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Historical records of Indian Ocean giant tortoise populations

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WITH APPENDICES BY

C. GORDON AND R. BURLEIGH

Historical records from the seventeenth to the nineteenth centuries indicate that giant tortoises became extinct on many western Indian Ocean islands during this period, and that by 1900 the surviving population on Aldabra was very small. These data are reviewed, the causes of decline and extinction discussed, and the implications for the history of the Aldabra population are considered.

INTRODUCTION

The main sources of historical information on the giant tortoises of the western Indian Ocean are the papers by Günther (1877, 1898), Sauzier (1895) and Rothschild (1915). Rothschild gives the most comprehensive geographical summary, including records from the following localities: Madagascar, Aldabra, Farquhar, Astove, Providence, Iles Africaines, Alphonse, 'Amirante', Agalega, Cosmoledo, Iles Glorieuses, Assumption, 'Chagos', the Comores, Mauritius, Réunion and Rodrigues, and in the Seychelles, Mahé, St Anne, Moyenne, Ile aux Cerfs, Conception, Silhouette, Ile du Nord, Ile aux Récifs, Ile aux Frégates, Praslin, Aride, Félicité, Marianne, La Digue, Les Soeurs, and Ile aux Vaches marines. These distributions were summarized by Stoddart (1971, pp. 619–622). During the last 10 years the literature search for tortoise references has been extended, especially by the Aldabra Data Unit at the British Museum (Natural History), and it has also been possible to examine archives in Seychelles, Mauritius, Bombay, London and Paris.

In summarizing present knowledge, four sources of confusion need to be kept in mind. First, some early travellers' accounts may be fictional in part or in whole. Leguat's *New voyage to the East Indies* (1708), which gives the most detailed early account of tortoises on Réunion, has been argued by Atkinson (1921, 1922) to be wholly imaginary, though Dehérain (1926), using archival evidence, considers that the voyage probably took place, and zoologists have generally accepted that the descriptions of tortoises and birds are based on observation. Secondly, many early accounts are at least partly based on plagiarism, both in circumstantial biological detail and in illustrations. Examples relating to marine mammals in the western Indian Ocean are given by Stoddart (1972). Thirdly, there is long-standing confusion between land tortoises and marine turtles, which in many cases is now impossible to resolve; it is certainly true that some of the islands listed as tortoise localities by Rothschild have no other supporting records but are well known as breeding areas for green turtle (e.g. Agalega, Coetivy, Diego Garcia). Fourthly, there is much confusion in seventeenth and eighteenth century accounts over the identity and even existence of islands, especially the smaller coral islands: thus Farquhar is

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often called Juan de Nova even though there is another island with the latter name in the Mozambique Channel.

In this paper we review present knowledge of giant tortoise distribution and history in these islands, revising some of Rothschild's judgements, and making particular use of 'Papers on tortoises of Mauritius, Seychelles and Aldabra, and of the Galapagos' collected by Albert Günther and now in the British Museum (Natural History) (Günther Collection, 72).

THE MASCARENE ISLANDS

Mauritius

Mauritius was discovered in 1511 but was not settled for many decades. The first Dutch expedition in 1598 was followed by the establishment of a Dutch settlement in 1638 which lasted until 1710; the French colonized the island in 1715, and thereafter occupation was continuous. In 1630 Herbert (1634, pp. 213–214) described 'land Tortyses, (so great that they will creepe with two mens burthen, and serve more for sport, then service or solemne Banquet) . . . The Ile has no humane inhabitants. These creatures that possesse it, have it on condition, to pay tribute (without exception) to such ships, as famine, or foule weather force to anchor there.' Herbert himself (1638, p. 349) thought tortoises 'odious food' and 'better meat for Hogs' than man. Other early reports of large tortoises in great numbers are those of Morisot (1651, p. 8), Flacourt (1658, p. 169) and Mandelslo (1669, pp. 199–200). As early as 1671, however, they had become rare on the main island, though still numerous on nearby islets such as Ile aux Cerfs (Pitot 1905, p. 126). Hubert Hugo in 1673 described the taking of tortoises for salted meat, the making of fat (400–500 animals yielding about 100 l), and the destruction of eggs and young tortoises by pigs, as a result of which the animals had almost disappeared (Pitot 1905, p. 163). In May 1674 Hugo was still able to take 320 tortoises from Ile Plate (Pitot 1905, p. 164). The date of their final extinction on the main island is not known: Grant (1801, p. 194) reported that they were still abundant in 1741, which seems unlikely, but by 1778 they were **rare** (Sauzier 1895, p. 17).

Réunion

Réunion was discovered in 1512 but the first account of the tortoises is dated 1650 (Leguat 1708, p. 40). According to Du Quesne,

'The Land Turtles are also some of the Riches of the Island. There are vast Numbers of them: Their Flesh is very delicate; the Fat better than Butter or the best Oil, for all sorts of Sawces. Some of the Sea Turtles weigh above 500 Pound weight. The Land Turtles are not so big; but the great ones carry a Man with more ease than a Man can carry them. This Oil of Turtle, for 'tis a sort of Fat, which do's not congeal as other Fat do's, is an excellent Remedy in several Distempers.'

