

Type locality of the Edible-nest Swiftlet *Aerodramus fuciphagus* (Thunberg 1812) (Aves, Apodidae, Collocaliini) and present status of the topotypical population

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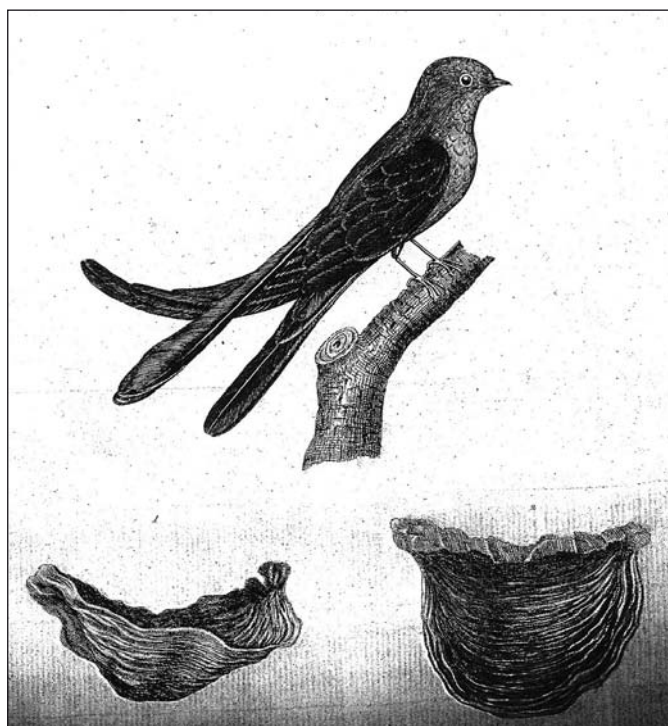
Aerodramus fuciphagus (Thunberg 1812), with the type locality 'Java', is widely used as the species name of swiftlets that produce the best quality 'white' edible nests. The author of this name, Carl Peter Thunberg, made a short diversion from the route from Buitenzorg (Bogor) to Batavia (Jakarta) in June 1777 to visit caves at Mount Tjerretton. Here he was presented with examples of the swiftlets and the edible nests made by them, as described and illustrated in a subsequent publication. The later nomenclatural vagaries of the Edible-nest Swiftlet of Java were resolved by demonstration that the type of nest built is species-specific, and therefore that Thunberg's name has undoubted validity and priority. In an attempt to find the type locality, a field visit in 2018 compared Thunberg's description of 'Tjerretton' ('Cherretton' in the English translation) with a hill and cave currently known as Keraton. Although the outcome was not conclusive, we are convinced that Thunberg's edible-nest swiftlets were from a cave in the Tajur-Klapanunggal karst area. One cave (Gajah) has been an important source of edible birds' nests from the 17th century to the present time. In the year 1948 the harvest from Gajah cave was 106,671 nests (approximately 1,000 kg). In 2017–2018, single harvests from Gajah cave were just over 2 kg, denoting a huge decline now threatening the topotypical population of this important species.

INTRODUCTION

In global and regional bird books and checklists, in scientific literature, in national and local laws and regulations and in the edible birds' nest trade in South-East and East Asia, the combination *Aerodramus fuciphagus* (Thunberg 1812), with the type locality 'Java', is very widely used as the species name of swiftlets that produce the best quality 'white' edible nests. The author of this name was a Swedish botanist and physician, Carl Peter Thunberg, a pupil and 'disciple' of Linnaeus, who made a visit to Japan in the late 18th century. On both stages of his journey, outward and returning, Thunberg spent time in Dutch colonial Java: one month in 1775 and six months in 1777.

Thirty-five years after his second visit, Thunberg (1812) published the description of '*de Svalor, som bygga gelé-actigte*

Figure 1. Illustration accompanying Thunberg's (1812) type description of *Hirundo fuciphaga* collected at 'Tjerretton'.

