

No evidence for widespread island extinctions after Pleistocene hominin arrival

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The arrival of modern humans into previously unoccupied island ecosystems is closely linked to widespread extinction, and a key reason cited for Pleistocene megafauna extinction is anthropogenic overhunting. A common assumption based on late Holocene records is that humans always negatively impact insular biotas, which requires an extrapolation of recent human behavior and technology into the archaeological past. Hominins have been on islands since at least the early Pleistocene and *Homo sapiens* for at least 50 thousand y (ka). Over such lengthy intervals it is scarcely surprising that significant evolutionary, behavioral, and cultural changes occurred. However, the deep-time link between human arrival and island extinctions has never been explored globally. Here, we examine archaeological and paleontological records of all Pleistocene islands with a documented hominin presence to examine whether humans have always been destructive agents. We show that extinctions at a global level cannot be associated with Pleistocene hominin arrival based on current data and are difficult to disentangle from records of environmental change. It is not until the Holocene that large-scale changes in technology, dispersal, demography, and human behavior visibly affect island ecosystems. The extinction acceleration we are currently experiencing is thus not inherent but rather part of a more recent cultural complex.

Holocene | island biogeography | human colonization | megafauna | extinction

When humans first arrived on the islands of New Zealand, they encountered a diverse and rich ecosystem including nine species of moa (1). Within 200 y of human arrival, all these were extinct (2), alongside at least 25 other vertebrates (3). Over the late Holocene, this sequence of events played out across more than 40 islands of the Pacific: On average, almost 50% of Pacific island birds have become extinct following human colonization (4), with the bulk of these extinctions occurring prior to European contact (5, 6). These patterns mirror the extinction records of Indian Ocean islands, such as the Mascarenes and Madagascar (7, 8), suggesting a global pattern of island extinction immediately following human colonization.

Islands are particularly prone to widespread extinction and extirpation of biota because of their smaller resident faunas and populations, lower genetic diversities, susceptibility to stochastic processes, less opportunity for recolonization, and higher levels

of endemism compared to continents (9). The stunning extinction record of the Pacific and Indian Ocean islands is attributed to human activities, especially overhunting, habitat alteration, and introduction of invasive species (2, 10, 11). The chronology of island extinctions and human colonization have provided an enticing analog for understanding megafauna extinctions on the continents (3). Martin (12, 13) formulated the overkill hypothesis with explicit reference to anthropogenic extinctions on Madagascar and New Zealand, respectively, arguing that similar mechanisms could be invoked to explain African and North and South American megafauna extinctions.

Island records have subsequently often been considered ideal models for understanding how Pleistocene extinctions unfolded on the continents (14–19), despite the acknowledged and significant differences that exist between island and continental ecosystems (3, 20). Today, island extinctions are overwhelmingly interpreted

Significance

We provide global assessment of the possible link between Pleistocene hominin arrival and island extinction. The existing records on islands around the world do not support a significant and detrimental impact on island biotas following island colonization prior to the Holocene. This suggests that models using island extinctions as evidence in support of anthropogenic megafaunal overhunting, or as extensions of continental-level extinctions, need to be reconsidered.

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as a continuation of a global extinction event initiated more than 50,000 y ago by humans (21–25). Well-known records of island extinctions, in which a close association between human arrival and faunal extinction have been firmly established, continue to be widely cited in support of anthropogenic extinction scenarios on other landmasses (e.g., refs. 24–26). Island extinction records are thus a key component in the debate over causes of megafauna losses.

The hypothesis that humans are the primary driver of island extinctions relies on penecontemporaneous records indicating human arrival into virgin ecosystems (i.e., those without prior human contact) closely linked with extinction (19, 21, 26). However, although many islands have been considered in appraising global extinction scenarios (e.g., refs. 2, 4–8, 10, 11), those considerations have focused almost entirely on those with a Holocene human presence. Despite the importance of Pleistocene islands for this paradigm, and the growing archaeological record of island colonization events during the Quaternary, few islands with Pleistocene records have been explicitly included in any global assessment of Quaternary extinctions. This is important because technologies, behaviors, and even the hominin species involved are not homogenous across islands. Hominins have visited or lived on oceanic islands since at least the early Pleistocene (27–29), and *Homo sapiens* for at least 50 thousand y (ka) (30), and during this time, many significant evolutionary, behavioral, and cultural changes have occurred (31). A review of whether an association between hominin arrival and extinction exists for all islands occupied during the Pleistocene is a critical first step in addressing this deficit.

Here, we examine whether any data support the hypothesis that Pleistocene hominin arrival on an island is coincident with the disappearance of insular taxa. We examine the archaeological and paleontological records of all islands with a documented Pleistocene hominin presence and some record of faunal extinction. We treat oceanic islands (islands that have never been connected to continental landmasses during the Quaternary) and continental islands (promontories that were connected to continents during the Last Glacial Maximum (LGM) and earlier periods of time but are islands today) separately. We also explore data relating to large-scale geologic events (e.g., vulcanism) and the apparent ecological impact of different hominins on island ecosystems. We restricted our assessment to establishing whether a temporal overlap exists between taxon extinction and hominin arrival. We do not argue that this implies a causal relationship between arrival and extinction; rather, we take it as the first indication that such a relationship might exist. This allows us to evaluate the suggestion that modern humans and our immediate antecedents have always had a negative influence on virgin island ecosystems (e.g., refs. 15, 19, 23, 32, 33; see also ref. 34). This long-term perspective is a necessary step in understanding the impacts of humans on modern ecosystems globally and informing island conservation efforts today (11, 35).

Results

Islands Prior to *H. sapiens*. The earliest records of hominins on oceanic islands (Figs. 1 and 2) are represented by simple toolkits recovered from early to middle Pleistocene deposits on Flores (>1 Ma) (29) and Sulawesi (194 to 118 ka) (36) and cut-marked rhino bones and stone tools associated with a variety of fossil faunas from Luzon, Philippines (~709 ka) (28). It is possible that extinction of *Nesorhinus philippinensis* and *Celebochoerus cagayanensis* in Luzon are broadly synchronous with first hominin arrivals (Figs. 1 and 2), but at present, the evidence is based only on a single-dated locality, providing no firm insights into length of coexistence. It seems that much of the Philippines megafauna might have been extinct by 50 to 60 ka, and no clear extinctions are linked to *Homo luzonensis*. A giant rat (*Batomys* species [sp.]) and a dwarf buffalo (*Bubalus* sp.) are from the same palimpsest bone beds as the *H. luzonensis* fossils. They are not present in later deposits at Callao Cave or in any other sites so far excavated in Luzon, suggesting they might have gone extinct before the end of the Pleistocene. On Flores,

there are no known extinctions closely associated with the first hominin appearance. Sulawesi shows no clear temporal associations between the arrival of an as-yet unidentified hominin and faunal losses, although the extinction of a stegodon (*Stegodon* sp.) and a buffalo (*Bubalus grovesi*) may be associated if minimum ages are close to the true ages. The only extinct taxon recorded on Naxos (*Paleoloxodon lomoloini*) occurred well after the arrival of hominins. In Sardinia, the appearance of hominins is likewise associated with no losses. On Crete, however, the extinction of two birds (*Athene cretensis* and *Aquila chrysaetos simurgh*) and a mustelid (*Lutrogale cretensis*) could be synchronous with hominin arrival. On continental islands, the earliest record of hominins come in the form of *Homo erectus* on Java at 1.3 Ma (27) and *Homo ? antecessor* in Britain, perhaps as early as 1 Ma (37). Taiwan also has an as-yet unassigned hominin dated to perhaps as early as 450 ka (38). While no extinctions are recorded coincident with these arrivals (Fig. 3), they occurred during periods when the islands were connected to continental landmasses (Fig. 4) and should be understood in the context of range expansions of these hominins rather than colonization of virgin ecosystems. While the paleontological and archaeological records are admittedly limited, on this evidence seven extinctions across three islands may be the result of pre-*sapiens* hominin arrival.

Oceanic Islands with *H. sapiens*. The earliest direct evidence of *H. sapiens* on oceanic islands dates to around 50 ka and are situated in Asia (Fig. 1). Extinctions temporally associated with first arrivals in the broadest possible sense considered here (i.e., within 5,000 y) include the loss of two proboscideans (*Mammuthus columbia* and *Mammuthus exilis*) and a vole (*Microtus miguelsenensis*) from the California Channel Islands, a giant deer (*Megaloceros giganteus*) and a lemming (*Dicrostonyx torquatus*) from Ireland, an elephant from Sulawesi (*Elephas/Paleoloxodon* large sp.), and a crane (*Grus* sp.) from Timor. On Flores, a stork (*Leptoptilos robustus*), a vulture (*Trigonoceps* sp.), a songbird (confer *Acridotheres*), a stegodon (*Stegodon florensis insularis*), and *Homo floresiensis* disappear close to the first *H. sapiens* arrival as well as being coeval with a volcanic eruption on the island (Fig. 2). In the Philippines, *H. luzonensis* continued to inhabit Luzon until or shortly before 55 ka, with the first evidence of modern humans in the Philippines (on Palawan) currently around >47 ka (39). On only two islands, Cyprus and Kume, is there any evidence that all recorded island extinctions occur shortly after human arrival. Based on these data, most known extinctions on oceanic islands cannot be correlated with Pleistocene hominin arrival or separated from nonanthropogenic processes.

