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Attenborough's echidna rediscovered by combining Indigenous knowledge with camera-trapping

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We confirm the 'rediscovery' of Attenborough's long-beaked echidna (*Zaglossus attenboroughi*), one of only five modern egg-laying mammals and, until now, one of the planet's most enigmatic 'lost species'. Unrecorded for 62 years, we present the first scientific evidence of its survival to the present day. We highlight the importance of combining local Indigenous knowledge with camera-trapping to making the rediscovery, and we also discuss follow-up conservation actions to safeguard this Critically Endangered species.

When species go undocumented for sustained periods of time this raises extinction concerns. In 2022, Long and Rodriguez proposed a nomenclature to describe long unrecorded animal, plant, and fungi species that are not yet classified extinct: those for which no genetic, photographic, or audio evidence has been recorded in over a decade are called 'lost species'[1]. Currently there are more than 2,000 so-called lost species[1]. Some may well be extinct – casualties of a global biodiversity crisis[2] – but rediscoveries offer hope that others survive[3], especially in places where biological research has been limited[4].

On the world's largest tropical island, New Guinea, numerous species rediscoveries have recently been made[5], including in the remote North Coastal Ranges (NCR) – isolated mountain areas with profound endemism situated across northern New Guinea[6]. Among the NCR, the Cyclops Mountains (Fig. 1) is the only known location in which another lost species, Attenborough's long-beaked echidna, *Zaglossus attenboroughi* (Flannery & Groves, 1998), has been recorded in modern times, when the holotype specimen was collected in 1961[7].

Taxonomists currently recognise three modern long-beaked echidnas, classified in the genus *Zaglossus*: the Western long-beaked echidna (*Z. bruijnii*); the Eastern long-beaked echidna (*Z. bartoni*); and Attenborough's long-beaked echidna (*Z. attenboroughi*). Together they represent three of the five modern egg-laying mammal species — sole living representatives of the monotreme lineage that diverged from therians (marsupials and placental mammals) approximately 200 million years ago (mya)[8–10]. *Z. attenboroughi*, named after naturalist Sir David Attenborough, was described as a new species in 1998[7], based on the holotype specimen (Fig. 2b) collected in 1961 from Gunung Rara, a peak in the Cyclops[7]. One additional modern museum specimen referred to as *Z. attenboroughi* has been reported in the literature, a small adult long-beaked echidna (Australian Museum, Sydney, specimen AM M.9852, full skeleton) collected from an uncertain locality in New Guinea in 1958[10]. The species is listed as Critically Endangered by the IUCN[11] and is a global priority for mammal conservation under the Zoological Society of London's EDGE (Evolutionarily Distinct and Globally Endangered) programme[12].

Countering concerns that *Z. attenboroughi* went extinct after the collection of the holotype in 1961, a team discovered 'nose pokes' (echidna trace signs created when they forage for underground invertebrates[13], see Fig. 2a) in the Cyclops in 2007 and Indigenous communities reported echidna sightings in the previous twenty years[14]. In 2017 and 2018, researchers used participatory mapping and Indigenous and local knowledge surveys to assess the probability that echidnas persist. The study recorded numerous sightings, and extinction date estimation analysis indicated that echidnas were likely extant in 2020[15].

In 2022 and 2023, we deployed camera-traps in the Cyclops Mountains, guided by the results of Indigenous and local knowledge surveys, in an attempt to gather photographic evidence of the survival of Attenborough's long-beaked echidna.

Results

Attenborough's long-beaked echidna still survives in the Cyclops Mountains

We didn't capture any photographic evidence of *Z. attenboroughi* during the 2022 survey; from the 2023 survey, we obtained 110 echidna photographs (e.g. Fig. 2c–f) from 26 independent capture events, taken by six different cameras deployed at higher elevations in the Cyclops Mountains. We also captured 15 videos (e.g. Supplementary Movies 1–3). Confirming the