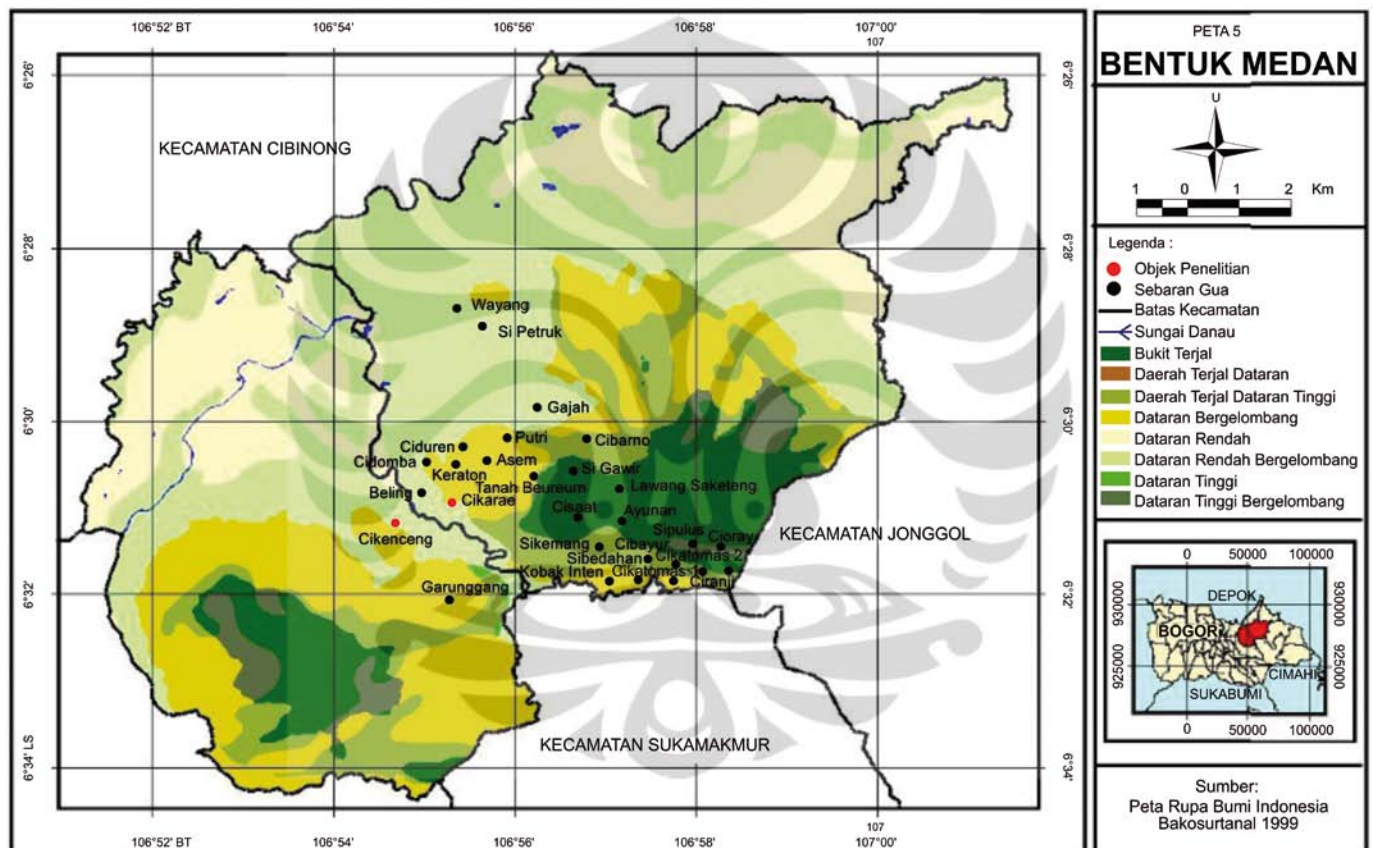


ätbare Nästen' [the Swallow that makes gelatinous edible nests]. Presumably familiar with travellers' tales and other semi-fabulous accounts of these birds, he chose the name '*HIRUNDO Fuciphaga*' [in translation, 'seaweed-eating swallow'], with the following description in Latin (part of which is translated into English): *Supra atra, subtus cinerea, tota immaculata* ['above black, below grey, unspotted throughout']. *Corpus supra atrum, immaculatum, vix nitens: subtus cinereum vel sordide fuscum seu albidum a gula ad basiu caudadae; pollices circiter quator longum. Rostrum brevissimum, depressum, apice incurvum. Cauda rotundata, supra infraque atra, tota immaculata, longitudine corporis* ['Tail rounded, above and below black, all unspotted, as long as the body']. *Alae atrae, immaculatae, acutae, cauda duplo longiores. Pedes nigri, breves. Habitat in Java, in Montium rimis preagrandibus, fere inacessilibus, ad Tjerretton; et alibi in insulis Moluccanis.* ['Lives in Java, in vast fissures of the hills, almost inaccessible, at Tjerretton; and elsewhere in the Moluccan islands']. This description was accompanied by an illustration that shows the bird, perched on a twig in an impossible posture, juxtaposed with two unmistakable 'white' edible nests, composed entirely of laminae of hardened secretions of the hypertrophic sublingual salivary glands (Figure 1). The details of Thunberg's description of *Hirundo fuciphaga* indicate that he had carcasses or skins before him, but he designated no type specimen.

Drawing on a biography of Thunberg by Skuncke (2014), Cranbrook (2018) mistakenly interpreted the locality 'Tjerretton' as a variant spelling of Cirebon, a city visited by Thunberg in 1777. Noting that no locality of this name was known by contacts among Indonesian speleologists, Cranbrook (2018) also suggested that Thunberg's specimens might have been taken in a cave at Ciampea, near Bogor, a known breeding locality of Edible-nest Swiftlets (Medway 1962).

Thunberg's travels were published first in Swedish (Thunberg 1788–1793) and shortly thereafter in English translation (Thunberg 1794–1795). In the latter, the account of his itinerary in Java in 1777 provides more precise information on the location of the cave ('Cherretton' in the English translation) where he obtained his material of *HIRUNDO Fuciphaga*. Using that descriptive data, we carried out field exploration in West Java in October 2018, focussing on a hill and cave currently known as Keraton, as described below. In the same limestone karst region, one nearby cave (Gajah) has continuously been an important source of edible birds' nests from the 17th century to the present time. Available records of nest harvests from this cave show a progressive decline to a very

Figure 2. The Tajur-Klapanunggal limestone karst area, reproduced with permission from Map 1 of the dissertation by Putri (2010).



low level in 2018, raising justifiable concern about the status of the toptypical population of these commercially and scientifically important Edible-nest Swiftlets.