Continental Islands with *H. sapiens*. On continental islands, the earliest record of *H. sapiens* is Sumatra at 73 to 63 ka (40), although it was not an island at this time: As noted above, human arrival on these islands occurred during connections with continental landmasses and should be interpreted in this light (Figs. 3 and 4). Extinctions in Borneo and Sumatra are very poorly documented, especially with reference to extinctions on Java. Most large mammals such as rhinos, tigers, and tapirs, resident when modern humans arrived, all survived at least until very recently. Extinctions on Java occurred prior to the first documentation of likely *H. sapiens* on the island and have been tied to faunal turnover events resulting from episodic connection to the Southeast Asian mainland during glacial periods (41). These extinctions were likely triggered by the loss of extensive savannahs on the island and replacement by closed forests (42). Likewise, in Britain, most extinctions occurred prior to the arrival of *H. sapiens*. Extinctions during island phases are perhaps due to the expansion of the British–Irish Ice Sheet (43); however, most extinctions likely occurred during connections with the mainland (Fig. 4) and should be understood within the context of European continental extinctions (44). These have generally been attributed to environmental change

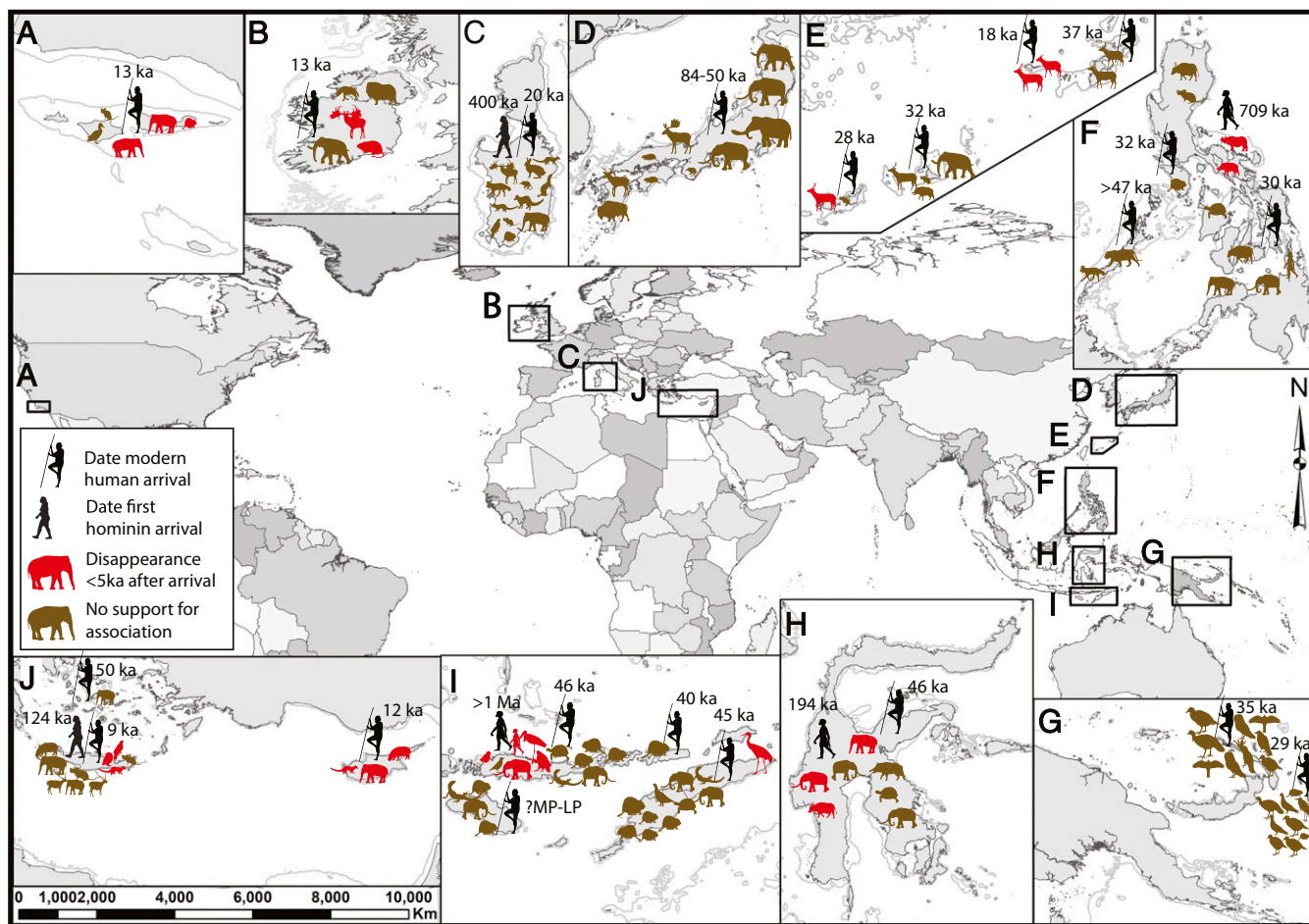


Fig. 1. Oceanic island groups with a documented record of Pleistocene hominins and faunal extinction. Clockwise from the top are San Miguel, Santa Rosa, and Santa Cruz (A); Ireland (B); Sardinia (C); Honshu, Shikoku, and Kyushu (D); Ishigaki, Miyako, Kume, and Okinawa (E); Luzon, Mindanao, Mindoro, and Palawan (F); New Ireland and Buka (G); Sulawesi (H); Timor, Alor, Flores, and Sumba (I); and Cyprus, Crete, and Naxos (J). MP, middle Pleistocene; LP, late Pleistocene.

(44). Almost all Pleistocene extinctions on New Guinea occurred a considerable time after human arrival, with both extinctions and arrival likely occurring while a connection with Australia existed (Fig. 4). Two extinctions (*Hulitherium tomassetti* and *Casuarius lydekkeri*) may be considered coeval with human arrival if the minimum ages are close to the true ages of the fossils. Likewise, on Kangaroo Island, three marsupial species (*Procoptodon brownneorum*, *Procoptodon gilli*, and *Procoptodon* sp. indeterminant) could have disappeared close in time with first human arrival, provided minimum ages are considered close to true ages. Only two marsupials (*Protemnodon anak* and *Simosthenurus occidentalis*) disappeared from Tasmania close in time to the first human records on the island and neither of them are associated with archaeological records. Continental islands were islands for very little of the Pleistocene, and although some extinctions appear coincident with the beginning of insularity, most likely they occurred during periods of connection with continents (Fig. 4). Thus, the mechanisms underlying these extinctions are unlikely to be directly comparable to those acting on oceanic islands.

Summary of Extinctions. If Pleistocene hominin populations, including Pleistocene members of our own species, were as destructive as humans in the late Holocene, their impacts should be particularly visible in the records of isolated oceanic islands. This was not observed in our data. Only on Cyprus and Kume do the data support all recorded extinctions coeval with human arrival.

All other Pleistocene extinctions on oceanic islands appear unrelated as to the cause or staggered, at least within the chronological resolution currently available (see also ref. 45). Oceanic and distant continental island cumulative extinctions are modest in absolute terms—the maximum recorded are 12 each for Sardinia and Flores. Both islands are relatively large and not particularly isolated, although separated by deep-sea passages from nearby continents. Extinctions on continental shelf islands, when well represented and constrained, are staggered and appear largely confined to periods of connections with the mainland. Separations from the nearest continent was relatively uncommon across continental islands, at least during the last 500 ka, and largely dependent on interglacial conditions and associated with significant environmental changes (42, 44). In continental islands with good fossil records (e.g., Java and Britain), extinctions are numerous, but their causes should be considered largely as an extension of the mechanisms underlying continental losses (42, 44).

Discussion

Faunal turnovers are common on oceanic islands and extinctions are a natural process as ecosystems move toward equilibrium, even on very large islands (46, 47). Smaller and more isolated islands severely impact genetic diversity, precipitating extinctions even in the absence of humans (e.g., ref. 48). This process can be intensified by rising sea levels in an effect known as relaxation (49).