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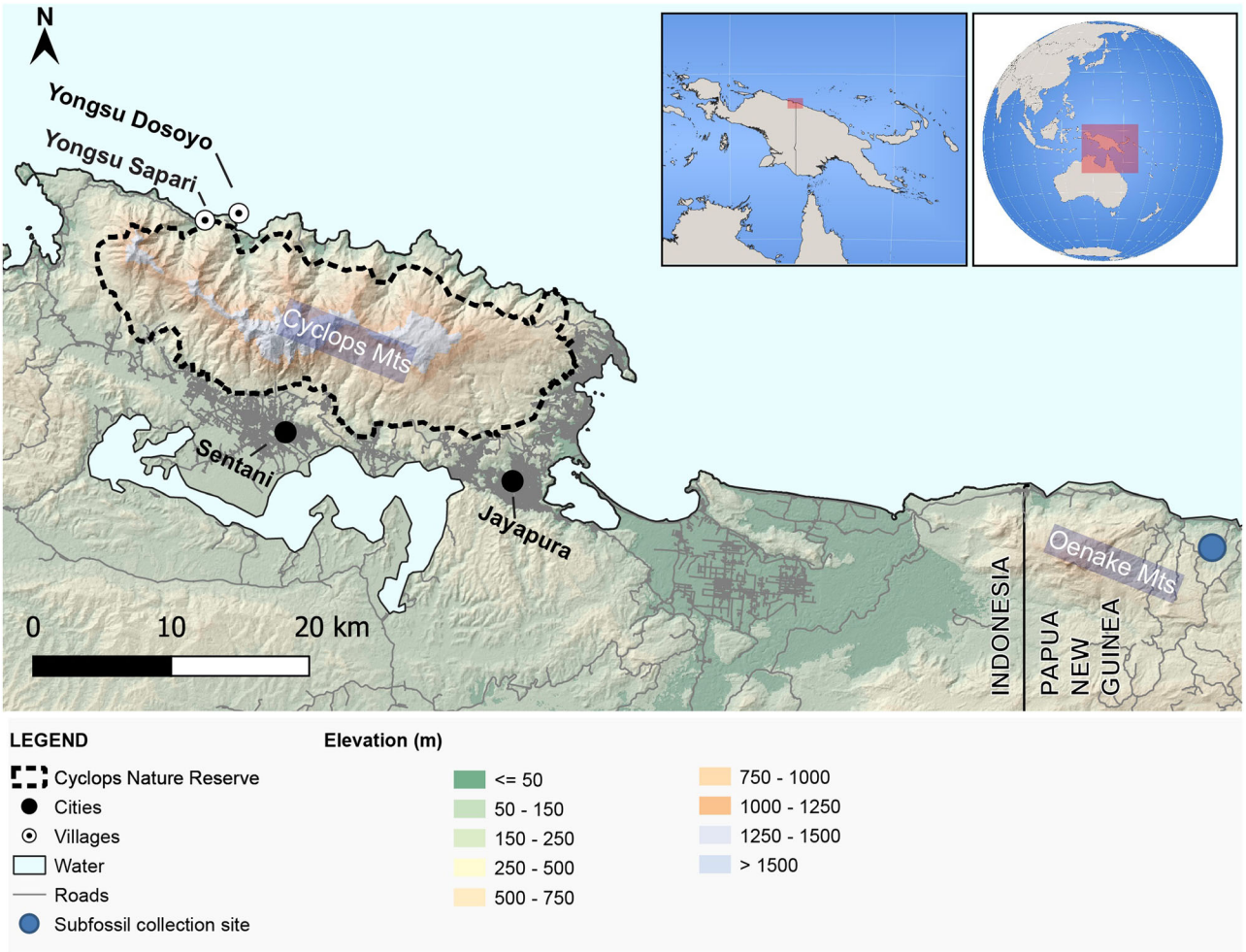

Fig. 1 | The Cyclops Mountains region. The Cyclops Mountains are a small range at the Indonesia-Papua New Guinea border. The mountains, which reach a maximum altitude of 1970 m, contain the 31,500 ha Pegunungan Cycloops protected area (black dashed line), and are surrounded by urban settlements to the south and west, and small villages of Indigenous communities, such as Yongsu Sapari and Yongsu Dosoyo, to the north. The Cyclops are the last known location of Attenborough's long-beaked echidna, but there is also subfossil evidence from Lachitu Cave in the Oenake Mountains, Papua New Guinea, that it once existed there (see Supplementary Fig. 1).

identification of the photographed animals requires examining features that distinguish different *Zaglossus* species. The two principal species to consider are *Z. attenboroughi*, the only species reported to date from higher elevations in the Cyclops, and *Z. bruijnii*. Though *Z. bruijnii* is currently thought restricted to the far west of New Guinea, there are historical records from northern regions[17], including a museum specimen registered as coming from Humboldt Bay, next to the Cyclops, in 1911 (mammal collection of Museum Zoologicum Bogoriense, Cibinong, Indonesia, specimen number 404). This makes *Z. bruijnii* a relevant candidate for an echidna species documented in the Cyclops today.