NOMENCLATURE HISTORY OF THE EDIBLE-NEST SWIFTLET OF JAVA

In the early 17th century, spices were the principal local products sought by the merchants of the newly-established Dutch Vereenigde Oost-Indische Compagnie (VOC). There was also a profitable *entrepôt* trade in manufactured goods from Far Eastern sources, notably silks and porcelains (Leur 1960). The administrators of VOC soon discovered a local product particularly desired by the Chinese suppliers of these expensive goods: an edible birds' nest. This curiosity was described by local writers, including the physician Jacob de Bondt, an early resident of Batavia (Bontius 1658), and Georg Rumpf, the blind scholar of Amboyna (Rumphius 1750), and repeated in the *Ornithology* of the English scholar John Ray (1676). The first two sources were cited as defining references in the description of the bird that made edible nests, named *Hirundo esculenta* by Linnaeus (1758).

These authors wrote at a time when swallows (now Hirundinidae) were combined with swifts, later separated as Apodidae by Scopoli (1777). In his recapitulation of the characters of the glossy-plumaged species *esculenta*, Linnaeus repeated a feature noted by Rumphius (1750), describing it: '*rectricibus omnibus macula alba notatis*' ['with all tail feathers marked by a white spot']. White spots in all but the central pair of tail-feathers characterise the Glossy Swiftlet still known by Linnaeus's species name, *Collocalia esculenta* (Linnaeus 1758), occurring in Sulawesi, Ambon (the type locality) and elsewhere in the Moluccas, through New Guinea to the Solomon Islands (Rheindt *et al.* 2017). The nests of Glossy Swiftlets are composed of strands of vegetable material, bound together and attached to the substrate by a sufficient amount of

edible substance to make them marketable after processing, as described by Rumphius (1750). Following Linnaeus, for half a century the name *Hirundo esculenta* (Linnaeus 1758) was applied to all edible-nest swiftlets, including those of Java.

It appears that, some time after his visit to Java, Thunberg realised the significance of the white spots on the tail feathers as a defining character of *Hirundo esculenta* of Linnaeus (1758). His birds from 'Tjerretton', in Java, lacked this character and were matt-plumaged, and therefore represented a previously undescribed species of edible-nest swiftlet. His identification was widely accepted and, following separation of the swiftlets as genus *Collocalia* (gender feminine) by Gray (1840), the species name *Collocalia fuciphaga* (Thunberg 1812) came into general use for the Edible-nest Swiftlet.

The lack of a type specimen raised problems when, in 1900, among the birds that he had shot in flight, a tea-planter and naturalist collector resident at Sukabumi in Java, Max E. G. Bartels, recognised two similar dark-plumaged swiftlets, one larger than the other. Receiving the skins, the distinguished German ornithologist Erwin Stresemann realised that Thunberg's description could fit either. He applied the name *Collocalia fuciphaga* to the larger species and identified the smaller as *Collocalia vestita* (Lesson 1843), type locality Sumatra (Stresemann 1914). In a subsequent revision, Stresemann (1925) synonymised another dusky swiftlet from Java, *Hemiprocne salangana* Streubel 1848, with *C. fuciphaga*, and recognised *vestita* as a subspecies of *C. francica* (Gmelin 1789), then thought to range from Mauritius and Madagascar through islands of the tropical Indian Ocean, South-East Asia including the Indonesian Archipelago, to Papuaia and the South Pacific Islands. On information from the son of Bartels (also named Max), Stresemann (1925) believed that *C. fuciphaga*—thus newly circumscribed—made nests either from edible (salivary) substance or from vegetable materials. In a final revision, Stresemann (1931), who never got on top of the systematics of this notoriously difficult group of swiftlets, separated the small-bodied Javan populations of *vestita* as a new subspecies (*javensis*

Stresemann 1931) in the species *francica*, but made no further change to the status of Javan populations of *fuciphaga*, which he considered a taxon endemic to Java.

Today, taxonomic understanding of the dusky Javan edible-nest swiftlet group is very different, first clarified by the findings of Sims (1961) and Medway (1966), who showed that nest form and structure, whether of vegetable matter or of dried saliva, was species-specific. Their findings have in turn been clarified by DNA sequencing which has revealed convergences and parallelism in nest structure and still more complex relationships (Lee *et al.* 1996, Price *et al.* 2004, 2005, Thomassen *et al.* 2005, Rheindt *et al.* 2014). The dull dusky palaeotropic swiftlets that Stresemann (1914, 1925, 1931) and others had included with the glossy swiftlets in *Collocalia* are now separated in the genus *Aerodramus* (Oberholser 1906) (gender masculine), following Brooke (1972). Most of the multitude of subspecies that Stresemann (1914, 1925, 1931) had clustered in *fuciphagus* and *francicus* are now split off as species as well. The larger of the two dusky Javan swiftlets was found to make a nest of primarily vegetable materials bound with little saliva; Streubel's name *salangana* was found to apply and has been resurrected for it. This species is now understood to occur throughout the Greater Sundas, reaching the south Philippines. The smaller of the two is the Edible-nest Swiftlet of Java, making white, all-saliva nests; and the circumstances of its original collection by Thunberg, with both nests and birds, confirm that *fuciphagus* Thunberg 1812 is its senior and valid name, in the combination *Aerodramus fuciphagus*. Stresemann's (1931) name *javensis* is a junior synonym; and *vestitus* Lesson is a replacement subspecies of *fuciphagus* in Sumatra and Borneo (Dickinson & Remsen 2013).