In 1665 Rennefort found tortoises everywhere, though with the young and eggs much disturbed by pigs (Grant 1801, p. 149), and in 1671 it was reported that one could not go six steps without finding one (Froidevaux 1899, p. 216). One of the fullest accounts of the Réunion tortoises came from Dubois (1897, pp. 79–80):

'All the Island is filled with land-tortoises, which is one of the good gifts of the place. They have the neck long, the head made like the tortoises of Europe, a large tail, and four feet. They are from two or three feet in length and one foot and a half broad, or thereabouts, and

more than a foot in thickness. One of the Tortoises carries a man easily on its back, and tis as much as a man can do to carry one of them. The flesh of this Tortoise is like that of ox, and their tripe has the same taste. The liver of these Tortoises is very large; tis one of the most delicate morsels which man can eat; who had any of the same in France would make good cheer on fast days. There's enough to feed four persons in one of these livers. At the side of the flanks of these Tortoises there are *pannes* which they take for melting, from which they make oil which never congeals. This is as good for all things as good butter – tis the butter of this land. These *pannes* yield ordinarily two pots of oil, more or less, if the season allows of finding these tortoises fat. They are not always so. This oil is marvellous for rubbing afflicted limbs.' (Original French version in Vaillant 1899*a*, p. 20.)

By 1688 the tortoise had become the ordinary food of the people on Réunion (P. Bernardin, in Froidevaux 1899, p. 217).

Numbers not surprisingly fell rapidly over the next half-century. An anonymous writer described them as 'entièrement détruites' in 1732 (Froidevaux 1899, p. 217), though two small ones could still be found to be sent to the Académie Royale des Sciences in Paris in 1737 (Vaillant 1899*b*). They were described as rare in 1754 (Vaillant 1899*a*, p. 22). It is not clear when they finally became extinct, though Bory de St Vincent (1804, vol. 1, p. 248) mentions animals up to about 230 kg, perhaps domesticated.

Rodrigues

Rodrigues was the last of the Mascarenes to be discovered (in 1638). Francois Leguat (1708, pp. 64–65) gave the first detailed description of the tortoises in 1691, if indeed his account can be accepted as factual and not imaginary as has been alleged:

'We saw no four-footed Creatures, but Rats, Lizards and Land-Turtles, of which there are different sorts. I have seen one that weigh'd one hundred pound, and had Flesh enough about it, to feed a good number of Men. This flesh is very wholsom, and tastes something like Mutton. The Fat is extremely white, and never Congeals nor rises in your Stomach, eat as much as you will of it. We all unanimously agreed, 'twas better than the best Butter in Europe. To anoint one's self with this Oil, is an excellent Remedy for Surfeits, Colds, Cramps, and several other Distempers. The Liver of this Animal is extraordinarily delicate, 'tis so Delicious that one may say of it, it always carries its own Sauce with it, dress it how you will.

The Bones of the Turtles are Massy, I mean they have no Marrow in them. Every one knows, that these Animals in general are hatch'd of Eggs. The Land-Turtles lay theirs in the Sand, and cover them, that they may be hatch'd: The Scale of it, or rather the Shell, is soft, and the Substance within good to eat. There are such plenty of Land-Turtles in this Isle, that sometimes you see two or three thousand of them in a Flock; so that one may go above a hundred Paces on their Backs; or, to speak more properly on their Carapaces, without setting foot to the Ground. They meet together in the Evening in shady Places, and lie so close, that one wou'd think those Places were pav'd with them. There's one thing very odd among them; they always place Sentinels at some Distance from their Troop, at the four corners of their Camp, to which the Sentinels turn their Backs, and look with the Eyes, as if they were on the Watch. This we have always observ'd of them; and this Mystery seems the more difficult to be comprehended, for that these Creatures are incapable to defend themselves, or to fly.'

An anonymous author in 1725 found them very abundant, reaching 0.9–1.1 m in length (Milne-Edwards 1875). Herbert & Nichelson (1750, pp. 274–276) refer to a settlement formed

to collect tortoises for export to Mauritius. At the time of the Transit of Venus Expedition in 1761, the Abbé Pingré found 12–15 negroes so occupied at the settlement, and the Abbé himself ate nothing else while at Rodrigues: 'soupe de tortue, tortue en fricassée, tortues en daube, tortues en godiveau, oeufs de tortue, foie de tortue, tels étaient presque nos uniques ragouts' (Dupon 1969, pp. 24–27). The trade was extremely wasteful. Milne-Edwards (1875) gives details of six voyages during 1759–61 in which nearly 21 000 animals (presumably mostly small) were removed from the island: two of these voyages each carried 5000 animals, but of these only 1350 and 3800 survived the journey.