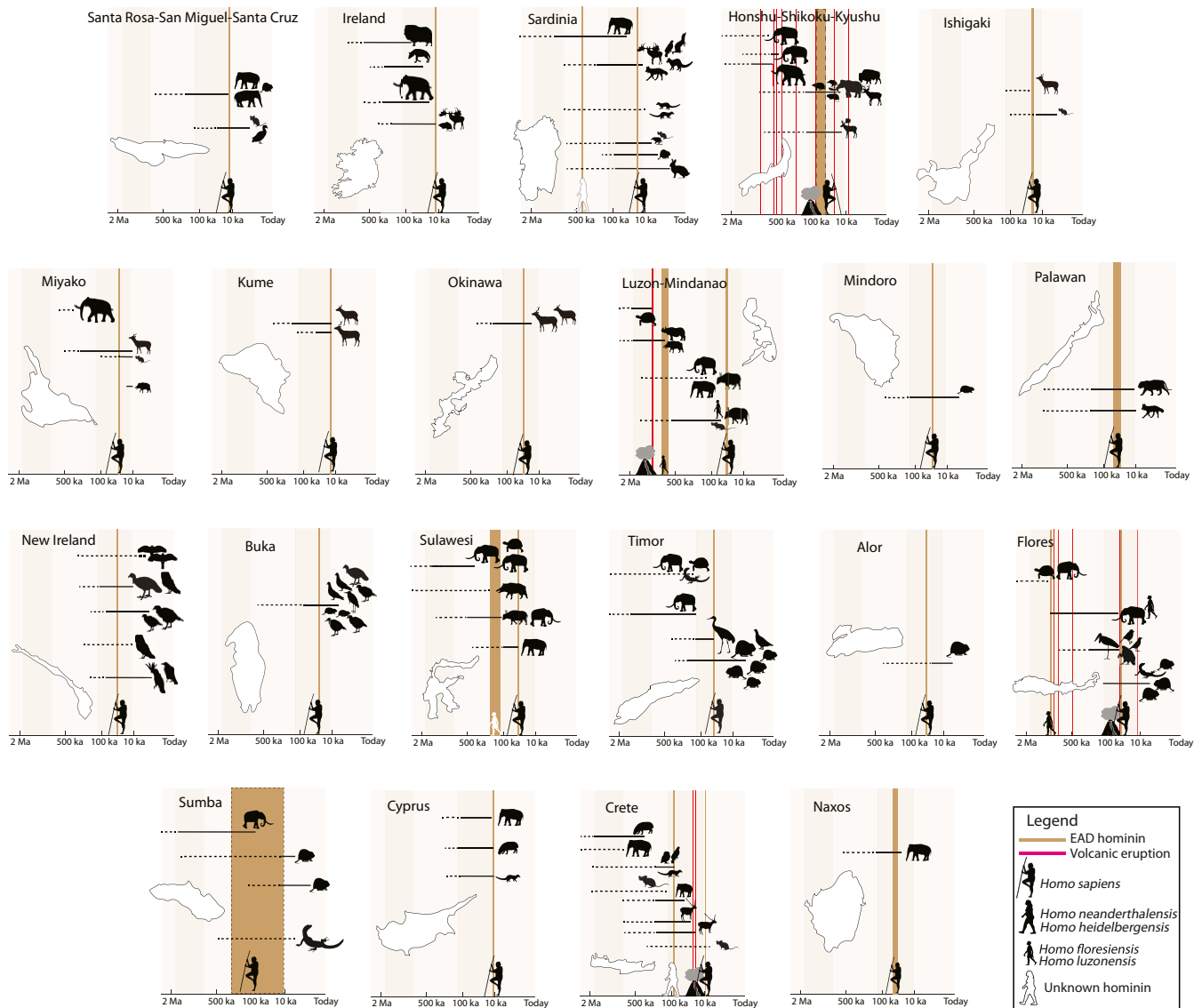


Fig. 2. Extinction chronology (right end of horizontal bars) shown with respect to the first hominin and *H. sapiens* arrival (vertical bars and boxes) to oceanic islands. Outlines for island groups are shown as one island during LGM connection. Extinct taxon LADs are represented by horizontal lines. In cases in which the LAD was highly imprecise, occurrence was represented by a dashed line only. Where dates had been provided for individual taxa, associated sedimentary contexts, and/or sites, this was represented by a dashed line progressing to a solid line, with the end of the solid line representing the LAD. Taxa on one island sharing LADs close in time (at a level indistinguishable on the scale used here) were grouped together. Horizontal lines are only illustrative of prior occurrence and are not lengthened to scale. More details on how this figure was constructed are presented in [SI Appendix, Supplementary Information Text](#), and dates and associated references are listed in [SI Appendix, Table S1](#).

The size of an island and thus diversity of its resources are likely the most important factors for successful hominin colonization, with a lack of terrestrial protein an obvious challenge (50, 51). Specialization in marine resources can remove this limitation (51). Other raw material limitations include lithics, bamboo and/or wood, and availability of fresh water; these provide some measure of how, where, and which islands had exploitable resources. In oceanic islands, the availability of freshwater may have been the biggest limitation for occupation, as many tiny islands were not settled until very late in the Holocene, when strategies for capturing freshwater became available, even if marine protein was abundant (52).

In Martin's overhunting concept (12–14), island extinctions were regarded as accelerated versions of mainland losses, with the added feature that there was very little choice of what to hunt. K-selected taxa are considered most vulnerable to extinction from

overhunting in megafauna extinction models (53). However, oceanic island conditions independent of humans tend to favor r-selected taxa, such that large, slow-breeding species are less likely to be found on islands than continents. Notable exceptions include tortoises and proboscideans; although, the latter exhibit dwarfing on islands, potentially signaling an evolutionary shift in response to insular conditions (54). Nevertheless, island overhunting remains one of the key factors explaining Pleistocene and Holocene extinctions (6, 10, 11).

Early hominins on islands such as *H. floresiensis* and *H. luzonensis* exploited a range of terrestrial fauna (28, 55). While access to maritime resources was available to *H. erectus* on Java (56), there is no unambiguous evidence that anything other than terrestrial resources were consumed (57). There is evidence from Callao Cave that a hominin hunted or scavenged the Philippine brown deer (*Rusa marianna*) and the Philippine warty pig (*Sus philippensis*).

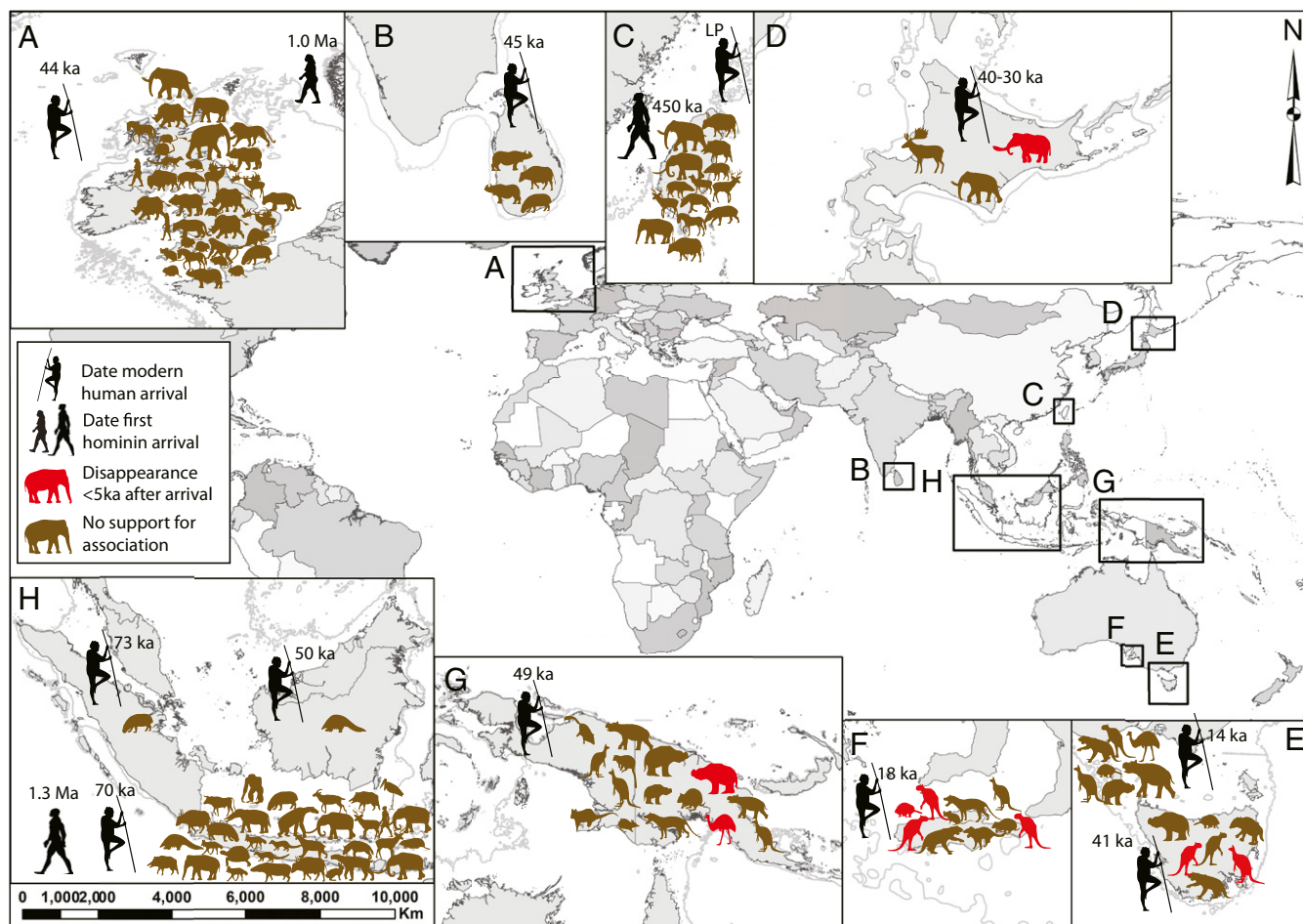


Fig. 3. Continental island groups with a documented record of Pleistocene hominins and faunal extinction. Clockwise from the top are Britain (A); Sri Lanka (B); Taiwan (C); Hokkaido (D); King Island and Tasmania (E); Kangaroo Island (F); New Guinea (G); and Borneo, Java, and Sumatra (H). LP, late Pleistocene.