EDIBLE BIRDS' NEST CAVES

At the time of Thunberg's return visit to Java (1777), the trade in edible birds' nests was providing significant tax revenue for the VOC. A few decades later, during the British occupation of Java (1811–1816), the annual export of edible nests to China was 200 *pikul* (12,300 kg), of which half was harvested from the state-owned caves in the sea-cliffs of Karangbolong on the south coast (Raffles 1817, 1: 205–208). From 1743, the VOC had claimed the coastal strip 2.5 km wide, and hence these caves. By an arrangement agreed in 1757, the right to collect the nests was returned to the rulers of Yogyakarta and Surakarta, but the harvest had to be sold to the Dutch residents stationed at the royal courts. These officials transmitted the nests to the provincial Governor at Semarang who, in turn, forwarded them to Batavia, where taxes amounting to 22% *ad valorem* were exacted (Blussé 1994).

There were also productive areas of limestone karst and caves in the Priangan *Ommelanden* [hinterland] nearer Batavia. Those at Ciampea, north-west of Buitenzorg, were bought in 1778 by J. van Riemsdijk for the sum of 60,400 Rijksdollars, and may have yielded up to 40 *pikul* (2,470 kg) per annum (Blussé 1994). On the opposite side of Buitenzorg was another valuable location, now identified as the Tajur-Klapanunggal karst area (Putri 2010). The birds' nest caves of this area had been known to the VOC authorities for many years, as shown by the account in the Daily Register of Batavia Castle of a 12-day trip (11–23 August 1690) to Klapanunggal and Gunung Karang by a small military detachment (ANRI 1690). This report included descriptions of edible birds' nest caves, the chief being known as Guha Gajah (elephant cave) because of the image of an elephant in rock in the interior. This cave had a single vertical entrance, requiring a rope to descend, leading to extensive underground chambers including one that, in the Dutch original of this report, was said to resemble a 'paleys', in Indonesian *istana* or, alternatively, *keraton*, a term that drew our attention when we began to investigate its location.

Table 1. Named caves in the plan of Michiels's concession at Klapanunggal, provided in 1961 by P. P. N. (Baru).

Sedelon	Sibunut	Sikori	Siagara
Siangin	Sidarandan	Sikukulu	Siorai ^{1,2}
Siangin	Siduren ¹	Silandak	Sipajing
Sibajangbang	Sigadjah ^{1,2}	Silaneuh	Sipapagan
Sibajur ¹	Sigawir ²	Sileungsi	Siponek
Sibalubawang	Sigugula	Sileuwit	Situdang
Sibebedahan ^{1,2}	Sikaijang	Siljerlang	Tanahbeureum ^{1,2}
Siberla	Sikambar	Siljuring	Tjikatarna
Sibetot	Sikaret	Silungtek	
Sibudjang	Sikolak	Simarang	

Notes:

1. Cave names also mapped by Putri (2010) in the Tajur-Klapanunggal karst area.
2. Cave names also listed by the Indonesian Speleological Society website <http://caves.or.id/>.

Table 2. Named caves of Tajur-Klapanunggal karst area shown by Putri (2010: Map 1).

Asem ¹	Cikarae ¹	Gajah ^{1,2}	Si Gawir ¹
Ayunan	Cikatomas ¹	Garunggang	Si Petruk
Baling	Cikatomas (2) ¹	Keraton ¹	Sibedahan ¹
Cibarno	Cikenceng ¹	Kobak Inten ¹	Sikemang
Cibayur ^{1,2}	Cioray ^{1,2}	Lawang	Sipulus
Cidomba ¹	Cirani	Saketeng	Tanah Beureum ^{1,2}
Ciduren ²	Cisaat	Putri	Wayang

Notes:

1. Cave names also listed by the Indonesian Speleological Society website <http://caves.or.id/>.
2. Cave names also shown on the plan of P. P. N. (Baru), formerly Michiels's concession area.

Table 3. Nest harvests from Gajah cave. 1960s data provided by H. Ubak Sya'roni; 2017–2018 data provided by present cave managers. Cave managers estimate c. 100 nests per kg.

Year	Date	Amount (kg)
1961	12 October	184.76
1962	18 February	122.78
	29 April	180.13
	24 June	148.12
	19 August	197.06
	18 November	187.66
	Total	
1963	20 January	134.72
	March	153.75
	26 May	142.53
	August	149.90
	Total	
1964	20 January	131.23
	19 March	147.47
	20 May	162.41
	3 September	146.70
	7 December	147.21
	Total	
1965	28 February	150.80
2017	September	2.1
	December	2.4
2018	March	2.8
	June	2.1
	September	2.1
	December	Not harvested

Figure 3. The plan of Michiels Klapanunggal concession of 6,660 ha, transferred in 1948 to P. P. N. (Baru).