Within a few years numbers had collapsed. D'Après de Manneville in 1775 reported this decrease and ascribed it to the depredations of rats and wild cats as well as to the export trade and local consumption for food (Dupon 1969, pp. 38–40). According to Pierre Poivre, the export reached 4000–5000 animals per year in the period 1750–70, each animal with an average mass of 9 kg (Froberville 1848). By 1795 they had been virtually exterminated; Marragon saw two in a remote area (Dupon 1969, pp. 27–31). By 1800 the Rodrigues tortoises could be considered extinct.

THE GRANITIC SEYCHELLES

The granitic Seychelles were first discovered in 1609, when John Jourdain arrived at North Island, near Silhouette. A boat sent ashore 'brought soe many land tortells as they could well carrie. . . The tortells were good meate, as good as freshe beefe, but after two or three meales our men would not eate them, because they did look soe uglie before they weare boyled; and soe greate that eight of them did almost lade our skiffe' (Foster 1905, p. 47). Jourdain then went on to Mahé, finding 'much fishe and fowle and tortells (but our men would not eate any of them, but the tortells wee could kill with staves at our pleasure)' (Foster 1905, p. 49). On the same voyage, William Revett also noted 'lande turtles of so huge a bignes which men will think incredible; of which our company had small luste to eat of, being such huge defourmed creatures and footed with five claws lyke a beare' (Foster 1905, p. 350).

Thereafter the Seychelles were not revisited until an expedition arrived from Mauritius in 1742, though settlement was not attempted until after 1768. Tortoises rapidly became the chief export of the islands, and remained so until the end of the century. Toussaint (1965) has documented the scale of the trade from Mauritius customs records. He lists 25 ships entering Mauritius from Seychelles and carrying tortoises between 1773 and 1810. With an average ship load of 200–250, and assuming that those landed in Mauritius represented about half those removed from Seychelles, the total export was about 10 000, or less than 300 each year. These records undoubtedly substantially underrepresent the scale of the trade. Malavois, who became commandant in 1786, wrote a 'Mémoire sur la tortue de terre', dated 25 March 1787, in which he estimated the total remaining population as 6000–8000. The decline had resulted not only from the export trade to Mauritius and local consumption for food, but also from predation by cats and rats. A tradition had also arisen whereby naval vessels in the harbour had the right to be supplied with tortoises for food, and this had accounted for 3000 in 1784–6; it is also recorded that between 25 August 1782 and 30 June 1784 the then commandant had supplied nine ships with 1103 animals. Malavois saw that some measure of control was needed if the tortoises were not to become extinct. He proposed that they should be concentrated in two reserves, one of 3000 on St Anne and one of 3000–4000 on Ile aux Cerfs (Fauvel 1909, p. 278).

By November 1803 the administrator reported that there were no more tortoises to be had,

though the alternative sources then mentioned (Agalega, Coetivy, Diego Garcia) suggest that he could have meant marine turtles rather than land tortoises. As late as 1826 two cargoes of 2400 tortoises were landed in Mauritius from Seychelles, but their precise provenance is not recorded (Sauzier 1895, p. 27). By 1839, tortoises were being imported to Mahé from Aldabra (Harrison 1839, p. 443). Froberville (1848, p. 92) noted that they had become rare, though still a delicacy at Seychellois feasts.

The later history of tortoises in the granitic Seychelles is one of domesticated animals in small numbers. Gordon wrote in 1874 to Joseph Hooker telling of scores of tortoises kept in small enclosures before being killed and eaten when 4 years old (Günther Papers, 72). In 1881 Gordon wrote a hitherto unpublished memorandum (appendix 1) entitled 'Gigantic land tortoises of Seychelles', in which he named 13 families with domestic herds on five islands, seven of them on Mahé; he also included much interesting biological information. The largest of the animals was 1.7 m long and weighed 230 kg. In March 1882 Coppinger (1883, p. 215) saw two large animals at Government House, a male of 181 kg and a female of 227 kg, and commented that 'of late years [tortoises have] been introduced into many of the neighbouring islands'. From 1902 to 1922 a herd was maintained at Government House, and detailed records (now lost) were kept of breeding performance (Davidson 1911; *Seychelles Bulletin*, 2, 3 and 5 June 1976). A colony was also established on Curieuse, numbering 42 in 1895 (Administrator, Seychelles, to Secretary of State, 13 March 1896: Gunther Papers, 72; Gunther 1898, p. 26). Nothing is known of the future of this colony, and almost nothing is known of tortoises on other granitic islands, although according to Froberville (1848, p. 98) the tortoises were more numerous and larger on Silhouette than on Mahé. There is an urgent need to catalogue and record existing domestic tortoises on islands such as Frégate, and to establish their history from their owners.

WESTERN INDIAN OCEAN CORAL ISLANDS

The historical evidence concerning tortoises on the smaller coral islands of the western Indian Ocean is much more fragmentary than that for the Mascarenes or granitic Seychelles. It is briefly summarized for each island or group of islands, other than Aldabra itself, below.

