation from the nearest viable recruitment source, taken to be Mt. Sau Lal, its genetic viability seems highly questionable. In turn this dramatically increases the chance of temporary extirpations with a reduced probability of recolonization. Assuming that the species is incapable of sustained flight and does not fly across open water, the isolation reveals itself not only in a 34 km wide gap that needs to be covered but even more so because dispersers need to negotiate a potentially hazardous crossing along the narrow Goh-Puan isthmus (see Fig. 7). Averaging 2.3–4.8 km wide and running unbroken for 8.9 km along bare blow-outs, open scrub and patchy denser woodland, such a bottleneck can be expected to inhibit population exchange and gene flow between both island halves.
4.9. Does Bruijn’s Brush-turkey occur on Batanta? | There is a contemporary report of a ‘large brush-turkey’ of undetermined generic identity, but speculated to involve Bruijn’s Brush-turkey, from 700 m elevation on Mt. Batanta in the center of the eponymous island (Diamond 1986). However, two lines of albeit circumstantial evidence suggest occurrence of the species there is not particularly likely.

Firstly, an ornithological expedition by E. T. Gilliard, K. Somadikarta and five co-workers collected ardently on the southern slopes of Mt. Batanta (Greenway 1966) above the village of Wai Lebed (Greenway 1966) between 12 June and 8 July 1964. Their expedition was the first to have reached the summit of Mt. Batanta (1,170 m) and to have gained insight into the island’s montane avifauna (Greenway 1966). The party collected 11 field days within the unique area on the island that boasts the optimum breeding habitat of Bruijn’s Brush-turkey as now documented for Waigeo, without encountering any sign of it. Instead, the expedition established that local reports reinforcing Gilliard’s prior expectation that the species ought to be present on Batanta in fact referred to the ground-dwelling pigeon *Otidiphaps nobilis* (Greenway 1966; Jones et al. 1995). In retrospect, with all novel information at hand, and in the knowledge that Gilliard was a field ornithologist *par excellence*, who carried multiple prior field experience with Wattled Brush-turkey, it is hard to believe that incubation mounds of Bruijn’s Brush-turkey could have been systematically overlooked, if indeed present on the island.

Second, although affinities of the Batanta avifauna, both in terms of species assemblage as subspecific affiliation, overwhelmingly lie with Waigeo, my work showed that the mix of strictly montane populations persisting on Waigeo and Batanta respectively is totally dissimilar. Considering only those reliably known taxa that on present knowledge likely are genuinely confined to cloud-forest above 620 m elevation on those particular islands, I record the cuckoo *Chalcites meyerii*, the jewel-babbler *Eupetes castanotus gilliardi*, the robin *Pocicloidyas placens*, and honeyeater *Meliphaga montana margaretae* for Batanta as opposed to the brush-turkey *Aepypodius bruijini*, the owlet-nightjar *Aegotheles wallacii*, the scrubwren *Sericornis beccarii*, and the honeyeaters *Meliphaga orientalis facialis*, and *Myzomela nigrita steini* for Waigeo. Despite a favorable geological configuration, staunch ornithogeographic argument suiting Diamond’s presupposition that Bruijn’s Brush-turkey ought to be present on modern Batanta therefore appears to be lacking plainly.

In the absence to date of a well-documented record for the species on Batanta and in view of the tendency that albeit circumstantial evidence contravening with a potential occurrence on the island outweighs speculations to the contrary, I recommend that Bruijn’s Brush-turkey, pending further field investigation, be continued to be treated

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34 The bird in question apparently was glimpsed by an Indonesian field assistant, not a trained naturalist, during a rapid ornithological reconnaissance visit between 14–19 February 1986 (Diamond 1986).