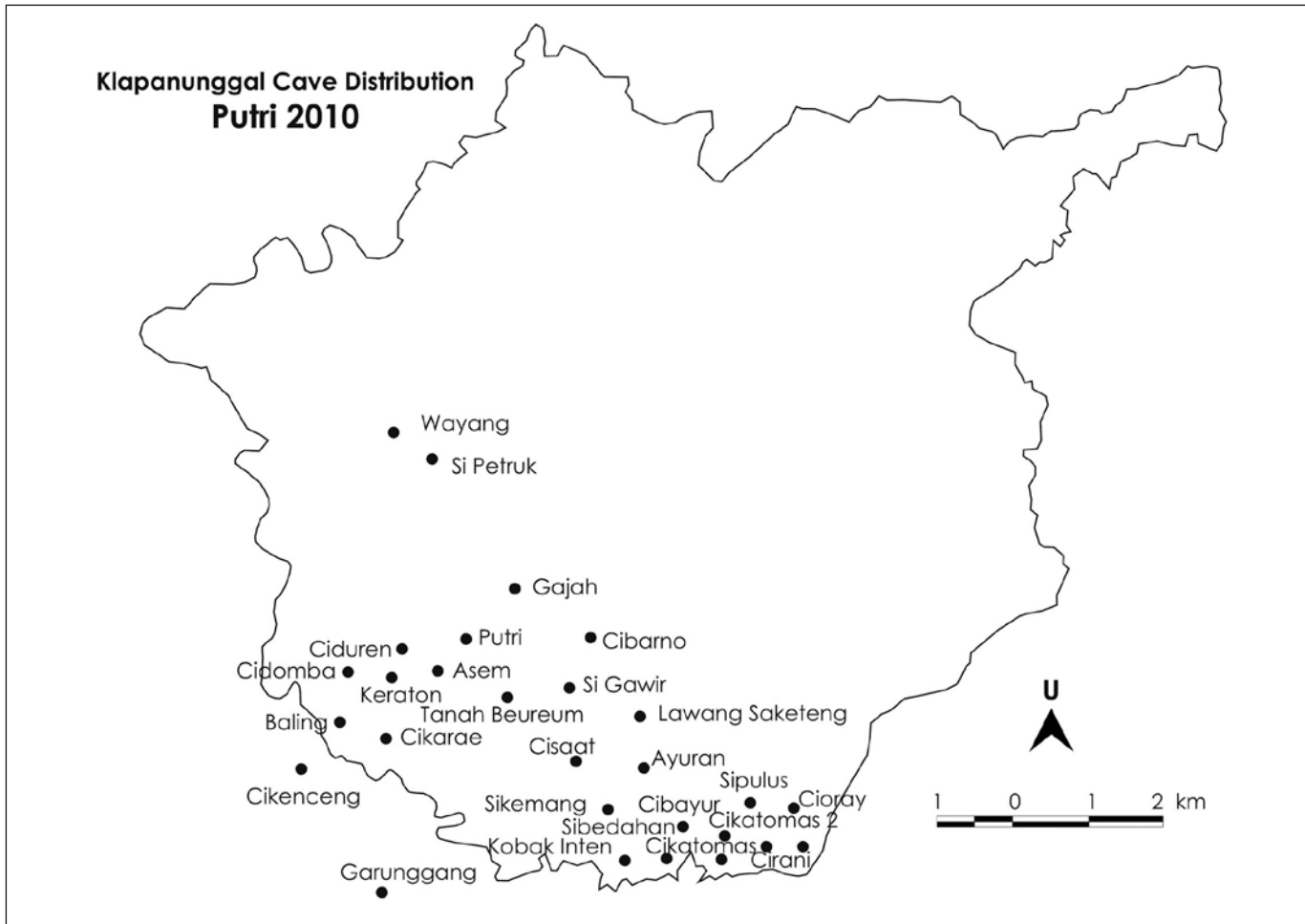
According to local tradition, rights to harvest the edible nests in Klapanunggal caves, among which Gajah was the most important, were acquired (by inference in the mid-18th century) by Raden Simarjaya, an exile from Banyumas, who was succeeded in ownership by his son Raden Kartawijaya Narun (Sya'roni 1990). In Narun's time, according to Sya'roni (1990), the Klapanunggal concession was sold by VOC to a member of the family Michiels. Lohanda (1985) and Snoek (2003) confirm that the date was 1778, the purchaser Jonathan Michiels (1737–1788), the price 26,400 Rijksdollars, and the nest harvest (in 1777) 10 *pikul* (617 kg), valued at 5,000 Rijksdollars. According to Sya'roni (1990), an agreement between Michiels and Narun stipulated that descendants of the latter should continue to manage the caves at Klapanunggal, be free from conscription and levies imposed by the colonial administration, and that 10% of the income from the cave should be paid to the local community of Kampung Guha. These conditions did not prevent Jonathan Michiels from prospering greatly. In the next generation, backed by profits from the nest harvest at Klapanunggal, his younger son and sole successor, Augustijn Michiels, also known as Mayor Jantje (1769–1833), was reputed to be the wealthiest man in the *Ommelanden* (Fabricius 1985). After his death, Augustijn Michiels's estate was dispersed, and a considerable portion of his land-holding passed to his daughter Agraphina (Snoek 2003).

THUNBERG'S JOURNEYS

On his first visit to Java, in 1775, Thunberg remained in Batavia, administrative capital of the VOC, making arrangements for his onward voyage to Japan. On the return journey, his ship docked in Batavia on 4 January 1777. From the end of March, he travelled eastward to Cirebon and Semarang, where he lodged with the physician J. F. A. Bönneken. The provincial Governor gave the two men a pass to the VOC's fortified posts, and invited them to make an inventory of local plants that were or could be used for medicinal purposes (Skuncke 2014). Thunberg returned to Batavia on 1 June 1777. Shortly thereafter, he set off again for the inland hill resort at Cipanas.