African Banks

Rothschild (1915, p. 423) includes African Banks (Ilots Africaines) in his list of tortoise localities, presumably on the basis of a reference by Froberville (1849, p. 111). The Banks comprise two small sand cays with low scrub which could not support a tortoise population (Stoddart & Poore 1970*b*, p. 188). C. Shackleton's *Plan of the African Islands* (Dalrymple 1805) mentions 'turtle in abundance'. African Banks should be deleted from the list of Indian Ocean tortoise localities.

Agalega

This is also listed by Rothschild (1915, p. 423). D'Unienville (1838, vol. 3, pp. 193–194) states that the island has no land quadrupeds, though Froberville (1848, p. 83) refers to the existence of a few land tortoises there in 1785. These were probably landed from a passing ship. The two islands of Agalega are large, and if tortoises had naturally existed there they would probably have formed a considerable population. Agalega should also be deleted as a tortoise locality.

Alphonse

Alphonse is listed by Rothschild (1915, p. 423), presumably on the basis of Foberville's (1848, p. 111) reference to very abundant land tortoise. D'Unienville (1838, vol. 3, p. 212), however, specifically states that the island has sea turtles only. We have seen no other reference to tortoises on Alphonse, and it should accordingly be deleted from the list of known localities.

Amirantes

Froberville (1848, p. 111) mentions many land tortoises on islands in the Amirantes, without specific locality, and Rothschild (1915, p. 423) includes the group in his locality list. As with Alphonse, however, D'Unienville (1838, vol. 3, p. 212) refers only to sea turtles. Günther (1898, pp. 15–16) describes fossil tortoise eggs embedded in conglomerate from the Amirantes, but these specimens cannot now be found in the British Museum (Natural History) and their precise provenance is not known. Without further confirmation the presence of tortoises on any of the Amirantes must be considered doubtful.

Assumption

Froberville (1848, p. 114) mentioned 'tortues', without qualification, and Rothschild (1915, p. 423) includes Assumption in his tortoise distribution list. No other historical records have been found, though Fryer (1908; 1911, pp. 421–423) found fossil tortoise bones and Honegger (1966) fossil tortoise eggs (cf. Stoddart *et al.* 1970, p. 132). Further tortoise bones and a possible egg were collected by S. Blackmore and M. Walker in 1977. The fossil material requires further investigation: there is no evidence of the existence of tortoises at the time of discovery or settlement, and the remains may be Pleistocene rather than Recent in age.

Astove

Tortoises have undoubtedly existed on Astove. Froberville (1848, p. 114) refers to 'quantités de grosses tortues' on the northern plain during the visit of the *Charles* and *Elisabeth* in October 1742, and the island is listed by Rothschild (1915, p. 423). But there were no tortoises there in 1836 (Stirling 1843), and we have found no earlier reference. Fryer (1911, p. 428) gives a second-hand report of large bones, probably of tortoises, found in the limestone, and this would repay further investigation. As on Assumption, the Astove tortoises may have been Pleistocene rather than Recent. In 1968 there were several recently released Aldabran tortoises on the island (Bayne *et al.* 1970).

Bird

This island is not listed by Rothschild (1915) and Froberville (1848, p. 99) mentions only turtles there. We have found no indication of tortoises having existed on it.

Cargados Carajos

These small remote sand cays originally had considerable populations of green turtles on them (Staub & Guého 1968) but there is no evidence that tortoises ever existed there; they are not listed by Rothschild (1915).

Chagos Archipelago

Rothschild (1915, p. 423) lists 'Chagos' without precise identification of islands. D'Unienville (1838, vol. 3, pp. 187–190) mentions 'tortues' on Three Brothers and Peros Banhos, but these

references are almost certainly to turtles. A famous large tortoise, said to be 150 years old, lived on Egmont in the last century, but it was a domesticated animal, reputedly from Aldabra and said to have been the largest living land tortoise (Rothschild 1897, p. 407; Günther 1898, p. 25). It seems unlikely that wild tortoises ever existed in the Chagos Archipelago, but the swamps on Peros Banhos and other islands should be searched for their remains.

Coetivy

No tortoises were reported here by Captain Laurent of *Le Foudroyant* in 1781 (Froberville 1848, p. 88) but turtles were reported by D'Unienville (1838) and Froberville (1848, p. 88). There is no evidence of tortoises ever having existed here, and the island is not listed by Rothschild (1915).

Cosmoledo

Cosmoledo is listed as a tortoise island by Rothschild (1915, p. 423) but we have found no historical references to it at all. Moresby (1842) visited Cosmoledo in 1822 but does not mention tortoises, nor did Rivers (Seychelles Archives, MS) in 1878. Fryer (1911, pp. 420–421 and 428), however, found fossil eggs on West Northeast Island. Whether tortoises have existed on Cosmoledo in historic times thus remains uncertain.

Denis

Denis is not listed as a tortoise island by Rothschild (1915). When it was discovered in August 1773 by Denis de Trobriand, however, it was described as 'généralement couverte de tortües de terre et de mer' (Fauvel 1909, p. 47). We have found no further mention of tortoises here, and the date of their extinction is not known. James Hornell collected fossil tortoise eggs on Denis in 1927, presumably from phosphorites. A radiocarbon age of 1308 ± 85 a B.P. has been obtained for this by R. Burleigh (appendix 2): this date is particularly significant since it pre-dates the discovery of the Seychelles by Europeans and hence lessens the possibility of artificial introduction.