35 Within the Raja Ampat archipelago, modern Waigeo, Batanta and Kofiau comprise an ophiolite complex, the Waigeo terrane (Pigram and Davies 1987). Batanta (516 km²) being the disproportionately smallest of the four modern Pleistocene fragments that make up the bulk of the archipelago today, not surprisingly also features the most impoverished birdlife. Conceivably, its avifauna is relaxing back to species numbers akin to oceanic island avifaunas through the process of selective extinction unfolding in the wake of Holocene island fissure and the subsequent continuous isolation of taxa unable to disperse across water (cf. Mayr and Diamond 2001). No less than 34 resident land and fresh water species inhabiting Waigeo appear to be absent from Batanta (Rothschild et al. 1932; Gyldenstolpe 1955; Mees 1965; Greenway 1966; I.M. unpublished data). However, tagging the island’s avifauna as a mere subset of that of Waigeo would be a caricature of the reality since Batanta also boasts 16 sedentary species in common with Salawati or the Bird’s Head region (*sensu* Beehler et al. 1986) that are genuinely absent from Waigeo, albeit three of those solely founded on Bruijn’s trade skins, not having been relocated subsequently, may be subject to future revision.

36 I stress here that the montane avifauna of Waigeo was unknown at the time of Diamond’s report.
as endemic to Waigeo, as practically all recent authors have (see Jones et al. 1995; Dekker and McGowan 1995; Dekker et al. 2000).

4.10. Predation My work suggests that human predation, contrary to previous speculations (e.g. Dekker and McGowan 1995; Moeliker 2002ab), currently is a negligible threat to the brush-turkey population. Bruijn’s Brush-turkey is not a specifically targeted game species but evidently incidentally occurs as by-catch during subsistence pig-hunting and snaring that targets Dusky Megapode and Western Crowned-Pigeon Goura cristata (Dekker and Argeloo 1993; Heij and Post 2001; I.M. unpublished data). Nevertheless, I recommend that parforce pig-hunting and snaring be restricted to designated sectors near habitation and subsistence areas. In addition, I recommend that the core locations of Bruijn’s Brush-turkey be declared strictly ‘no hunting areas’ and accessed for scientific monitoring only. This last measure should not pose any foreseeable problems to local communities since these highest ridges remain entirely unexploited, if ever visited by man ever. A complete hunting ban on wild boar is probably highly unrealistic and even undesirable in view of potential nest predation.37

Introduced mammalian predators may be a more serious cause for concern. Runaway dogs certainly are a problem locally in Waigeo’s forests and constitute a hazard to Bruijn’s Brush-turkey in view of its reluctance to flush (see Chapter 3.5). For instance, on Mt. Nok the present work yielded five diurnal sightings of at least two different individuals during 14 field days at mid-elevations between 280 and 665 m (Mauro 2002). In the Arfak Mts., the in the New Guinea region prehistorically introduced wild boar is known to compete with the Wattled Brush-turkey for the roots of a certain tuber, and to occasionally raid its mounds to scrounge off eggs (I.M. unpublished data). Wild boar was not found to utilize cloud-forest on Mt. Sau Lal during this study. Moreover, the first incubation mound of Bruijn’s Brush-turkey to be disclosed to science on Mt. Nok in May 2002 (Mauro 2002; see Chapter 3.1), where incubation was evidently in progress, was located less than 100 m away from both a wallow and breeding nest of boar, without predation being recorded. Nevertheless, I expect that nest predation by boar locally does occur in the Bruijn’s Brush-turkey. In addition, my work suggests that natural predation by the native monitor lizard Varanus indicus kalabeck, which unexpectedly manages to exist near permanent water sources up to at least 840 m elevation locally in the mountains of Waigeo (I.M. unpublished data), may pose a contributory threat locally, especially where subpopulations already are dwindling and territories occur at low densities such as on Mt. Nok. An in mid-May 2002 just recently abandoned mound there featured two conspicuous digging holes in the apex, closely corresponding to varanid predation patterns that I have observed elsewhere. Conversely, despite at least three different mature monitors inhabiting the c. 400 m stretch between this mound and the sole active mound under surveillance on Mt. Nok, 91 observation-hours at the latter mound did not yield any visits from monitors. Expert investigation into the impact of (especially alien) predators on Waigeo continues to impose itself (see Dekker et al. 2000).