On his return from Cipanas, Thunberg's journey took him through Megamendoeng (now Megamendung), arriving at Buitenzorg (now Bogor) on 25 June 1777 (Steenis-Kruseman 1950). On the following day, he continued on the route to Batavia, where he arrived on 28 June. Meanwhile: 'On the 26th, we made another short excursion from the strait road to Mount Cherretton, which is worthy of note in many respects. It stands quite detached almost in the middle of the country. Our chief view in going thither was to see its singular cavities, in which the Swallows (*Hirundo esculenta*) build their nests that are gelatinous in nature, and are used as food. We

Figure 4. Named caves shown on Plan 1 of Putri (2010).



ascended on foot within a short space of time, to the summit of the mountain, and found that these cavities were, strictly speaking, on the southern side of the mountain, and were quite covered at the top ... I entered into several of these, and descended likewise a good way into them ... The Javanese would not allow us to take any nests away with us, but had nevertheless the politeness, not only to give us some which were undamaged, but likewise to present us, at our request, with two Swallows, of the species that built here, and which were small and quite black' (Thunberg 1794–1795 4: 163-164).

A short diversion, not far after the start of the journey from Buitenzorg to Batavia, would have taken Dr Thunberg into the Tajur-Klapanunggal Karst Region (Putri 2010; Figure 2). As noted above, for at least 87 years the VOC administration had known that this area was an important source of edible birds' nests. In 1777, the Klapanunggal caves were still in the hands of Javanese owners, such as those whose courtesy in providing him with examples of birds and nests was noted by Thunberg. The following year (1778), the concession was sold to Jonathan Michiels. That the Michiels family retained possession until World War II is confirmed by the title of ownership ('P.P.N. Baru / Konsesi Guha / EX Michiels Arnold N.V') on a plan given to Cranbrook in January 1961 by Serjeant Kosim, at that time administrator of *Pusat Perkebunan Negara (Baru)* [Central National Plantations (New)], *Tjabang Djawa-Barat*, Unit II. The concession area was 6,660 ha, and the plan showed the location of 38 named birds' nest caves (and three groups of caves) (Table 1, Figure 3). Allowing for changes in orthography, none of these cave names could be transliterated in Latin, Swedish or English, respectively, as Tjerretton, Tcheraton or Cherretton. For comparison, Putri (2010) mapped 26 named caves (two with the same name) within the Tajur-Klapanunggal karst area, and the

website of the Indonesian Speleological Society (<http://caves.or.id/>) lists 22 named caves (Table 2). Allowing for change from Dutch to modern Indonesian spelling, there is limited overlap between these three sources. Clearly, there has been, and still is, considerable fluidity in the names of caves.

FINDING 'TJERRETTON', 'TCHERATON' OR 'CHERRETTON'

Thunberg's account of his journey on 26 June 1777 (above) shows that 'a short diversion from the strait road' would have taken him into the Tajur-Klapanunggal Limestone Karst area, lying east of the route to Jakarta, now in Desa Leuwikaret, Kecamatan Klapanunggal. There is little doubt that the initial consonant cluster (Tj, Tch or Ch) of different language versions (Latin, Swedish or English, respectively) in standard Indonesian spelling would now be transcribed as 'C', i.e. Cereton or Ceraton. No hill or cave with this name is found in any of the three sources (Tables 1 & 2). Considering the likelihood that, over some 240 years, the name may have changed, our attention focussed on a hill and cave known as Keraton, a relatively minor transformation of Thunberg's original name (Table 2, Figure 4).

By courtesy of the Institut Pertanian Bogor (IPB University), transportation was provided on 17 October 2018. From the vehicle, we could not avoid sight of the huge cement factories in the neighbourhood and, at the point where we turned into the road towards Leuwikaret, a small karst outcrop was being quarried to extinction. In the village, we enlisted assistance from Palikar (Pecinta Alam Leuwikaret), an association for climbing and caving in this area, offering guided visits to many named local caves. With



ALAN SPECK

Plate 1. The entrance to Gua Gajah, bottom left, showing the wall around the present enclosure, June 2015.



ALAN SPECK

Plate 2. The entrance to Gua Gajah is a vertical descent, June 2015.

two guides added to the team, a short drive from Leuwikaret village and a walk from the parked vehicle led to an entrance to Keraton cave lying, in conformity with Thunberg's account, on the southern side of the hill, overlooking the broad valley of the river Cileungsi, at 6.517°S 106.924°E. Proceeding from the small entrance chamber, a short incline downwards led to a lateral passage, accessed by a step-up onto the flattened top of a wet stalagmite. A further short walk brought us to the brink of a deep fissure, open above at the summit of the hill and dropping before us to a depth of 90–100 m, according to the Palikar guides. The cave floor of the short passages to this point consisted of trodden earth, with no guano. Features matching Thunberg's account are the position of the cave on the southern side of the hill, and the deep vertical fissure dropping from the summit of the hill, down to a lower level of caverns. However, the two guides from Palikar told us that, while there were many bats in the passages that lay below, there were no swiftlets in this cave, and no history of past occupation by swiftlets.