Both species are still extant on Luzon. Zooarchaeological records from Borneo and Java indicate that *H. sapiens* used a range of techniques to hunt and trap terrestrial, aquatic, and arboreal vertebrates (58, 59). The introduction of ranged weaponry (e.g., bows, arrows, and spears) more broadly across Southeast Asia seems to have had an impact on the diversity of fauna hunted and especially arboreal taxa such as monkeys and civets. However, those species hunted most intensively, such as long-tailed macaques, leaf monkeys, and binturongs, are still extant today (59).

Pleistocene records associated with *H. sapiens* in oceanic islands in Wallacea are dominated by marine fish and shellfish and include early evidence of pelagic fishing and complex fishing technologies (57). A notable exception is Sulawesi, where cave art dated to ~44 ka depicts therianthropes in a hunting scene with anoa and Sulawesi warty pigs (60), and the earliest archaeological deposits are dominated by babirusa (*Babirusa babirusa*) and anoa (*Bubalus depressicornis*) (61). Both taxa are extant on the island. On Okinawa of the central Ryukyus, the Jōmon people hunted wild boars (*Sus scrofa*) intensively, which became smaller until 6 ka. Subsistence shifted to shellfish, and wild boars became larger again (62), suggesting that cultural and/or environmental controls may have existed on some islands to curb overhunting to extinction.

While three terrestrial taxa are recorded as going extinct at the same time as human arrival on the California Channel Islands, there is no indication that mammoths were ever hunted, and subsistence focused on marine resources (63). Similarly, archaeological records on Tasmania show that only small to medium animals were

hunted, and there is no evidence that any extinct species were exploited by humans or that people were responsible for their extinction (64, 65). Archaeological records from Cyprus suggest large-scale extinctions directly following human arrival around 12 ka (66), and this is one of only two islands where a convincing overlap exists between island extinction and first human arrival.

Extinctions, when present and tied to subsistence activities, are difficult to disentangle from records of environmental change. In the Tabon Caves in Palawan, Philippines, the first humans arrived at ~47 ka, when forest cover on the island was limited and open woodland dominated. Late Pleistocene forager communities predominately hunted deer (67). In the early Holocene, rainforests expanded, and Palawan lost more than 80% of its landmass because of rising sea levels. Deer populations diminished, and the bearded pig became the principal large mammal resource. By ~3 ka, deer populations were extinct. While humans hunting played a significant role in their disappearance, gross changes in climate and environment also impacted population resilience (67), as demonstrated by the continuing survival of deer on three islands in the Calamian group still supporting more open environments.

Hominins also became extinct on at least some islands in the Pleistocene (Fig. 1), and several archaeological records appear to represent island abandonment. The tiny island of Kisar in Wallacea, for example, was first occupied about 16 ka. Human occupation was only successfully achieved following the establishment of extensive maritime trading networks, and island abandonment in the early Holocene may have been linked to the collapse of these networks (51). Kangaroo Island preserves the

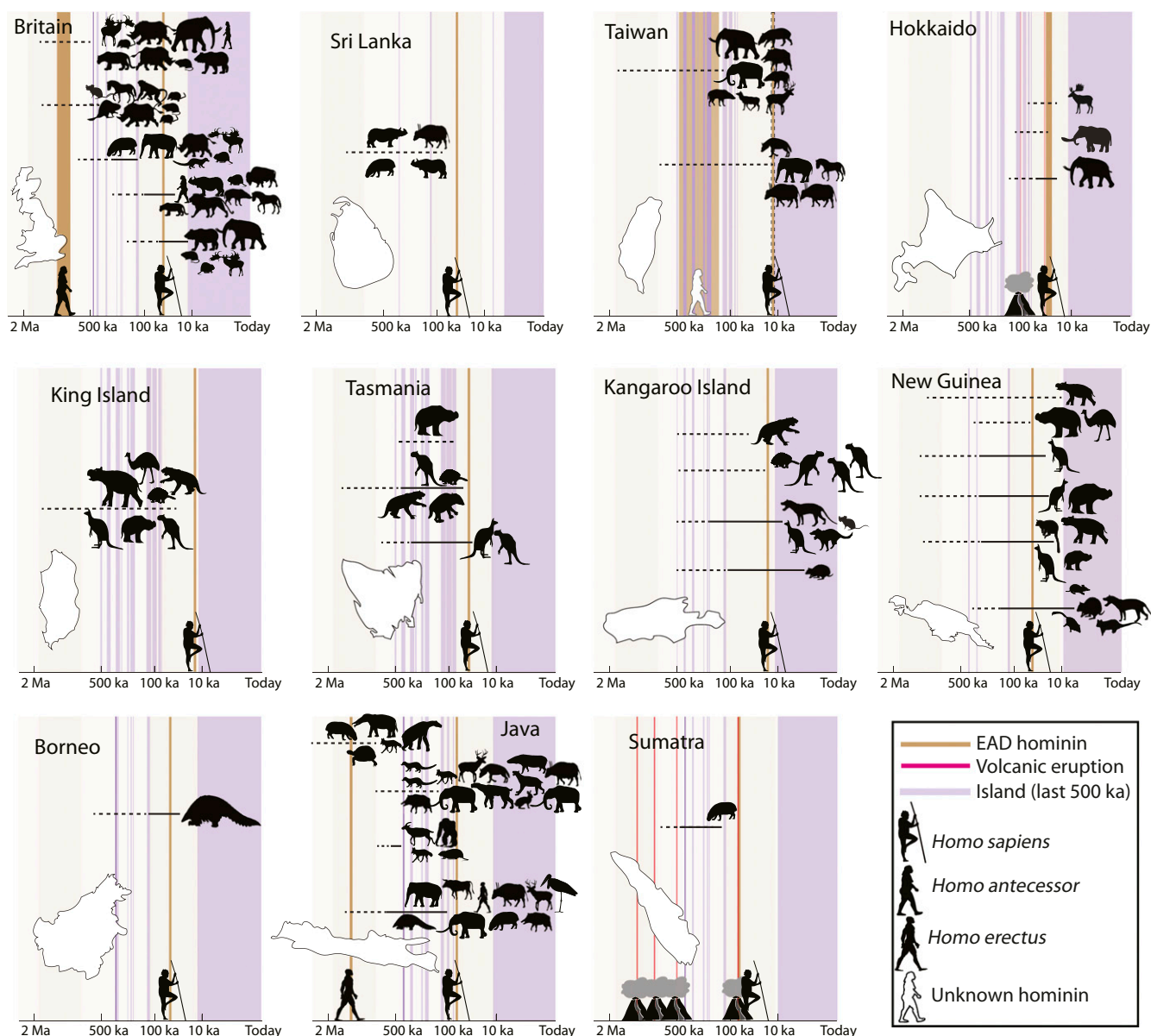


Fig. 4. Extinction chronology (right end of horizontal bars) shown with respect to first hominin and *H. sapiens* arrival (vertical bars and boxes) to continental islands. Purple vertical bars represent periods when these landmasses were islands. Extinct taxon LADs are represented by horizontal lines. In cases in which the LAD was highly imprecise, occurrence was represented by a dashed line only. When dates had been provided for individual taxa, associated sedimentary contexts, and/or sites, this was represented by a dashed line progressing to a solid line, with the end of the solid line representing the LAD. Taxa on one island sharing LADs close in time (at a level indistinguishable on the scale used here) were grouped together. Horizontal lines are only illustrative of prior occurrence and are not lengthened to scale. More details on how this figure was constructed is presented in [SI Appendix, Supplementary Information Text](#), and dates and associated references are listed in [SI Appendix, Tables S1 and S2](#).

best direct positive evidence of abandonment. There, records suggest that Indigenous Australian occupation ceased by around 4 ka, and although transient visits (or perhaps continued limited settlement) may have continued for a further 2,000 y (68), by the time Europeans arrived there were no human inhabitants on the island. Cyprus shows that after pygmy hippos became extinct human presence was limited until the Early Neolithic (66).

Because of their size and isolation, islands, especially small distant islands, are particularly prone to random events. We found few instances in which volcanic activity was perhaps coeval with extinction (Figs. 2 and 4); however, these events were also indistinguishable in time from the first arrival of humans on islands. The Quaternary history of large-scale volcanic eruptions have been particularly well investigated in Honshu, Shikoku, Kyushu,

and Hokkaido (69), and eruptions seem not to be synchronous with the extinctions of mammalian species (Figs. 2 and 4). This also applies to the eruption record for Flores. The effects of major eruptions on local extinctions are difficult to assess, even for relatively well-documented major eruptions that occurred on islands in historic times. Nevertheless, studies of the ecological impacts of volcanic eruptions have indicated short recovery times and no long-term changes in mammal communities (70).

The arrival of humans on islands in the Holocene is often considered synchronous with large-scale extinctions of insular endemics. These extinctions are conceptually associated with human agency through mechanisms such as overhunting, habitat alteration, and the introduction of domestics and commensals (2–4). The latter arguably have had a much greater impact on

island extinctions than overhunting, particularly for small mammals and birds but also larger mammals. On Miyako Island of the Ryukyus, for example, endemic deer (*Capreolus tokunagai*) were not displaced by first human arrival, but rather, their extinction coincides with the human introduction of suids in the late Pleistocene or early Holocene (71). As a result, what happened on islands in the Holocene has often provided the theoretical and practical framework for understanding extinction processes associated with people (11). This makes sense when considering the Holocene expansion of *H. sapiens* into previously unreachable or untenable regions. It also applies to continental islands, where insular conditions and technological changes were coincident with the onset of the Holocene (e.g., ref. 72). However, the Pleistocene record is significantly more ambiguous regarding the impacts of hominins on island biota. This is due to factors intimately tied to subsistence strategies, technological and behavioral changes occurring throughout the Pleistocene, and the distinct nature of islands and their resources globally.