37 The intention introduced by Moeliker (2002abc) to train the bird hunters of Waigeo and engage them at stipend into the collection of biological information about Bruijn’s Brush-turkey ‘so they get the financial means to buy chickens rather than catching the brush-turkeys themselves’, shall remain a fine example of a nonsense measure founded on poor understanding of the real threats that impinge on the species.
4.11. *Instability in the Waigeo ultramafics and the role of wild fire* | Waigeo consists predominantly of limestone and ultramafics, infertile substrates that are known to delay recovery of vegetation following environmental perturbation (overview in Proctor 2003). I identified habitat destruction as a result of wild fires as the most serious threatening process for Bruijn’s Brush-turkey. Four traceable fire paths from the past 25 years averaged 64.8 km² (± 46.4; 2.5–200 km²; \( n = 4 \)), together affecting c. 259 km² or 8.4 % of the island’s area. These known fire events acted over disproportionately large surfaces when compared to the size of individual locations of the species (see Table 3). Fires are directly responsible for severe internal degradation and partial obliteration of 18 % of cloud-forest on Mt. Sau Lal plus a presently unquantifiable yet significant portion of the

\[38\] The southeastern peninsula around Urbinasopen, at least up to 12–14 km inland along the Rumei R. and its headwaters, was severely degraded by large-scale, probably mainly ground fires in 1982 (Dekker and Argeloo 1993). What must have been an extremely violent canopy fire, reputedly resulting from an unattended cooking fire lit by a hunting party, literally expunged all forest up to the 600 m summit of Mt. Bomjar near Lupintol (see Fig. 7) during the same warm episode. Another unattended cooking fire flared up near the Sau Lal cove on the north coast in 1982 and blazed the entire area around Fofak Bay west to approx. E 130° 34' including the village grounds of Kapadiri, Goh and Arawai and east to the summit area of Mt. Sau Lal up to 820 m elevation locally, leaving c. 200 km² in ashes. In contrast, widespread forest destruction around Kabarei, offshore Manuram I., and on the northeastern peninsula around Yenbekaki inland into the Mnier Hills, probably dates back from nickel exploration and open pit extraction activities during the seventies involving the use of fire to clear land as the standard *modus operandi* those days (Heij and Post 2001; Post 2001; many local informants verbally to I.M.). More recently in 2002 fire was deliberately set to clear a reputedly snake-infested ridge on the eastern slopes of Mt. Waimila, which ravaged the forest up to an estimated 300 m elevation locally (see Fig. 8). During the course of this study prolonged fires often associated with land clearance for sustenance gardens and road building, and as a cover-up for illegal timber extraction operations, occurred near Waremag and at various sites in the Kabui Bay, on the south coast of Gam and at Saporkren.
Mnier Hills, and probably irretrievably degraded hundreds of km$^2$ of low-lying forested areas, including corridors between locations.

The impact of fire must also be assessed against the backdrop that the predominant scrub vegetation over ultramafic outcrops on Waigeo, long interpreted as an edaphic climax, now is considered to represent an early stage in a successional sequence induced by fire (Takeuchi 2003; see also Proctor 2003). Van Royen (1960) described the Waigeo ultramafic scrub as an edaphic climax but as Takeuchi (2003) recently has pointed out, its spatial proximity and structural resemblance to other communities suggest otherwise. By analogy to similar environments, Takeuchi concluded that most of the Waigeo ultramafics probably represent an early stage in a successional sequence induced by fire, the principal characteristics of the open scrub hardly differing from landslide series described from ultramafics in the Bowutu Mts., Morobe province, PNG, except that such communities extend continuously over hundreds of hectares on Waigeo. This distinction in spatial scale and the associated patchy distribution of ultramafic forest on Waigeo is as expected if wild fires periodically reset seral sequences over large areas. 39 Ironically, van Royen’s own observations provide evidence of instability in the Waigeo ultramafic vegetation: a Gymnostoma forest he described in 1955 remained only as relictual trees surrounded by scrubland in 2003 (Takeuchi 2003). On the western slopes of Mt. Sau Lal hundreds of hectares of scattered standing burnt-out forest tree trunks amidst an ocean of fern-dominated scrub are testimony to both the closed multi-storied forest that survived there until the horrific wild fires of 1982–1983, as the adverse soil chemical factors delaying recolonization (see Proctor 2003).

Fire may be a naturally frequent ecological perturbation factor in comparatively dry environments like Waigeo. However, three out of four wild fires above occurred during the El Niño-induced drought event of 1982–83. Moreover, interviews indicated that most fires on the island are started deliberately, and that the use of fire certainly has increased significantly in the wake of logging operations. I recommend that an island-wide awareness campaign is set up to prevent future wild fires.