In contrast, there are no records of the most widespread species of *Zaglossus*, *Z. bartoni*, from the Cyclops area, though it does have a broad distribution across most other mountain regions of New Guinea, including other NCR[18]. *Z. bartoni* and *Z. attenboroughi* are similar species distinguished – on the basis of the two museum specimens of the latter thus far available – mainly by the markedly smaller size of *Z. attenboroughi*[7]. Though we cannot firmly distinguish between *Z. attenboroughi and Z. bartoni* based on the camera-trap images, the echidnas in the images appear consistent in overall size, and we conclude only one species is present. Current taxonomic consensus is that *Z. bartoni and Z. attenboroughi* are closely related allospecies that are distributed vicariantly and do not occur sympatrically[7]. Of the two species, as *Z. attenboroughi* is the only one so far recorded in the Cyclops, we conclude the camera-trap images are not of *Z. bartoni*, and are thus either of *Z. attenboroughi* or *Z. bruijnii*. This being said, given the widespread distribution of *Z. bartoni*, and its variability in body size, pelage colour, and fur thickness[7], we believe there is a need for a renewed focus on the taxonomy and geographic variation of all *Zaglossus*. No integrative review of *Zaglossus* taxonomy drawing on both morphological features and genetic comparisons has ever been published. Future work is needed to evaluate the taxonomic status of various long-beaked echidna populations, and to confirm whether *Z. attenboroughi* should be recognised as a distinct species or, for example, as a small-bodied population of *Z. bartoni*.

More morphologically distinctive is the Western long-beaked echidna, *Z. bruijnii*, which differs from *Z. bartoni* and *Z. attenboroughi* in skull features, usually shorter fur, greater likelihood of spines being present on the underside, and in foot anatomy. A key external feature distinguishing *Z. bruijnii* from other echidna species is the three, or occasionally four, claws on the forefeet – other echidna species have five[7]. Our camera-trap footage (e.g. Fig. 2c–f) shows individuals with five claws (Fig. 2d) on the forefeet, consistent with *Z. attenboroughi* but not with *Z. bruijnii*. From the photographic evidence, combined with the fact that *Z. attenboroughi* is the only echidna species known from higher elevations in the Cyclops, we conclude the continuing survival of this 'lost species'. Furthermore, we captured photographs of multiple individuals, seemingly in courtship (Fig. 2f), suggesting that not only does *Z. attenboroughi* survive, but its population is also reproducing.