Europa

Europa is not listed by Rothschild (1915) and we have found no reference to tortoises existing there.

Farquhar

Rothschild (1915, p. 423) includes Farquhar in his list of tortoise islands, presumably on the basis of a description by J. Grossin in 1742. Grossin described 'quantité de Tortue de terre dont les plus petite sont plus grosse que les plus grosse de l'isle Rodrigues' (Fauvel 1900). He named the island as Juan de Nova, and Fauvel identified it with Farquhar. This identification needs re-examination, since it does not appear to accord with Grossin's course relative to Agalega; Grossin's latitude also does not seem appropriate for Farquhar. It may be significant that the comment quoted above is the same as that given for Aldabra by Dalrymple in his chart of 1784. Margaro charted what is unmistakably the modern Farquhar in 1776 (Dalrymple 1784), and specifically stated that 'There is no fresh water, nor any quadruped'. D'Unienville (1838, vol. 3, p. 214) noted only sea turtles. There is substantial doubt, therefore, over the presence of wild tortoises on this island. In 1968 there were two semi-domesticated ones, recently imported (Stoddart & Poore 1970a).

Gloriosa

There are no historical records of tortoises on the Iles Glorieuses, nor are they included in Rothchild's (1915) list. Battistini & Cremers (1972, p. 2), however, have found fossil tortoise bones in raised reef limestones on Grande Glorieuse. Whether tortoises have existed there in historic times is not known.

Platte

There are no historic records or other indications of tortoises on Platte. 'Several' domestic ones were placed there from Mahé in 1883 (Gunther 1898, p. 26). The island is not listed by Rothschild (1915).

Providence

The former status of tortoises on this island is highly uncertain. Froberville (1848, pp. 111–112) mentions 'grande quantité de tortues de mer et de terre', but D'Unienville (1838, vol. 3, p. 213) mentions only sea turtle. Sauzier (1895, p. 27) refers to a cargo of 800 'tortoises' from Providence landed at Mauritius in 1826, but it is possible that these were turtle. In 1882 Coppinger (1883, p. 234) found seven animals imported from Aldabra. Providence is listed as a tortoise island by Rothschild (1915, p. 423), but this must be regarded as doubtful in the absence of less ambiguous evidence.

St Pierre

There are no historic references to tortoises on St Pierre, nor is the island in Rothschild's list (1915). Moresby (1842) went there in 1822 but does not mention tortoises. The only indication of their former existence is that Fryer (1911, p. 434) reported seeing a fossil tortoise egg, said to have come from St Pierre, when he was in Seychelles. The possible existence of fossil material needs investigation.

Tromelin

There are no records of tortoises on Tromelin, either historic or fossil, and the island is not listed by Rothschild (1915).

ALDABRA

Accounts of tortoises on Aldabra in historic times are more complete than for any other western Indian Ocean coral island. The first visit from which records are available was that by the *Charles* and *Elisabeth* in 1744: Dalrymple (1784) records 'a great many land-turtle much larger than those at Rodrigue' in an annotation to the 1744 chart. Early in the nineteenth century the island was said to 'abound with land turtle' (Horsburgh 1809, p. 125). In 1822, when Moresby (1842, pp. 676 and 741) went there, tortoises were very abundant; there was an annual export to Mahé and Mauritius, where they were sold for 1–3 Spanish dollars each. Richard Owen, H.M.S. *Leven*, made a new chart in 1824 and inscribed Ile Malabar with the words 'abundance of land tortoise'.

It is likely that serious cropping only began at about this time. Toussaint's catalogue of Mauritius ship movements (1967, pp. 470–475) mentions only four vessels, all of 30–50 tons, arriving at Mauritius from Aldabra in 36 years (one in 1796, two in 1798, one in 1803). But whalers started operating in Seychelles waters after 1823, and by 1839 there was a regular export of Aldabra tortoises to Mahé, where local supplies had become extinct (Harrison 1839, p. 443). Stone enclosures were built on the atoll in the early nineteenth century to serve as pens for captured animals (Sauzier 1895; Voeltzkow 1897, p. 52; Stoddart 1971; McKenzie 1971).

Kersten (1871, p. 119) records that in 1842 two ships from Hamburg with 100 men collected 1200 tortoises, some weighing 360–410 kg, and this gives some indication of the scope of a considerable if episodic trade.