4.12. A logging epidemic on Waigeo

The highly praised ironwood species ‘Merbau’ Intsia bijuga occurs at stocking densities conducive to commercial extraction on Waigeo and became the main stake of a recent logging boom on the island (see e.g. Dekker 2000). This followed in the wake of both the inevitable eastward domestic shift, from the turn of the century onward, of timber interests to the last frontier that Indonesian New Guinea is, as enactment of devolution legislation around the same time. The novel legislation rapidly gave rise to a new breed of logging outfits exploiting vulnerabilities in (1) the ‘KOPERMAS’ Community Co-operative Enterprise scheme as a get-at-able vehicle for managing natural resources; and (2) the so-called HPHH license system through which the regency administrator grants communities organized in a legally registered body, exclusive of Adat organizations, the right for one year to harvest a 0.1 km$^2$ concession unit on ancestral land located within conversion forest. Whereas participating communities on paper legally own KOPERMAS, outsourcing of capital investment dictates that in practice they are little more than rubberstamps by and large manipulated by timber entrepreneurs with military and police backing. Clearly, this sets ajar potential application of immense outside pressure upon communities participating...

39 On present knowledge, the ultramafics support more endemic plant species than any other community represented on Waigeo. However, in a fire-induced successional environment, closed forest may logically be expected to constitute the most diverse community, and Takeuchi (2003) considered that several endemic taxa may well be threatened by the reduction of taller communities. For instance, from the circumstances of their collection, Archidendron rojenii, Alstonia beatriceis and Maesa rheophytica probably are associated with the advanced stages of the ultramafic succession, whereas Guioa waigeoensis and Alyxia laurina, known by several collections from the open areas, likely represent seral taxa (Takeuchi 2003).
under the scheme to breach concession terms and, if need be, encroach upon designated conservation areas. At Waremag on the eastern shores of Mayalibit Bay (see Fig. 7) logging activity for instance extended across a continuum in excess of 17 km² (I.M. unpublished data).

Comprehensive investigation into the spatial extent and impact of the logging epidemic on Waigeo has not been forthcoming to date. However, about 14 % of the West Waigeo Nature Reserve was already affected in 2000 (Anonymous 2000), and evidence is mounting that most of the accessible tracts within the reserve by now have been severely degraded by the usual interplay of logging, road building, and the widespread subsequent use of fire as a cover up. Such operations contravene with the existing protected area network, are extremely destructive, with little transparency and low returns to the local communities (Donnelly et al. 2003; I.M. unpublished data). Moreover, because these concessions profoundly alter a long-standing customary land-tenure status qua, and for a variety of contributory reasons, considerable disagreement and conflict emerges, deeply dividing land owners, family clans, and ultimately entire villages.40

While timber extraction proper likely will only affect low-lying areas in the short term, the preservation of lowland forest corridors linking breeding habitats of Bruijn’s Brush-turkey is imperative in view of a potential temporal dependency upon lowlands of at least a subset of the population.41


While Moeliker et al. (2003) appear to have been more preoccupied by the question of ‘who will locate the next overlooked historical museum specimen of Bruijn’s Brush-turkey’, the information accumulated during the present study impels deep concern and vigilance as regards the species’ future, and enjoins revision of its current conservation status. I propose that Bruijn’s Brush-turkey, currently treated as Vulnerable (BirdLife International 2001), be upgraded to Endangered based on criteria EN B1+2ab(ii,iii,v) (IUCN 2001). The species is almost certainly confined to an area of 1,734 km² in the eastern half of Waigeo and EOO as delineated by MCP comprising all locations there amounts to 751 km² [<5,000 km²; criterion B1]. The species’ AOO now stands at 24 km² and even if all locations within its EOO eventually should prove to be fully saturated at the IUCN 4 km²-gridcell reference scale, still could not exceed 192 km² [<500 km²; criterion B2]. Viable populations that are safe from genetic stochasticity exist at only three locations [<5 locations; qualifier a]. Fires severely degraded and partially obliterated 18 % of the Mt. Sau Lal SA plus a significant portion of the Mnier Hills, and quite possibly irretrievably degraded hundreds of km² of low-lying forested areas including corridors between disjunct breeding zones [qualifier b(ii,iii)]. A continuing decline in number of mature individuals is inferred from the species’ observed constrained population density in post-fire successional regrowth on Mt. Sau Lal [qualifier b(v)].