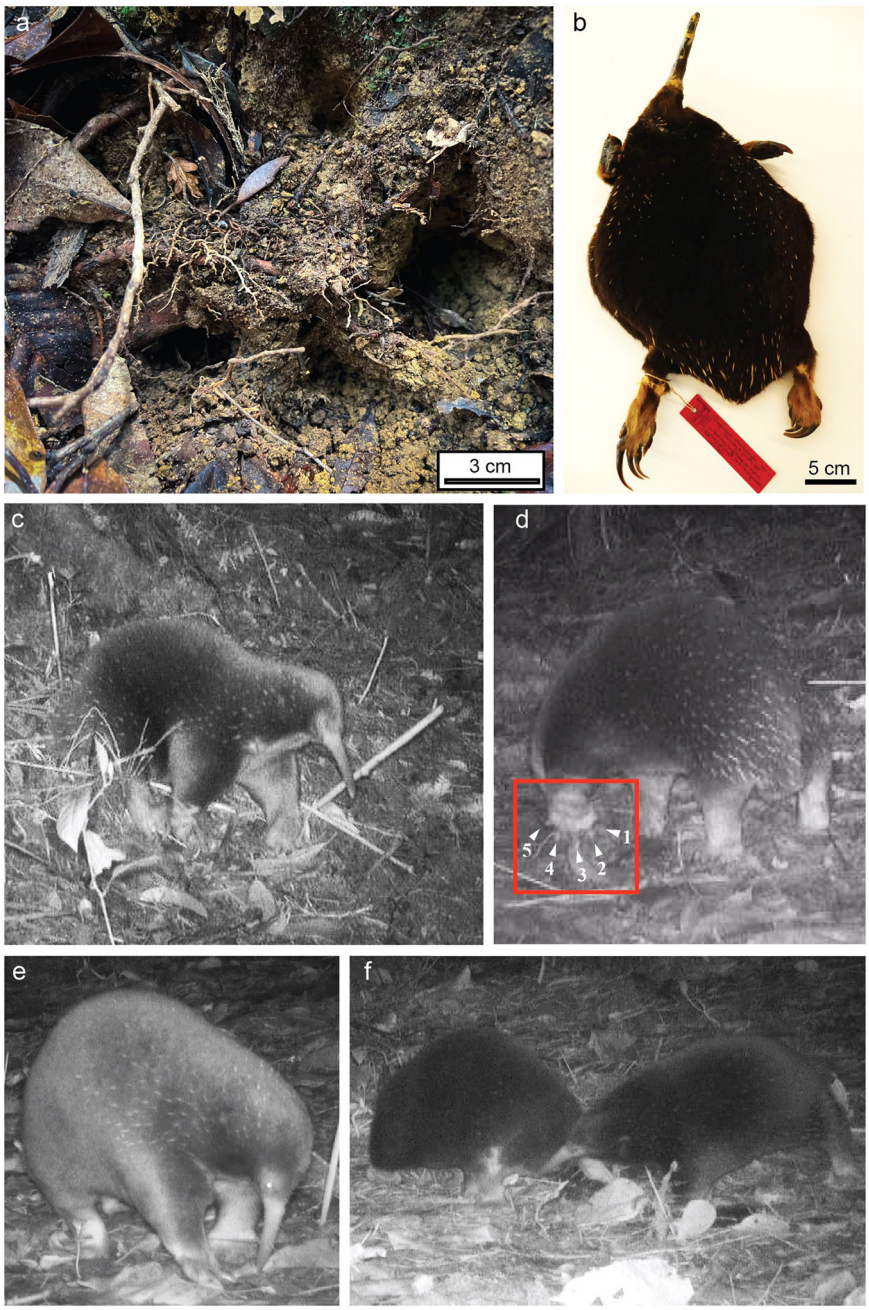

Fig. 2 | Photographs of Attenborough's echidna and their signs. a Echidna "nose-pokes", photographed in the Cyclops in 2023; **b** the holotype specimen of *Zaglossus attenboroughi*, held at Naturalis Biodiversity Center, Leiden, The Netherlands; **c** one of the first ever images of Attenborough's long-beaked echidna; **d** image showing the five forefoot claws that distinguish *Z. attenboroughi* from *Z. bruijnii*; **e** *Z. attenboroughi* foraging, which produces nose-pokes as in (**a**); **f** *Z. attenboroughi* shows typical echidna courtship behaviour, in which the presumed male follows the female (see also Supplementary Movie 3).

Attenborough's long-beaked echidna once lived in another North Coastal Range

We also present here, for the first time, subfossil bones of a small *Zaglossus* consistent with *Z. attenboroughi*. The material comes from the Lachitu Cave archaeological site (Papua New Guinea National Museum & Art Gallery collections, site code RIQ), found circa 80 km east of the Cyclops in the Oenake Range of Papua New Guinea and excavated in 2004-5 by the Australian National University[19] (Fig. 1). We identify these skeletal remains (Supplementary Fig. 1) as *Z. attenboroughi* on the basis of their small size relative to *Z. bartoni* and *Z. bruijnii*, and their morphological consistency with a *Z. attenboroughi* skeleton in the Australian Museum collections (AM M9852[9]), indicating the species once extended further east into another NCR and into low-lying coastal rainforest. The fossil fragments were found in sedimentary layers, Late Pleistocene to Middle Holocene (c.30,000 to 6,000 years BP) in age according to the site's marine-shell radiocarbon dating sequence, but is absent from the most recent Late Holocene units (500 years BP to contemporary times). *Z. attenboroughi* is no longer found outside the Cyclops Mountains; it has not been detected in faunal surveys by Marshall, Menzies, Flannery, Seri, and German, amongst others, in the Oenake, the Bewani, the Torricelli, and the Prince Alexander Ranges of Sandaun and East Sepik Provinces (Papua New Guinea) or their surrounding lowland environments[20–22]. Echidnas of any kind appear to be unfamiliar or unknown to contemporary hunters in these areas (Flannery, pers. comms. 2004), suggesting localised decline or extinction in the Oenake Mountains[18] since the Late Pleistocene. However, to our knowledge, no camera-trap studies have been conducted in the Oenake range, and there has been a paucity of surveys of Indigenous and local knowledge; further surveys may, therefore, be merited.

Discussion

Though we here demonstrate the rediscovery of *Z. attenboroughi* under the Long and Rodriguez definition, it is important not to lose sight of the nuance

of this finding. Though the holotype specimen of *Z. attenboroughi* was collected in 1961, the animal has only been considered a distinct species since 1998. Furthermore, systematic efforts to obtain photographic, audio, or genetic evidence of its existence only began in 2007[14], so that the likelihood of the animal being rediscovered beforehand was minimal. Most importantly, community members in the Cyclops report having sighted the echidna between 1961 and 2023[14,15]. Under the Long and Rodriguez definition, this information is not sufficient to rediscover the echidna – or call into question whether it was ever lost –, but it is essential to keep in mind when considering so-called lost species.