The effects of this cropping on the population are uncertain. There was concern in scientific circles in England about the possible extinction of the Aldabra tortoise, following reports that the atoll was to be leased for wood-cutting, and in April 1874 a Memorial was sent to the Governor of Mauritius, signed by Hooker, Owen, Darwin, Newton, Günther and others, asking for conservation measures (Günther 1877, pp. 20–22). That numbers had probably considerably declined was indicated by Wharton's experience in H.M.S. *Fawn* in 1878, when a party of sailors took 3 days to find one animal (Wharton 1883, p. 77). Rivers, who visited the atoll in December 1878, thought there were plenty of tortoises but saw none. He reported that they were concentrated at Cinq Cases, and only appeared during the rains. He did see large footprints, nine inches in diameter (Chief Civil Commissioner to Governor, 21 January 1879, Günther Papers, 72; in a similar report in the Seychelles Archives the footsteps have become faeces with the same dimension: Chief Civil Commissioner to Governor, Letter Book Outward 1878–80, Seychelles Archives B37). Rivers also noted the absence of dead carapaces, now a common sight, and he also recorded that the population had been damaged by pigs introduced some years before, but which had themselves died out. The Seychelles Government was already alarmed at the status of the Aldabra tortoises: the Chief Civil Commissioner, Mahé, noted that 'many vessels call at Aldabra for the sake of capturing land tortoises. The only way to protect these animals, in fact the only way to save them from eventual annihilation, is to have a Govt. Guardian on the Island and to strictly preserve the forest' (Chief Commissioner to Governor of Seychelles, 21 January 1879: Seychelles Archives).

Aldabra was first settled by a small fishing party at the end of 1889, and the first land lease was granted to James Spurs on 15 July 1891. This and subsequent leases included specific prohibitions on the killing of tortoises. When G. Cayley visited Picard in 1890 he found 15 Seychellois who in 2 months had seen only a single tortoise, though numbers were said to exist on Malabar (Seychelles Archives C/55/73).

Spurs, the new lessee, thought the tortoises generally to be 'still numerous', though extinct on Picard. He reintroduced 11 to that island from other parts of the atoll (Spurs 1892, p. 48); Rothschild (1915, p. 433) says that tortoises were reintroduced to Aldabra from Seychelles, but this may result from a misreading of Spurs. In 1892 Griffith reported that the tortoises were 'apparently prolific', and he recorded Spur's belief that there were not less than 1000 on the atoll (Griffith to Administrator, 13 June 1892: Seychelles Archives). He also felt that rats were an important element in limiting numbers (Griffith to Lt. Governor, Mauritius, 1893: Seychelles Archives). In 1895 Abbott 'met with but few' in a visit of 3 months and thought the population had been 'greatly diminished' by whalers and fishermen: he considered (as did Nicoll 11 years later (1908, p. 130) that there were more domesticated tortoises in the Seychelles proper than wild ones on Aldabra (Abbott 1893, p. 761), and that Spur's estimate of 1000 was 'very considerably overestimated' (Griffith to Lt. Governor, Mauritius, 4 April 1893: Gunther Papers).

Siebert Baty in 1893 saw 'traces' near Anse Var of tortoises turned loose on Picard by Spurs; his map of the Settlement includes a tortoise pen. Voeltzkow (1897, pp. 52–56) in the same year, while thinking there were 'still a great many', saw no skeletons and found few living animals: he saw two on his first day of search, none on the second, one on the third, and later

six on the south coast, all in areas where they are now prolific. He was also the first to record the existence of tortoise enclosures at Takamaka. Bergne (1900) does not mention tortoises at all. Nicoll, who visited both Picard and Takamaka in 1906, almost incredibly saw none either (Nicoll 1908, p. 130). There thus seems little doubt that from about 1880 until the first years of this century tortoise numbers were very low.

Thereafter there is some indication in the records of increasing numbers. On 29 July 1900 the Governor of Seychelles reported to the Secretary of State for the Colonies (Seychelles Archives C/55/73) that there were 'large numbers' on Picard (he saw five in 30 minutes) and 'great abundance' on Malabar. In 1906 Dupont (1907, p. 22) found that tortoises were 'still to be found in great number' in many parts of the atoll; he did not see them on Malabar but spent little time there. Fryer (1908), however, hardly mentions tortoises at all. He reports them plentiful at the east end of Grande Terre, on Malabar, and on Picard. Some indication of the population levels may be obtained from the fact that he saw a maximum of 17 in 1 day on Grande Terre (J. S. Gardiner to Under-Secretary of State for the Colonies, 12 July 1901: Günther Archives). Though he cut a trace right across Malabar near Anse Malabar he found only two young tortoises there (Fryer 1911, p. 420). 'It would be possible to live for years on Aldabra', he reported (1910, p. 258), 'and never see a specimen'. The Governor of Seychelles took a gloomy view of their survival. 'In a wild state at Aldabra practically all the young are destroyed by florentins (cranes), rats, and wild cats. . . No plan will effectively prevent the final extinction of these curious survivals in a wild state in their natural habitats' (Davidson 1911, pp. 623-624).

Not until 1916 do we find estimates of really substantial numbers. In that year Dupont estimated that there were 'many thousands' at Cinq Cases, and that tortoises were present in other parts of the atoll also, though in smaller numbers. In August 1929 he 'saw a great many land tortoise all over the place in their natural surroundings and they all looked very healthy' (Dupont 1929, p. 17).