Our data shows that hominins, including our own species, have not always had the negative impacts on island ecosystems that humans have today. Rather, extinctions accelerated beginning in the early to late Holocene, following expanded migration opportunities, increased seafaring and thus dispersal abilities, the introduction of widespread land clearance, the introduction of commensals and synanthropics, increased human densities, and the development of technologies allowing for the overexploitation of animal populations. Acknowledging that humans may not have always been detrimental to virgin ecosystems is important for identifying instances in which they have had a more passive or even beneficial impact. Such cases are critical for comparative studies aimed at identifying the factors increasing extinction risks of endemic island faunas. It is only through this process that we can hope to preserve the biodiversity that remains on islands today.

Materials and Methods

The aim of our study was to examine the coincidence of Pleistocene, as opposed to Holocene, hominin arrival with disappearance, so we restricted our analyses only to islands with evidence of Pleistocene hominin presence. For each island, we recorded the earliest appearance date (EAD) of the first hominin species on the island, as well as the EAD of *H. sapiens* (if different) on that island (*SI Appendix, Table S1*). In many instances, EADs were indirectly inferred based on archaeological records and the most widely accepted species attributions available (source references in *SI Appendix*). For each island, we also compiled a list of every extinct vertebrate (i.e., mammals, birds, and reptiles) taxon recorded from the literature, as well as its last appearance date (LAD) (*SI Appendix, Table S1*). Most species considered here have no direct dates associated with their remains, let alone their last appearance. Many are from sites that exceed the radiocarbon dating window, were historically collected with minimal stratigraphic information, and/or

have, at best, indirect dates associated with the strata from which they were found. The actual appearance and disappearance of taxa will be earlier and later than the EAD and LAD, respectively, because of the Signor–Lipps effect (73). Moreover, paleontological sites with good faunal sequences are rare, particularly for smaller islands (74, 75), such that the absolute number of dated occurrences for fossils on an island will usually be limited compared to continents and prohibiting the use of statistical techniques to accurately estimate extinction times. Thus, currently available data do not allow us to confidently assign last appearance datums or estimate true extinction windows for almost all taxa. Use of commonly applied data quality criteria or auditing of dating methods would require us to reject most islands from our examination and almost all species. However, the null hypothesis we test in this study is that there is evidence of hominin-driven extinctions following first Pleistocene arrival on an island. This can be achieved using available datasets (albeit weakly and subject to retesting once further data becomes available), as for any given island, a lack of reliable dates does not support the null hypothesis.

We only considered taxa identified to a level that would allow us to definitively assess whether extinction had occurred. In most cases, this was possible to do at the species level, although, where relevant, we also estimated extinction occurrence at higher taxonomic levels (e.g., family-level extinctions in the case of Stegodontidae). Nonvolant taxa were considered extinct on an island if they not only had disappeared from that island but were also absent from the island's nearest biogeographical source region. This is because, from an island biogeography perspective, the presence of regional species pools means that island recolonization could occur at any point, in which case the loss of the island population of a species would not count as a permanent extinction but rather a transient one. Thus, extirpated but extant taxa were only considered truly extinct from an island if there was no potential for recolonization of that species from a nearby source. This definition means that many well-established island extirpations (e.g., Palawan deer from Palawan in the Philippines, tigers from Borneo, mountain goats from Vancouver Island, brown bears from the Alexander Archipelago, etc.) are not considered in our analyses. For volant animals, taxa were only considered if they represented true endemic or resident taxa—migratory birds were not counted in our assessments. As such, our extinction estimates represent a minimum of insular vertebrate biodiversity loss on islands, and it is highly likely that the number of true extinctions was greater on all islands. Additional methods and considerations are discussed in *SI Appendix, Supplementary Information Text*.

Data Availability. All study data are included in the article and/or *SI Appendix*.

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Supplementary Information for

No evidence for widespread island extinctions after Pleistocene hominin arrival

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Tables S1 to S2
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Supplementary Information Text

Defining what constitutes an island often poses difficulty as any strict definition will likely either be so broad as to encompass virtually all landmasses on Earth, or too specific, whereby areas that are classically thought of as islands are excluded (1, 2). Rosenzweig (1, p. 211) suggested that, in a biological sense, islands could be defined as a “self-contained region whose species originate entirely by immigration from outside the region”. Whittaker and Fernández-Palacios (2) criticized this definition for being too restrictive and that it excluded real islands with high levels of endemism. They used a much broader and more classic definition—essentially that of a landmass surrounded by water—and thus included Australia under their ‘island continent’ subcategory. Because our intent is to examine extinctions on islands as opposed to continents, we restricted our analyses to geographical areas that are considered true islands today, following classic definitions (e.g. 2) and excluding all continents. Islands were considered for their present geography without any consideration of any local Quaternary geomorphological evolution, meaning that the Muria Volcano for example, which has long been isolated from the rest of what is now Java and on which a Pleistocene fauna contemporaneous to *Homo erectus* has been recovered, is here considered as part of Java. However, major geomorphological events were considered (see below). Our criteria resulted in the examination of 32 islands and island-complexes, the largest sample size of its kind.

We further divided islands into two groups: oceanic islands (islands that have never been connected to continental landmasses, at least since the Last Glacial Maximum [LGM]); and continental islands (promontories that were connected to continents during the LGM and earlier periods of time, but islands today). Connectivity was established by examining global bathymetric data using the gshhs high resolution world vector shoreline dataset version 2.3.7 (3; accessed 29th Jan 2018) and using Geographic Information Systems (GIS) to determine island areal extent based on the Miller et al. (2011) ‘scaled’ sea level curve (4) and the GEBCO 30-second arc dataset: GEBCO_2014 Grid (5), with a max low point of 120 m below present. These were drawn on maps as light grey contours and when contiguous with a continent, were considered continental islands, with the following caveats. Ireland was covered by the British–Irish Ice Sheet during the LGM and emerged from glaciation as an island between 20 and 18 ka, prior to the first record of post-LGM fauna and subsequent hominin presence (6–8). From the point of first colonisation considered here, Ireland falls into the oceanic island category. In Japan, the Tsugaru Strait (between Hokkaido and Honshu-Shikoku-Kyushu) and the Korean Strait (between the latter and Korean Peninsula) are generally considered not to have dried up during the LGM (9–13). Thus Honshu-Shikoku-Kyushu is classified here as an oceanic island, while Hokkaido falls into the continental island category.

Most continental islands considered here were islands during periods of high sea levels during the Quaternary, subject to bathymetric measurements and current understanding of geological history of the straits separating them from continents (14–19). Two notable exceptions are Britain and Sundaland (Java, Borneo, Sumatra). Britain first became an island approximately 450 ka following the first breach of the land bridge connecting it to the European mainland (20). For Sundaland, the subsidence of the low-lying continental shelf began approximately 400 ka, prior to which all major islands were connected (21). As a first level approximation of when continental islands were separated from the mainland over the last 500 ka, periods of insular conditions are shown in Figure 4 based on the Miller et al. (2011) ‘scaled’ sea level curve (4) and the GEBCO 30-second arc dataset: GEBCO_2014 Grid (5), with connection established for each island based on global bathymetric data and resolved at 1000 year level resolution (Table S2). For Britain and Sundaland, these are only shown back to MIS12 (other continental islands have no dated Pleistocene faunas older than MIS12). Because of this, for Britain, we only considered taxa dated to the stage just prior to the land bridge breach (i.e. the Anglian onwards), although we included the site of Ostend as it could potentially date to as late as MIS13 (22). We included all sites from Java due to the highly uncertain chronology of the earliest Pleistocene assemblages on that island.

Due to the limited availability of high-quality occurrence and geochronological data for most island systems considered, and given issues highlighted with ‘big data’ quantitative approaches to Quaternary extinction studies (23), we restricted our assessment to an examination of temporal overlap between taxon extinction (LAD) and hominin arrival (EAD). We do not argue this implies a causal relationship between arrival and extinction; rather, we take it as the first indication that such a relationship might exist. In order to determine overlap, hominin EADs and extinct species LADs were shown graphically for each island. Hominin EADs were represented as a vertical bar representing the ‘arrival window’ on the island, with uncertainty in EAD indicated by the width of the window, corresponding to published estimates (Table S1). Where this information was considered robust, the arrival window was represented as a vertical line only, and where information was considered highly uncertain, it is shown with a dashed border. Known past volcanic eruptions were shown similarly. In Japan, volcanic eruptions have been particularly well investigated, and are summarily given in (24). Based on this work, large-scale eruptions producing a huge amount of tephra are selected and shown in Figures 2 and 4. Extinct taxon LADs were represented by horizontal lines. In cases where the LAD was highly imprecise (e.g. ‘Middle Pleistocene’), occurrence was represented by a dashed line only. Where dates had been provided for individual taxa, associated sedimentary contexts, and/or sites, this was represented by a dashed line progressing to a solid line, with the end of the solid line representing the LAD. Taxa on one island sharing LADs close in time (at a level indistinguishable on the scale used here) were grouped together. Extinction records are shown as solid and dashed lines, as opposed to points, for ease of visual interpretation and to indicate that each taxon would have been present on the island at some unestablished point prior to their extinction. The dearth of occurrence data for almost all taxa considered here makes it impossible to calculate exactly how long each taxon had been established on each island in a quantitatively rigorous manner, or how much confidence can be attributed to each LAD. Thus, horizontal lines are only illustrative of prior occurrence and are not lengthened to scale. Each extinct taxon and first hominin and *Homo sapiens* arrival was illustrated on a global map, one for oceanic islands and another for continental islands. To visually represent where extinctions and arrivals closely coincided in time (here assessed at <5 ka or occurring within the window of hominin arrival), extinct taxa were colored in red where this occurred.