The entire world population of Bruijn’s Brush-turkey is believed to occur east of Mayalibit Bay and this has far-stretching implications for conservation planning and prioritization on Waigeo. The East Waigeo Nature Reserve covers 1,195 km² or 69 % of the island’s eastern half (Ministry of Forestry Decree 251/Kpts-II/1996 of 25 November 1996; see also McKenna et al. 2002; Erdmann and Pet 2002; Donnelly et al. 2003). However, almost a decade since its formal establishment, precise boundaries still need to be defined and it is unknown at present how well the reserve maps onto the 751 km²

40 In the year 2000 nearly half of the households of Waifoi moved to the mouth of the Waremag R. in order to accommodate timber extraction operations under the KOPERMAS scheme.
41 During the course of my work industrial scale timber extraction operations using heavy equipment with associated extensive road building was in progress: (1) around Salio; (2) along Waigeo’s southwestern shores from the entrance of Kabui Bay along the Kabui Strait all the way to Lupintol, with the exception of an enclave around Saporkren where logging as yet was strongly opposed; and (3) around Waremag (see Fig. 7).
MCP delineating the species’ EOO (see Fig. 7). An effort to harmonize borders is especially relevant at this time as a development master plan for the novel Raja Ampat regency is currently being drawn-up. More generally, based on the principle of representation, both in terms of species diversity as habitats, the region east of Mayalibit Bay must now immediately be upgraded as the key area for terrestrial conservation on Waigeo, and project intervention \textit{a priori} should serve that sector. The designation of Waisai (see Fig. 7) on Waigeo’s south coast as the capital of the novel Raja Ampat regency appears to be conflicting with the West Waigeo Nature Reserve, which in order to arrive at a gazetted 1,530 km² area surface, must comprise the entire low-lying western half of the island west of Mayalibit Bay, including Gam I. (Ministry of Forestry Decree 395/Kpts/Um/5/81 of 7 May 1981; see also Donnelly et al. 2003). Clearly, the development of this new regency impels attentive monitoring, and its explicit maritime disposition continuous hammering and advocacy. In addition, I recommend that: (1) An island-wide awareness campaign is set up to prevent future wild fires. (2) That ‘parforce’ pig-hunting and snaring be restricted to designated sectors near habitation and subsistence areas. (3) That the core locations of Bruijn’s Brush-turkey be declared strictly no hunting areas and accessed for scientific monitoring only.

Finally, from a conservation point of view five research priorities emerge: (1) Establish with absolute certainty that populations of Bruijn’s Brush-turkey indeed are present at both inferred principal locations (Mt. Danai and Mnier–Werar Hills) and the remaining hitherto unsurveyed ridges and peaks identified in this study. (2) Establish beyond reasonable doubt whether the species is genuinely absent from Batanta. (3) Study nesting site philopatry and the extent of gene flow across locations, preferably using a non-invasive molecular technique. (4) Investigate the impact of ENSO-induced drought events on the species’ reproductive success. (5) Study the impact of alien mammalian predators on the island.

Fundamental to any proposed conservation initiative for Waigeo is the idea that it should carefully balance the needs of local communities in terms of their ability to earn sufficient hard cash in order to obtain those basic goods and services that cannot be fulfilled from their subsistence way of living. Adherence to traditional customary 	extit{Adat} law, ownership and tenure of land, reefs and natural resources slackens as integration into the market-oriented cash economy accelerates rapidly. Growing cash-dependency combined with dramatically increased prices of basic commodities and services following the outbreak of the Indonesian monetary crisis deeply impact the islanders’ livelihood. Hence to ease the financial burden, there are enormous incentives from the communities’ perspective to sell off forestry resources on customary-owned ancestral land contravening with designated protected areas. Conflicts emerge because young generations increasingly reject the limitations on resource exploitation imposed by customary 	extit{Sasi} regimes that essentially evolved to ensure long-term sustainability through moderation and temporary abstinence. Moreover, Waigeo’s population is structurally diverse (Masinambouw 1983; Silzer and Clouse 1991), further complicating the issue of customary land and resource ownership because original inhabitants, ancient migrants, and indeed any community inhabiting a given sector for a prolonged period of time, all readily claim access rights beyond subsistence use (Donnelly et al. 2003; I.M. unpublished data). Unfortunately, there is little prospect that the novel regency government could alleviate such claims in the short term, considering its presently limited fiscal capacity and modest annual provision from the central government’s General Allocation Fund, which merely covers direct governance administrative costs. Unless the regional government thus succeeds in securing its own revenue in a sustainable, ideally non-resource-extractive manner, the devolution of power in Indonesia, at least in this particular instance, unfortunately will completely fail to redeem the real development expectations and issues at the community level. Moreover, because the private sector as a whole essentially took over the central role of governments in providing basic services, and because the communities are not
principally opposed to resource extraction *an sich* but merely expect to reciprocally benefit from it, convincing them to terminate unsustainable resource exploitation might prove exceedingly difficult, even if they do understand the long-term deleterious impact of such practices. Any conservation project intervention therefore likely will require immediately effective cash-generating alternatives to rival destructive resource use. However, it can also be expected that companies responding by evincing greater corporate responsibility through more equitable profit-sharing with compliant communities, due to the remunerative nature of unsustainable exploitation, might prove unchallengeable.