In the Terpera language of Yongsu Sapari and Yongsu Dosoyo, Attenborough's long-beaked echidna is called *Payangko*, and our camera-trap images demonstrate the potential importance of Indigenous and local knowledge in biodiversity research. Our success in capturing the first photographic evidence of the species was built on the Indigenous and local knowledge of communities in the Cyclops, which informed us on echidna behaviour and habitat, where to place camera-traps, how to search for echidna signs and, fundamentally, gave us confidence the species was still extant. Indigenous and local knowledge in the Cyclops is part of a broader knowledge system and local cosmology that informs issues such as land stewardship, sustainable hunting practices, and resource management. The community of Yongsu Sapari, for example, has for centuries maintained no-hunting and no-logging areas that support sustainable forest management. This underscores the need for Indigenous and local knowledge to be recognised not as an ancillary resource but as a fundamental and complex backdrop to developing a conservation strategy for *Z. attenboroughi* and the Cyclops Mountains.

The apparent present-day absence of *Z. attenboroughi* from the Oenake Mountains, combined with our discovery of subfossil bones there, emphasises the risk of local extinction for this species. At present, we do not know the population number of *Z. attenboroughi* in the Cyclops. Because we cannot identify individuals from our camera-trap images, precluding capture-recapture population size estimation methods, and because we localised our survey to a single area potentially unrepresentative of the wider Cyclops, we cannot estimate population size. We also do not know the principal conservation threats to Attenborough's echidna; imminent research is needed to address these knowledge gaps to help prevent the global extinction of *Z. attenboroughi*.

At a time of global biodiversity loss and unparalleled extinctions, the rediscovery of *Z. attenboroughi* through photographic evidence, aided by Indigenous and local knowledge, provides a story of conservation optimism. We hope that it will provide a foundation for further conservation efforts in the Cyclops, and a model for further 'lost species' searches worldwide.

Methods

2022 survey

Between July and October 2022, we deployed 11 Reconyx® Professional Covert IR camera-traps, over an area of approximately 10 km^2 around Yongsu Dosoyo and Yongsu Sapari, up to 900 m in elevation. We decided camera-trap locations using the Indigenous community sightings data recorded in previous work[15]. We input sightings into the R package *RgeoProfile* to implement Geographic Profiling[16], a modelling framework that uses the Dirichlet Process Mixture (DPM) to infer the 'source locations' that generated sightings. We interpret these source locations as places most likely to see echidna activity, and therefore as promising sampling locations. Each camera was active for an average of 58 ± 34 days, and we sampled for a total of 659 camera-trap nights, but we did not record echidnas.

2023 survey

We extended our camera-trap survey in the Cyclops during June and July 2023, deploying 73 camera-traps between 143 m and 1963 m in elevation, over an area of approximately 7 km^2. We deployed camera-traps to maximise detection, placing them along animal trails, ridgelines, and locations containing putative nose-pokes. We placed cameras at least 50 m apart as a compromise between reducing the chance that multiple cameras take photographs of the same individual and the difficulty of moving equipment long distances within a densely-forested mountain landscape. We note, however, that given the average home range (39 ha) of the related species *Zaglossus bartoni*[13], multiple cameras may take photographs of the same individual. Cameras were active for an average of 163 ± 98 days, totalling 11,869 camera-trap nights. We do not provide geographic coordinates for the locations of our surveys, in part to ensure that this information is not used to target the species.

Data availability

The camera-trap images used in this study are available, on request, by contacting the authors.

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Author contributions

J.A.K., L.-R.D, N.I, A.H., A.T., P.A.B. and H.J. conceived of and designed the study. G.M, S.D.A., J.A.K., A.T., L.-R.D, N.I, A.H., H.Y., T., S.C., and A.B. collected the data. G.M, J.A.K., A.T., L.-R.D, A.B., I.K., M.K., P.A.B., S.D.A, M.K.I., N.I, A.H., S.C., L.K., K.M.H. and H.J. analysed the data. J.A.K., A.T., L.-R.D., G.M, M.W., A.B., K.M.H., M.J.F, P.J.V, P.A.B., S.D.A, M.K.I., N.I, A.H., L.K. and H.J. wrote the manuscript. N.I, A.H., H.J.K., M.K., I.K., C.H, S.W., A.Y., P.J.D.V., S.B.S and P.N. provided logistical support.

Competing interests

The authors declare no competing interests.

Additional information

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