CONCLUSION

Uncertainty about the cave name and the lack of a present or confirmed past population of Edible-nest Swiftlets prevent us from claiming that, at Keraton, we have definitely rediscovered 'Tjerreton' cave. Of alternative possibilities, Gajah cave (nearby, at 6.511°S 106.923°E) would have been equally close for Thunberg to pass by in 1777, on a 'short diversion from the strait road [from Buitenzorg to Batavia]'. As noted (above), the 1690 detachment from Batavia castle likened a chamber in Gajah cave to a 'paleys', possibly translated 'keraton'. However, Gajah cave was known consistently by that name since at least 1690, and Thunberg is unlikely to have been told another. Moreover, Gajah has a single entrance opening in fairly level topography (Plates 1 & 2), not on the southern slope of a hill. Nonetheless, we are confident that the Tajur-Klapanunggal Limestone Karst region can be confirmed as the locality where, from a cave then known as 'Tjerreton', Thunberg collected edible nests and the 'swallows', 'small and quite black'. This result identifies the type locality of the Edible-nest Swiftlet *Aerodramus fuciphagus* (Thunberg 1812) as the Tajur-Klapanunggal Limestone Karst region.

Diary notes made during a visit to Gajah cave in January 1961 by Cranbrook (then known as Lord Medway) included statements by informants of past nest yields, said to be based on four harvests per annum at intervals of 85, 85, 85 and 110 days, with the last long interval intended to allow the birds to rear viable young. In 1948,

the first year of the new, mixed civilian and military administration of P. P. N. (Baru), the annual harvest from Gajah cave was 106,671 nests (approximately 1,000 kg) and, in 1960, 70,845 nests, weighing 636 kg (Medway 1961). Subsequent data from 1961–1965 show that, in practice, the regime was more variable: intervals between harvests ranged from 52–95 days, while four or five harvests yielded annual totals that declined progressively. Half a century later, in 2017–2018, only Gajah cave remains under management, and information provided by the managers shows a regime of quarterly harvests, each yielding little over 2 kg (Table 3). These figures represent a huge decline in the population of Edible-nest Swiftlets occupying this historic cave. It is likely that inappropriate management practices over many years have been the cause.

For comparison, swiftlets of the same species but a different subspecies, *Aerodramus fuciphagus vestitus* (Lesson 1843), nesting in limestone caves of the Baram region, Sarawak, Malaysia, show a multi-brooded cycle of determinate two-egg clutches, with two or three breeding peaks in the season from August to the following May or June (Lim & Cranbrook 2014). The average duration of nest-building is 30 days, with an extension of 10–14 days if the previous nest was harvested before the cycle was completed; incubation average 25 days (range 19–32 days); fledging average 45 days (range 37–54 days). In conditions prevailing in Sarawak, successful breeding between one nest harvest and the next by the local subspecies of Edible-nest Swiftlet therefore requires on average 110 days and at the extreme 130 days to ensure the fledging of viable young birds. Despite differing environmental conditions experienced at Klapanunggal by the toptypical subspecies *A. f. fuciphagus*, it is unlikely that the duration of successive stages of nest-building, incubation and fledging will differ significantly. If the nest harvest has been repeated throughout Gajah cave at quarterly (90 day) intervals, many breeding pairs will have failed to rear viable young. Unless sufficient pairs are left to breed, adult mortality will inevitably exceed recruitment. The decline in yields from 1948–1949 to 1959–1960 suggests that, even at that time, the nest-harvesting practices were unsustainable.

There are now large cement factories in Michiels's former Klapanunggal concession area, later held by P. P. N. (Baru). In 2019, the community managing Gajah cave, who claim traditional rights as descendants of Raden Simarjaya (Sya'roni 1990), have recognised the critical situation, and have closed the cave. Even if Gajah is not the only cave in Kecamatan Klapanunggal still occupied by a colony of Edible-nest Swiftlets, the disastrous decline in yields has serious implications for the remaining toptypical population of *Aerodramus fuciphagus fuciphagus* (Thunberg 1812).