Conversely, there is an urgent need to socialize protected area concepts, regulations and borders to local communities and convert Waigeo’s ‘paper parks’ to meaningful, properly demarcated protected areas that allow sustainable multiple-usage in designated zones, in turn hopefully engendering earnest custodial responsibility for resource management with enforcement and prosecution support from the new regency government. Of course, there is something of a catch-22 here because a state-centered approach to conservation seeking proper *in situ* protected area management and rigorous enforcement is likely to exacerbate the glaring contrast between long-term conservation targets and the increasing desire of local people to, beyond subsistence use, harvest natural resources on their ancestral land. Moreover, the climate of impunity in which the forces that irretrievably destroy Waigeo’s natural heritage proceed, is in sheer contrast to the body of restrictive legislation in which those concerned over the crisis are compelled to operate. Under Indonesian law strict nature reserves specifically exclude multiple uses such as ecotourism or extractive activities of any kind irrespective of their potential sustainability. Consequently, this category of protected areas often proves to be the most difficult to gain general acceptance for, as both local communities and governments see no direct economic benefits. Conversion of Waigeo’s two strict nature reserves into a single integrated protected area with national park status and multiple-usage zonations may be instrumental to effectively accommodating for-profit project interventions. Within the limitations imposed by the political tussle in Papua, conservation programs fundamentally need to acknowledge and empower customary ownership and tenure through an elaborate process of participatory mapping that could create a terrestrial conservation area by consensus. Next, there is a decisive role here for the conservation society, through private-public partnerships and preferably direct for-profit project interventions, to alleviate claims to destructive resource extraction outside the consensus protected area.

5. Summary | The field discovery, ecology, monitoring and conservation of an enigma: Bruijn’s Brush-turkey *Aepypodius bruijnii* Oustalet 1880 | The endemic megapode of Waigeo Island in eastern Indonesia, Bruijn’s Brush-turkey *Aepypodius bruijnii*, managed to remain entirely unknown in the living world during the more than 120 years that elapsed in between its formal description and ultimate field discovery reported in detail here. It is revealed that this unique mound-builder nests only on the island’s previously ornithologically unexplored highest summits, along an ecological gradient above 620 m elevation where a structurally distinctive, wind-sheared and possibly locally edaphically controlled, stunted cloud-forest thrives on infertile substrates. The species is confirmed to breed at two locations only, and the known population totals 47 mound-owning males. Its global population is estimated at 349 mound-owning males or 977 mature individuals, primarily confined to 60 km² of cloud-forest habitat spread over six locations, with 98 % of the population restricted to just three locations in the eastern part of the island. Details are provided on the species’ incubation mounds, bare parts, vocalizations, behavior, life history, social organization, altitudinal distribution, habitat preferences, spatio-temporal use of incubation sites, population densities, locations, and incidental lowland records. Threats that impinge on the species are discussed in depth, and it is concluded that its current precautionary treatment as Vulnerable warrants
upgrading to Endangered in accordance with the revised IUCN Red List categories and criteria. Habitat destruction as a consequence of wild fires and a recent logging epidemic is identified as the major factor threatening this unique brush-turkey’s long-term survival.

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7. References