Animal outlines used in our figures were either created ourselves, provided by courtesy of G.J. Price or downloaded from Phylopic.org. The latter are either in the public domain or are covered under Creative Commons licenses as follows: CC BY-SA 3.0 (Stegodon by Zimeces; Leptoptilos by L. Shyamal); CC BY 3.0 (Ardea by Rebecca Groom; Testudinidae by Andrew A. Farke; Elephas by T. Michael Keesey; Candiacerus by Zimices; Acrobates by Sarah Werning); CC BY-NC-SA 3.0 (Cuon by AnAgnosticGod (vectorized by T. Michael Keesey); Anas by Maija Karala; Panthera by Lukasiniho); CC BY-NC 3.0 (Mammuthus by Zimices; Chaeropsis by T. Michael Keesey (after Marek Velechovský); Leporidae by Sarah Werning; Accipiter by Shyamal; Rallidae by T. Michael Keesey (vectorization) and Hutton's Vulture (photography); Tyto by Unknown (photo), John E. McCormack, Michael G. Harvey, Brant C. Faircloth, Nicholas G. Crawford, Travis C. Glenn, Robb T. Brumfield & T. Michael Keesey; Equus by Mercedes Yrayzoz (vectorized by T. Michael Keesey); Alces by Rebecca Collins; Coelodonta by Rebecca Collins; Setonix by T. Michael Keesey (photo by Sean Mack); Caprinae by Zimices, based in Mauricio Antón skeletal; Bos by DFoidl (modified by T. Michael Keesey); Anthrocotherium by Dmitry Bogdanov; Homotherium by Zimices; Machairodontini by Dantheman9758 (vectorized by T. Michael Keesey); Sthenurine by Zimices; Dromaius by Darren Naish (vectorize by T. Michael Keesey); Palorchestes by Zimices; Sarcophilus by Sarah Werning).

Table S1. Reference data for Figures. The list of extinct species considered in our analyses for each island group as well as first hominin appearance, and *Homo sapiens* appearance are provided. References used for taxa are listed immediately after each taxon name, last appearance chronology provided after date listed. Volcanic eruption data from (24-29).

Island Group	Extinct Taxa Latest Published Date ¹	Hominin Earliest Published Date ¹
San Miguel-Santa Rosa-Santa Cruz	<i>Chendytes lawi</i> (30) 3 ka cal BP (30) <i>Peromyscus nesodytes</i> (31) ?1 ka cal BP (31) <i>Mammuthus columbia</i> (31) 14 ka cal BP ² (32) <i>Mammuthus exilis</i> (31) 13 ka cal BP (31) <i>Microtus miguелensis</i> (31) Terminal Pleistocene (31)	<i>Homo sapiens</i> (33, 34) 12-13 ka cal BP (33, 34)
Ireland	<i>Mammuthus primigenius</i> (35) 25 ka cal BP ² (36) <i>Crocota crocuta</i> (35) 38 ka cal BP (37) <i>Megaloceros giganteus</i> (35) 13 ka cal BP (38) <i>Dicrostonyx torquatus</i> (35) 12 ka cal BP (36) ² <i>Ovibos moschatus</i> (35) 109-74 ka (39)	<i>Homo sapiens</i> (40) 13 ka cal BP (40)
Sardinia	<i>Cynotherium sardous</i> (41, 42) 11 ka cal BP (43) <i>Praemegaceros cazioti</i> (42) 10 ka cal BP (44) <i>Prolagus sardus</i> (42) ~250 BP (45, 46) <i>Microtus henseli</i> (42) 3-2 ka cal BP (46) <i>Rhagamys orthodon</i> (42) ~5 ka (47) <i>Asoriculus similis</i> (42) ~5 ka (47) <i>Mammuthus lamarmorai</i> (42) 43 ka cal BP (48) <i>Sardolutra ichnusae</i> (42) LP (49) <i>Algarolutra majori</i> (42) LP (50) <i>Megalenhydris barbaricina</i> (42) 70-10 ka (51) <i>Enhydriactis galictoides</i> (42) LP (52) <i>Aquila nipaloides</i> (28) 17-9 ka cal BP (53)	Hominin gen. et sp. indet. (54) ~400 ka (54) <i>Homo sapiens</i> (55, 56) ~20 ka (55, 56)
Honshu-Shikoku-Kyushu	<i>Stegodon aurorae</i> (57) 0.7 Ma (57) <i>Mammuthus trogontherii</i> (58) 0.58 Ma (57) <i>Stegodon orientalis</i> (57) 0.55 Ma (57) <i>Palaeoloxodon naumanni</i> (59) 20 ka cal BP (59) <i>Cervus katusensis</i> (60) 20 ka cal BP (59) <i>Sinomegaceros yabei</i> (59) 14 ka cal BP (59) <i>Bison priscus</i> (59) 22-26 ka cal BP (59) <i>Anourosorex japonicus</i> (59) 22 ka cal BP (59) <i>Myodes japonicus</i> (61) 22 ka cal BP (59) <i>Microtus epiratticepoides</i> (62) 20 ka cal BP (59)	? <i>Homo sapiens</i> (63, 64) 84-50 ka (65)

Ishigaki	<i>Cervus</i> (<i>C. nippon</i> type) (66) >29 ka (66) <i>Niviventer</i> sp. (66) 2-4 ka cal BP (66, 67)	<i>Homo sapiens</i> (67) 28 ka cal BP (67)
Miyako	<i>Sus</i> sp. (small form) (68) 10-11 ka cal BP (69) <i>Diplothrix miyakoensis</i> (66) 10-11 ka cal BP (69) <i>Capreolus tokunagai</i> (66) 10-11 ka cal BP (69) <i>Mammuthus trogontherii</i> (58) MP (66)	<i>Homo sapiens</i> (70) 32 ka cal BP (70)
Kume	Muntacinae gen. et sp. indet. (66) 18 ka cal BP (71) <i>Cervus astylodon</i> (66) 18 ka cal BP (71)	<i>Homo sapiens</i> (71, 72) 18 ka cal BP (71, 72)
Okinawa	<i>Cervus astylodon</i> (59, 66) 20 ka cal BP (59) Muntacinae gen. et sp. indet. (59, 66) 20 ka cal BP (59)	<i>Homo sapiens</i> (73, 74) 37 ka cal BP (73, 74)
Luzon-Mindanao	<i>Nesorhinus philippinensis</i> (75) 709 ka (76) <i>Stegodon luzonensis</i> (77) MP (77) <i>Elephas beyeri</i> (78) MP (78) <i>Celebochoerus cagayanensis</i> (79) 709 ka (76) <i>Megalochelys sondaari</i> (80) 1 Ma (81) <i>Batomys</i> sp. (82) >52 ka (82, 83) <i>Bubalus cebuensis</i> (84) MP (84) <i>Bubalus</i> sp. (83) >52 ka (83) <i>Homo luzonensis</i> (85) ~55 ka (85)	Hominin gen. et sp. indet. (76) 709 ka (76) <i>Homo luzonensis</i> (85) 67 ka (86) <i>Homo sapiens</i> (87) ~30 ka (87)
Mindoro	<i>Crateromys paulus</i> (88) ~2 ka (88)	<i>Homo sapiens</i> (89, 90) ~32 ka (89, 90)
Palawan	<i>Panthera tigris</i> (64) ~11 ka (91) <i>Cuon</i> sp. (65) ~9.4 ka (92)	<i>Homo sapiens</i> (93, 94) >47 ka (93)
New Ireland	<i>Accipiter</i> 'sp. 2' (95) Holocene (95) <i>Accipiter</i> 'sp. 3' (95) Holocene (95) <i>Megapodius</i> sp. (95) 10-14 ka cal BP (95) <i>Gallirallus</i> sp. (95) <2 ka cal BP (95) <i>Porphyrio</i> sp. (95) <1.6 ka cal BP (95) <i>Cacatua</i> sp. (95) 1-5 ka cal BP (95) <i>Tyto</i> 'sp. 1' (95) >10 ka cal BP (95) <i>Tyto</i> 'sp. 2' (95) 5-10 ka cal BP (95) <i>Corvus</i> sp. (95) 1-5 ka cal BP (95)	<i>Homo sapiens</i> (95) 35 ka cal BP (95)
Buka	<i>Megapodius</i> sp. n. (96) ~5 ka (97) <i>Hypotaenidia</i> sp. n. (96) ~5 ka (97) <i>Porphyrio</i> sp. n. (96) ~5 ka (97) <i>Pareudiastes</i> sp. n. (96) ~5 ka (97) <i>Nycticorax</i> sp. n. (96) ~5 ka (97) Columbidae gen. et sp. n. (96) ~5 ka (97) Columbidae gen. et sp. n. (96) ~5 ka (97)	<i>Homo sapiens</i> (99) 29 ka RYBP (99)