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REFERENCES

- ANRI [Arsip Nasional Republik Indonesia] (1690) HR 2506. *Dagh Register in het Kasteel Batavia*. 23 August 1690, fols. 377–384.
- Blussé, L. (1994) [In praise of commodities: an essay on the cross-cultural trade in edible bird's-nests]. Pp.317-355 in R. Ptak & D. Rothermund, eds. *Emporia, commodities and entrepreneurs in Asian maritime trade C. 1400-1750*. Stuttgart: Franz Steiner Verlag.
- Bontius, J. (1658) [Historiae naturalis & medicae Indiae Orientalis] In W. Piso, ed. *De Indiae Utriusque re naturalis et medica*. Amsterdam: Elsevier.
- Brooke, R. K. (1972) Generic limits in old world Apodidae and Hirundinidae. *Bull. Brit. Orn. Club* 92: 53-57.
- Cranbrook, Earl of (2018) New light on the type locality of the Edible-nest Swiftlet *Aerodramus fuciphagus* (Thunberg, 1812). *The Linnean* 34: 11-14.
- Dickinson, E. C. & Remsen, J. V., Jr, eds. (2013) *The Howard & Moore complete checklist of the birds of the world*. Fourth edition, vol. 1. Eastbourne: Aves Press.
- Fabricius, J. (1985) *Burung-burung walet Klapanoenggal, dengan makalah*. Jakarta: Pustaka Azet.
- Gray, G. R. (1840) *A list of the genera of birds with an indication of the typical species of each genus*. London: R. & J. E. Taylor.
- Lee, P. L. M., Clayton, D. H., Griffiths, R. & Page, R. D. M. (1996) Does behaviour reflect phylogeny in swiftlets (Aves: Apodidae)? A test using cytochrome b mitochondrial DNA sequences. *P. Natl. Acad. Sci. USA* 93: 7091-7096.
- Leur, J. C. van (1960) *Indonesian trade and society*. Bandung: Bandung Sumur.
- Lim, C. K. & Cranbrook, Earl of (2014) *Swiftlets of Borneo: builders of edible nests*. Second edition. Kota Kinabalu: Natural History Publications.
- Linnaeus, C. (1758) *Systema Naturae per regna tria naturae*. 10th edition. Stockholm: L. Salvius.
- Lohanda, M. (1985) [Mayor Jantje dan unsur Indo-Belanda dalam musik rakyat Betawi.] Pp.157-178 in J. Fabricius, *Burung-burung walet Klapanoenggal*. Jakarta: Pustaka Azet.
- Medway, Lord (1961) Unpublished diary 20 January 1961 'At the Watchers' hut, Si Gajah cave, near Kg. Guha, Klapanunggal'. Photocopy deposited at Lee Kong Chian Natural History Museum, National University of Singapore.
- Medway, Lord (1962) The swiftlets (*Collocalia*) of Java and their relationships. *J. Bombay Nat. Hist. Soc.* 59: 146-153.
- Medway, Lord (1966) Field characters as a guide to the specific relations of swiftlets. *P. Linn. Soc. Lond.* 177: 151-172.
- Price, J. J., Johnson, K. P. & Clayton, D. H. (2004) The evolution of echolocation in swiftlets. *J. Avian Biol.* 35: 135-143.
- Price, J. J., Johnson, K. P., Bush, S. E. & Clayton, D. H. (2005) Phylogenetic relationships of the Papuan Swiftlet *Aerodramus papuensis* and implications for the evolution of echolocation. *Ibis* 147: 790-796.
- Putri, I. M. G. (2010) *Persebaran gua dan morfometri endokarst di Kawasan Karst Tajur-Klapanunggal, Kabupaten Bogor, Jawa Barat*. Unpublished dissertation. Department of Geography, Faculty of Mathematics and Natural Sciences, University of Indonesia.
- Raffles, T. S. (1817) *The History of Java*. 2 vols. London: Black, Parbury & Allen for the Hon. East India Company.
- Ray, J. (1676) *Francisci Willughbeii Ornithologiae*. London: Royal Society.
- Rheindt, F. E., Christidis, L., Norman, J. A., Eaton, J. A., Sadanandan, K. R. & Schodde, R. (2017) Speciation in Indo-Pacific swiftlets (Aves: Apodidae): integrating molecular and phenotypic data for a new provisional taxonomy of the *Collocalia esculenta* complex. *Zootaxa* 4250: 401-433.
- Rheindt, F. E., Norman, J. A. & Christidis, L. (2014) Extensive diversification across islands in the echolocating *Aerodramus* swiftlets. *Raffles B. Zool.* 62: 89-99.
- Rumphius, G. E. (1750) *Herbarium Amboinense (Het Amboinsche Kruid-boek)*. Edited by J. Burmannus. Amsterdam: Meinardum Uytwerf.
- Sims, R. W. (1961) The identification of Malaysian species of Swiftlets *Collocalia*. *Ibis* 103a: 205-210.
- Scopoli, G. A. (1777) *Introductio ad historiam naturalem*. Prague: Wolfgangum Gerle.
- Skuncke, M. C. (2014) *Carl Peter Thunberg: botanist and physician*. Uppsala: Swedish Collegium for Advanced Study.
- Snoek, K. (2003) *Manhafte heren en rijke erfdochteren. Het voorgeslacht van E. du Perron op Java*. Leiden: KITLV Uitgeverij.
- Steenis-Kruseman, M. J. van (1950) Malaysian plant collectors and collections being cyclopaedia or botanical expiration in Malaysia and a guide to the concerned literature up to 1950. *Flora Malesiana*. Ser. 1 Spermatophyta 1: 2-639.
- Stresemann, E. (1914) Was ist *Collocalia fuciphaga* (Thunb.)? *Verhandlungen der Ornithologischen Gesellschaft in Bayern* 12(1): 1-12.
- Stresemann, E. (1925) Bruchstücke einer Revision der Salanganen (*Collocalia*). *Mitteilungen Zoologischen Museum Berlin* 12(1): 179-190.
- Stresemann, E. (1931) Notes on the systematics and distribution of some swiftlets (*Collocalia*) of Malaysia and adjacent subregions. *B. Raffles Mus.* 6: 83-101.
- Sya'roni, H. Ubak (1990) *Status kepemilikan terhadap sarang burung walet di Gua Gajah, Kampung Guha Tonggoh, Desa Leuwikaret*. Cyclostyled booklet, foolscap, pp.15.
- Thomassen, H. A., den Tex, R. J., de Bakker, M. A. G. & Povel, G. D. E. (2005) Phylogenetic relationships among swifts and swiftlets: a multi locus approach. *Mol. Phylogenet. Evol.* 37: 264-277.
- Thunberg, C. P. (1788–1793) *Resa uti Europa, Afrika, Asia förätrad Aren 1770-1779*. 4 vols. Uppsala.
- Thunberg, C. P. (1794–1795) *Travels in Europe, Africa, and Asia etc.* 4 vols. London.
- Thunberg, C. P. (1812) Anmärkning om de Svalor, som bygga gelè-acktige ätbare Nästen. *Konglige Vetenskaps Acadamiens Nya Handlingar* 33: 151-156.
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