During this time, Aldabran tortoises were also being exported from the Seychelles. Thirteen animals were exported between 1890 and 1900 (Treasurer to Administrator, Seychelles Archives C/55/73). There are no records for the period 1900-27, but after 1927 there are annual statements of export in Seychelles *Blue books* (1922-39) and *Trade reports* (1932 to date). Almost all of these animals must have derived directly from Aldabra. During 1927-76 a total of 1117 tortoises left Seychelles (some years are missing), an average of 22 per annum; for some years the annual quota has been 50. The destination of most is given as Kenya though the ultimate destination of these is not known. The trade records do not, of course, include animals taken from Aldabra and consumed, killed or relocated within the Seychelles.

CONCLUSION

This analysis can be summarized briefly. Tortoises were widespread on the volcanic and granitic islands of the western Indian Ocean, on Aldabra, and possibly on some coral islands at the time of discovery and early settlement (up to the late eighteenth century). They were already rare by 1670 on Mauritius and by 1790 on the granitic Seychelles; and they were extinct on all the high islands by about 1800. Apart from Aldabra, historical evidence is scarce for the limestone islands, and it is at least possible that the tortoise remains on most of these islands are of Pleistocene rather than Recent age. At Aldabra itself, the population came close to extinction

because of predation by man at the end of the nineteenth century, and the present very high population levels are a recent phenomenon. The evidence of the existence of tortoises on the sand cays and limestone islands are summarized in table 1.

TABLE 1.

| | sand cays | limestone islands |
|---|-----------|-------------------|
| no evidence | 6 | 1 |
| suggested in the secondary literature but no direct evidence; record therefore doubtful | 5 | 0 |
| historical records | 0 | 1 |
| fossil materials | 2 | 5 |
| existing wild population | 0 | 1 |

We thank Mrs S. Lomas, Aldabra Data Unit, for her work on a bibliography of western Indian Ocean tortoises.

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Appendix 1. Gigantic land tortoises of Seychelles†

BY C. GORDON

In 1691 Leguat writes that these tortoises were so numerous that you could go for 100 yards on their backs, they were in herds of hundreds, they are only found now in their natural state on the isle Aldabra in the Amirantes Group.

They carry a supply of about 2 gallons [9.1 l] of water in a bag at the root of the neck, they have no hearing. The Male has a long tail, the female a short one, but they are usually coiled up, the male exceeds the female in size, the temperature of their blood remains at 62° [F; 26°C] vide Work on Gigantic tortoises by A. Gunther 1877, which contains the petition of Sir J. Hooker and others to the Government requesting that they should be preserved.

The following families of Seychelles possess the best specimens of these tortoises.

At Mahé: R. Gonthier, Mrs Savy, Mr Duchenne, Mr Serret, Mr E. Nageon, Mr C. Button, Mr C. Dupuy.

At Praslin: Mr Laprude.

At Ladigue: Mr A. Nageon, Mr F. Payette, Mr B. Payette.

At Ile Cerf: Mr D. Calais.

At Deux Soeurs: Mr J. Berlories.

If kept in a large space, they increase rapidly in size, and they increase slowly, if confined.

The males couple with the female in February and March: the females scoop out a hole some 7" [18 cm] in diameter and 1' 6" [46 cm] deep, and entering it, lays her eggs, urines over them, and making a paste with the mud, covers them over, heaping in the mud, and then standing over it, on the tips of her toes, flops down with all her weight on the heap, making the roof of her nest very hard and level with the ground around, this ground is so hard that when eggs come forth, the small tortoises are obliged to burrow under and come out at the edge of this roof, the eggs which are round 2½" [6 cm] diameter with hard shell are laid in batches of 15–18 and come out in 6 months after being laid, generally they are laid in April and come out in September or October. In 1877–8–9 no eggs were laid by any of the tortoises of this colony. The female lays two batches of eggs with an interval of 18 days between them, and she goes with the male in this interval, after this the male notices not the female.

The male mounts on the back of the female, and remains coupled for an hour uttering loud grunts, the under plate of the male is concave, in order to fasten over convexity on the back of the female, the under plate of the female is flat in order that she may ram down the earth of her nest as described.

(N.B. The turtle couples with the male for 12 h at a time in the water, generally at night, when he can be approached without shifting his seat. The turtle eggs are covered with membrane, the male has two hooks with which he holds on to the female, the under plate of the turtle male is flat.)

The female commences to lay her eggs at age of 15 years, she searches a dry suitable place, she opens a ditch of hole 10" [25 cm] deep with her front feet, she then enters this ditch, and,

† Günther Papers; British Museum (Natural History).

with her hind feet opens a hole 6" to 8" [15–20 cm] deep quite round, it takes her 10–12 hours to do this, she removes about a table spoonful each time with her nails, and waits 3 or 4 minutes between each scoop.

This information comes from a very intelligent gentleman Mr Charles Button of Providence Mahé.

The tortoises never quarrel among themselves. Some of these tortoises weigh 500 lbs [277 kg], and are 5' 6" long, 4' 6" wide and 3 ft thick [168 cm long, 137 cm wide and 91 cm thick].