	<i>Melomys spechti</i> (98) ~5 ka (97) <i>Solomys spriggsarum</i> (98) ~5 ka (97)	
Sulawesi	<i>Stegoloxodon celebensis</i> (100, 101) 400-600 ka (100) <i>Stegodon</i> sp. B (large-sized) (100) 354-484 ka (102, 103) <i>Stegodon</i> sp. (102) >194-118 ka (102) <i>Elephas/Palaeoloxodon</i> (large-sized) (100, 104) 35-50 ka (104) <i>Celebochoerus heekereni</i> (100, 102) >200 ka (100, 102) <i>Bubalus grovesi</i> (105) 94-115 ka (102) <i>Megalochelys</i> sp. (100) 400-600 ka (100)	Hominin gen. et sp. indet. (102) >194-118 ka (102) <i>Homo sapiens</i> (106) 46ka (107)
Timor	<i>Coryphomys buehleri</i> (108) ~2 ka (109) <i>Coryphomys musseri</i> (108) ~2 ka (109) Murine 'Gen. A' (108) late Holocene (108) Murine 'Gen. B' (108) late Holocene (108) Murine 'Gen. C' (108) late Holocene (108) <i>Stegodon timorensis</i> (110-113) >130 ka (113) <i>Stegodon 'trigonocephalus'</i> (114, 115) Pleistocene (114, 115) <i>Varanus</i> sp. nov. (116) Pleistocene (116) <i>Megalochelys</i> sp. (116) Pleistocene (116) <i>Turnix</i> sp. (117) 1.3 ka cal BP (117) <i>Grus</i> sp. (117) >42 ka (117)	<i>Homo sapiens</i> (118) 45 ka cal BP (118)
Alor	<i>Alormys aplini</i> (119) 3 ka cal BP (119)	<i>Homo sapiens</i> (120) 40 ka cal BP (120)
Flores	<i>Papagomys theodorverhoeveni</i> (121) ~3 ka (121, 122) <i>Spelaeomys florensis</i> (121) Holocene (121) <i>Varanus hooijeri</i> (123) Holocene (123) <i>Hooijeromys nusatenggara</i> (124) ~3 ka (122) <i>Stegodon florensis insularis</i> (3) 50 ka (92) <i>Homo floresiensis</i> (26) 50 ka (26) <i>Trigonocephalus</i> sp. (125) 50 ka (125) <i>Megalurus</i> sp. (126) 60 ka (126) cf. <i>Acridotheres</i> (126) 50 ka (125) <i>Leptoptilos robustus</i> (125) 50 ka (125) <i>Stegodon sondaari</i> (127, 128) >1.07 Ma (129, 130) <i>Megalochelys</i> sp. (94) >1.07 Ma (129, 130)	Hominin gen. et sp. indet. (131) >1 Ma (131) <i>Homo floresiensis</i> (76) 193 ka (76) <i>Homo sapiens</i> (125, 132) ~46 ka (125, 132)
Sumba	<i>Stegodon sumbaensis</i> (100, 133) 125-186 ka (133)	Hominin gen. et sp. indet. (134) ?late Middle

	<i>Milimonggamys juliae</i> (133) 54-222 cal AD (133) <i>Raksasamys tikusbesar</i> (133) 1935–1700 cal BC (133) <i>Varanus</i> cf. <i>hooijeri</i> (133) Holocene (133)	Pleistocene and early Upper Pleistocene (134)
Cyprus	<i>Hippopotamus minor</i> (135) 12 ka cal BP (136, 137, 138) <i>Palaeoloxodon cypriotes</i> (139) 12 ka cal BP (136, 138) <i>Genetta plesictoides</i> (140) 11 ka (140)	<i>Homo sapiens</i> (136) 12 ka cal BP (136, 138)
Crete	<i>Candiacervus</i> cf. <i>reumeri</i> (25, 141) 21.5 ka (142) <i>Candiacervus</i> sp. (25, 141) 33.5 ka (143) <i>Palaeoloxodon creutzburgi</i> (25, 141) 49 ka (142) <i>Mus minotaurus</i> (25, 144) Neolithic (Jarman cited in 143) <i>Lutrogale cretensis</i> (25, 141) 87 ka (143) <i>Athene cretensis</i> (145) 87 ka (143) <i>Aquila chrysaetos simurgh</i> (145) 87 ka (143) <i>Hippopotamus creutzburgi</i> (146) 378 ka (143) <i>Kritimys catreus</i> (144) MP (144) <i>Mammuthus creticus</i> (147) EP (147)	Hominin gen. et sp. indet. (148) ~85-124 ka (148) <i>Homo sapiens</i> (149) 9 ka cal BP (149)
Naxos	<i>Palaeoloxodon lomoloini</i> (150) 116-30 ka (150)	<i>Homo</i> sp. (151) 50-38 ka (151)
Britain	<i>Mammuthus trogontherii</i> (152) ~700-500 ka (MIS17-13) (153) <i>Sorex savini</i> (152) ~700-500 ka (MIS17-13) (153) <i>Pliomys episcopalpis</i> (154) ~500 ka (MIS13) (153) <i>Ursus deningeri</i> (154) ~500 ka (MIS13) (153) <i>Panthera</i> cf. <i>gombaszoegensis</i> (154) ~500 ka (MIS13) (153) <i>Stephanorhinus</i> sp. A (154) ~500 ka (MIS13) (153) <i>Stephanorhinus hundsheimensis</i> (154) ~500 ka (MIS13) (153) <i>Megaloceros verticornis</i> (155) ~300 ka (MIS10-6) (155) <i>Megaloceros dawkinsi</i> (154) ~500 ka (MIS13) (154)	<i>Homo ?antecessor</i> (154) 1-0.78 Ma (154) <i>Homo sapiens</i> (163) 44-41 ka cal BP (163)

	<p><i>Homo cf. heidelbergensis</i> (154) ~500 ka (MIS13) (154)</p> <p><i>Sorex runtonensis</i> (154) ~400 ka (MIS11) (154)</p> <p><i>Talpa minor</i> (152) ~400 ka (MIS11) (154)</p> <p><i>Trogontherium cuvieri</i> (152) ~400 ka (MIS11) (156)</p> <p><i>Apodemus maastrichtensis</i> (154) ~400 ka (MIS11) (154)</p> <p><i>Equus hydruntinus</i> (154) ~400 ka (MIS11) (154)</p> <p><i>Stephanorhinus kirchbergensis</i> (154) ~400 ka (MIS11) (154)</p> <p><i>Macaca sylvanus</i> (152, 154) ~400 ka (MIS11) (156)</p> <p><i>Palaeoloxodon antiquus</i> (157) >87 ka (157)</p> <p><i>Stephanorhinus hemitoechus</i> (157) >87 ka (157)</p> <p><i>Hippopotamus amphibius</i> (157) ~120 ka (157)</p> <p><i>Homo cf. neanderthalensis</i> (158) ~38-36 ka (158)</p> <p><i>Ursus spelaeus</i> (159) ~18 ka (159)</p> <p><i>Mammuthus primigenius</i> (160) 14 ka cal BP² (160)</p> <p><i>Coelodonta antiquitatis</i> (161) ~35 ka (161)</p> <p><i>Megaloceros giganteus</i> (162) ~12.5 ka (162)</p> <p><i>Ochotona pusilla</i> (159) ~22 ka (159)</p> <p><i>Dicrostonyx torquatus</i> (159) ~22 ka (159)</p> <p><i>Microtus gregalis</i> (159) ~47 ka (159)</p> <p><i>Crocota crocuta</i> (161) ~35 ka (161)</p> <p><i>Panthera leo</i> (161) >39 ka (161)</p> <p><i>Bison priscus</i> (159) ~28 ka (159)</p> <p><i>Equus ferus</i> (161) ~40 ka (161)</p> <p><i>Cyrraonyx antiqua</i> (155) ~300 ka (MIS10-6) (155)</p> <p><i>Arvicola cantiana</i> (152) ~100 ka (MIS5c) (152)</p> <p><i>Panthera pardus</i> (159) ~45 ka (159)</p> <p><i>Pitymys arvaloides</i> (152) ~400 ka (MIS11) (156)</p>	
Sri Lanka	<i>Hippopotamus amphibius</i> (164) ?Pleistocene (164)	<i>Homo sapiens</i> (165) ~45 ka (165)

	<i>Rhinoceros sinhaleyus</i> (164) ?Pleistocene (164) <i>Rhinoceros kagavena</i> (164) ?Pleistocene (164) <i>Bibos sinhaleyus</i> (164) ?Pleistocene (164)	
Taiwan	<i>Crocota crocuta</i> (166) LP (166) <i>Stegodon</i> sp. (166) MP (166) <i>Palaeoloxodon</i> sp. (166) LP (166) <i>Mammuthus</i> sp. (166) MP (166) <i>Equus dalianensis</i> (166) LP (166) <i>Tapirus</i> sp. (166) MP (166) <i>Potamochoerus</i> sp. (166) MP (166) <i>Sus houi</i> (166) MP (166) <i>Sus australis</i> (166) MP (166) <i>Muntiacus bohlini</i> (166) MP (166) <i>Elaphurus formosanus</i> (166) MP (166) <i>Bubalus teilhardi</i> (166) LP (166) <i>Bubalus youngi</i> (166) LP (166)	<i>Homo</i> sp. (167) 130-450 ka (167) <i>Homo sapiens</i> (168) LP (168)
Hokkaido	<i>Mammuthus primigenius</i> (59) 23 ka cal BP (59) <i>Palaeoloxodon naumanni</i> (59) 35 ka cal BP (59) <i>Sinomegaceros yabei</i> (59) ?60-25 ka (59)	? <i>Homo sapiens</i> (169, 170) ~30-40 ka (169, 170)
King Island	<i>Megalibgwilia</i> sp. (171) Pleistocene (171) <i>Simosthenurus occidentalis</i> (172-176) Pleistocene (172-176) <i>Diprotodon optatum</i> (177) Pleistocene (177) <i>Dromaius ater</i> (175) Pleistocene (175) <i>Zygomaturus trilobus</i> (175, 177, 178) Pleistocene (175, 177, 178) <i>Thylacoleo carnifex</i> (175) Pleistocene (175) <i>Protemnodon anak</i> (172-176) Pleistocene (172-176)	<i>Homo sapiens</i> (179) ~14 ka (179)
Tasmania	<i>Megalibgwilia</i> sp. (174-176, 180) 60-52 ka (174-176, 180) ? <i>Zygomaturus trilobus</i> (176) >75 ka (176) <i>Metasthenurus newtonae</i> (174-176, 180) 60-52 ka (174-176, 180) <i>Palorchestes azael</i> (174-176, 180) 60-52 ka (174-176, 180) <i>Protemnodon anak</i> (176) 43-41 ka cal BP (176) <i>Simosthenurus occidentalis</i> (181) 45-53 ka cal BP (181)	<i>Homo sapiens</i> (181) 41 ka cal BP (181)

	<i>Thylacoleo carnifex</i> (181) 57-49 ka (181)	
Kangaroo Island	<i>Megalibgwilia</i> sp. indet. (182) >20 ka (182) <i>Thylacinus cynocephalus</i> (182) 7 ka BP (182) <i>Sarcophilus harrisii</i> (182) 7 ka BP (182) <i>Potorous platyops</i> (182) 1 ka BP (183) <i>Thylacoleo carnifex</i> (182) >45 ka (146) <i>Lagorchestes leporides</i> (182) 7 ka BP (182) <i>Procoptodon browneorum</i> (182, 185) >20 ka (182) <i>Procoptodon gilli</i> (182, 185) >20 ka (182) <i>Protemnodon</i> sp. indet. (182) >20 ka (182) <i>Pseudomys gouldii</i> (182) 7 ka BP (182)	<i>Homo sapiens</i> (185) 18 ka BP (185)
New Guinea	<i>Dendrolagus noibano</i> (186) 29-18 ka cal BP ² (187, 188) <i>Protemnodon tumbuna</i> (186) 29-18 ka cal BP ² (187, 188) <i>Protemnodon nombe</i> (186) >29 ka cal BP ² (187, 188) Diprotodontid (186) 29-18 ka cal BP ² (187, 188) <i>Protemnodon hopei</i> (189) ~20 ka (187) <i>Maokopia ronaldi</i> (189) ~20 ka (187) <i>Hulitherium tomassetti</i> (190) >50 ka (191) <i>Casuarius lydekkeri</i> (192) >50 ka (191) <i>Kolopsis watutense</i> (193) Pleistocene (193) <i>Thylogale christenseni</i> (189) 3.5 ka cal BP (187) <i>Thylacinus cynocephalus</i> (194) <5 ka cal BP (187) Zygomaturinae small size (195) LP (195) <i>Petauroides ayamaruensis</i> (196) 8-7 ka cal BP ² (196, 197) <i>Dactylopsila kambuayi</i> (196) 8-7 ka cal BP ² (196, 197) <i>Peroryctes aruensis</i> (198) ~28-9 ka (198)	<i>Homo sapiens</i> (199) 49-43 ka cal BP (199)
Borneo	<i>Manis palaeojavanica</i> (200) ~35 ka (200)	<i>Homo sapiens</i> (201) ~50 ka (201)
Java	<i>Xenocyon trinilensis</i> (202) 0.54-0.43 Ma (203) <i>Xenocyon merriami</i> (204) EP (204) <i>Cuon priscus</i> (204) MP (204) <i>Cervus zwaani</i> (205, 206) MP (205, 206) <i>Stegodon hypsilophus</i> (202) MP (202) <i>Sinomastodon bumiajuensis</i> (202) EP (202)	<i>Homo erectus</i> (221) 1.3 Ma (221) <i>Homo sapiens</i> (222) ~70 ka (222)

	<i>Hexaprotodon simplex</i> (202) EP (202) <i>Elephas hysudrindicus</i> (202) 117-108 ka (207) <i>Manis palaeojavanica</i> (202) 117-108 ka (207) <i>Pachycrocuta brevirostris</i> (202) MP (163, 208) <i>Bos palaesondaicus</i> (202) 117-108 ka (207) <i>Homo erectus</i> (207) 117-108 ka (207) <i>Stegodon</i> sp. (208) MP (208) <i>Stegodon trigonocephalus</i> (202) 117-108 ka (207) <i>Duboisia santeng</i> (202) 0.54-0.43 Ma (203) <i>Hexaprotodon sivajavanicus</i> (202, 209) 117-108 ka (207) <i>Bubalus palaeokerabau</i> (207) 117-108 ka (207) <i>Sus sangiranensis</i> (210) MP (210) <i>Sus macrognathus</i> (207) 117-108 ka (207) <i>Axis lydekkeri</i> (211) 117-108 ka (207) <i>Lutrogale palaeoleptonyx</i> (212) MP (212) <i>Lutrogale robusta</i> (213) MP (214) <i>Rattus trinilensis</i> (212) 0.54-0.43 Ma (203) <i>Colossochelys</i> sp. (211) EP (211) <i>Merycopotamus dissimilis</i> (211) MP (211) <i>Caprolagus sivalensis</i> (211) MP (211) <i>Homotherium ultimum</i> (215) MP (211) <i>Hemimachairodus zwierzyckii</i> (216) MP (216) <i>Nestoritherium sivalense</i> (211) EP (217) <i>Megantereon megantereon</i> (211) MP (218) <i>Epileptobos groeneveldtii</i> (212) MP (212) <i>Meganthropus palaeojavanicus</i> (219) 0.54-0.43 Ma (203) <i>Leptoptilos titan</i> (220) Late Pleistocene (216)	
Sumatra	<i>Hexaprotodon</i> sp. (223) ~130 ka (223)	<i>Homo sapiens</i> (224) 73-63 ka (224)

¹Rounded values listed, refer to references for exact dates.

²Radiocarbon dates calibrated here using OxCal v. 4.4 (225) and the IntCal20 calibration curve (Reimer et al., 2020). Rounded median ages listed, refer to references for original radiocarbon results.

Table S2. Times when each continental island was an island in the last 500 ka, calculated based on the Miller et al. (4) 'scaled' sea level curve and the GEBCO 30-second arc dataset GEBCO_2014 Grid, with connection established for each island based on global bathymetric data and resolved at 1000 year level resolution.

Island	Depth below modern sea-level to establish connection	Times (ka) when an island in last 500 ka
Britain (*first separated 450 ka)	Between -31 and -31 m	0-11
		116-127
		130
		199-203
		209-217
		236-242
		311
		313
		315-316
		319-334
		397-417
		450*
Hokkaido	Between -50 and -51 m	0-12
		75
		80-85
		92-105
		113-131
		192-220
		233-243
		282-287
		308-335
		387-390
		392-422
		424
		483+
Kangaroo Island	Between -28 and -29 m	0-11
		116-127
		199-203
		209-217
		236-241
		315
		319-334
		397-417
		489-492
King Island	Between -53 and -54 m	0-12
		74-75

		80-85
		91-106
		111-131
		192-220
		229
		233-243
		282-288
		300
		303
		307-335
		386-424
		482+
New Guinea	Between -12 and -13 m	0-9
		119-127
		324-333
		400-415
Sri Lanka	Between -3 and -4 m	0-2
		5
		120-126
		324
		326-329
Sumatra (*first separated 400 ka)	Between -23 and -24 m	0-10
		116-127
		199-201
		210
		214-217
		237-241
		319
		321-334
		397-400*
Borneo (*first separated 400 ka)		0-11
		115-128
		130
		199-203
		208-218
		235-242
		311
		313
		315-316
		319-334
		396-400*
Java (*first separated 400 ka)		0-11
		81-84

		94-97
		99-100
		102-103
		105
		114-128
		130-131
		192
		194
		196-218
		234-243
		283-286
		308-316
		318-335
		393
		395-400*
Taiwan	Between -50 and -51 m	0-12
		75
		80-85
		93-105
		113-131
		192-219
		233-243
		283-287
		308-335
		388-390
		392-422
		424
		483
Tasmania	Between -58 and -59 m	0-13
		74-86
		88-108
		110-131
		192-220
		229
		233-244
		282-291
		300-336
		382
		384
		386-424
		482+

SI References

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