Appendix 2. Radiocarbon dating of eggshell of giant tortoise from Denis Island, Seychelles

BY R. BURLEIGH

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A radiocarbon date has been obtained at the British Museum Research Laboratory for an eggshell of the giant tortoise (*Geochelone gigantea*) from Denis Island on the northern rim of the Seychelles Bank (3° 47' S, 55° 39' E). The eggshell came from the collection of the British Museum (Natural History), Reg. no. 1927. 5.14.18, and was submitted for dating by Dr E. N. Arnold and Dr J. D. Taylor of the Department of Zoology, B.M.(N.H.). It was originally collected in 1927 by J. Hornell from a deposit which recent analysis has indicated was probably a calcareous beach sand incorporated in a soil. Although the eggshell was incomplete it could be identified with certainty as that of a giant tortoise. The purpose of the radiocarbon measurement was to indicate whether tortoises were present on Denis Island before people arrived there in historic times and, indirectly, to provide a minimum age for the deposits in which the eggshell was found.

A preliminary computer search of the 40 000 or so radiocarbon dates that have been published revealed no other instance in which the eggshells of reptiles had been dated. The nearest comparisons that could be found were with ostrich eggshell for which about 30 dates have been reported in *Radiocarbon*, and with three dates for eggshells of the extinct giant bird *Aepyornis maximus* from Madagascar. Although there was no direct information regarding the suitability for radiocarbon dating of the eggshell of the giant tortoise its isotope chemistry might reasonably be expected to be similar to that of these other apparently reliable materials.

Examination by X-ray diffraction showed that the eggshell was composed of unaltered aragonite. From the absence of any recrystallization to calcite it was inferred that no post-depositional exchange of carbon isotopes had taken place and no appreciable error in the apparent radiocarbon age of the eggshell was to be expected from this cause. The sample used for dating was a single fragment weighing approximately 15 g and comprising about two-thirds of a complete eggshell, presumably broken by the emergence of a hatchling. As it was otherwise well preserved and uncontaminated no special pretreatment was required and the entire sample was dissolved in dilute hydrochloric acid yielding about 3 l of carbon dioxide. All of this in turn was converted via acetylene to benzene for measurement of ¹⁴C activity by liquid scintillation counting, the standard method in use for radiocarbon dating at the British Museum

laboratory. The date obtained (BM-1331) was 1308 ± 85 radiocarbon years before A.D. 1950 (bp) on the basis of the conventional 5570 year half-life for ^{14}C ; the error quoted with this date was derived purely from counting statistics and is equivalent to ± 1 standard deviation. The stable carbon isotope ratio ($\delta^{13}\text{C}$) measured for this sample was -2.22 ± 0.18 parts per mille (‰) relative to the international P.D.B. standard (a Cretaceous belemnite), a value within the range in which some inorganic carbonates lie. The ^{14}C activity measured was age corrected for the difference between the $\delta^{13}\text{C}$ value of -2.22‰ obtained for the eggshell and the accepted average value for plant material (wood) of -25.00‰ to which all dates are normally referred. There is no *prima facie* reason to doubt the correctness of this procedure in this instance since, although giant tortoises do occasionally eat carrion, for example, and forage on the sea-shore, their diet is predominantly vegetarian and most of the carbon they assimilate must be derived directly from living plants. Therefore, any intake of older carbon is most probably negligible. Independently, if normalization against some $\delta^{13}\text{C}$ value more positive than that of plant material is actually more appropriate for the eggshell of giant tortoise because of fractionation during metabolism, then the effect would be to shift the date somewhat nearer the present, perhaps by up to 200 years. In principle this uncertainty could be resolved empirically by measuring the apparent radiocarbon age of the eggshell of a modern giant tortoise. Unfortunately any such measurement would be equivocal because of the dilution resulting from large scale combustion of fossil fuel since about A.D. 1850 and overcompensation of this by artificial ^{14}C derived from nuclear weapon testing.

Assuming that the date of 1308 ± 85 bp obtained from the eggshell is not seriously in error it is nevertheless strictly a 'radiocarbon age'. For greater absolute accuracy this must be corrected to allow for past variations in the level of natural ^{14}C and for the more accurate 5730 year half-life (although for convenience dates are still reported in *Radiocarbon* on the basis of the original 5570 year half-life). In practice these corrections have little effect on relatively recent dates. By using one of the more comprehensive and accessible of the published tables for correction of raw radiocarbon dates (*Antiquity* **49**, 251-266 (1975)), a calendar date of 1270 years before 1950 or A.D. 680 would be obtained. This date probably has an inherent error of about ± 100 years.

From this date it would appear that Denis Island was occupied by giant tortoises well before the arrival of European voyagers in the seventeenth century. The result also provides a reasonable minimum age for the deposit in which the eggshell was found, which analysis suggested was fairly recent. It would be of considerable interest to follow up this result by dating the remains of giant tortoises from other isolated islands or island groups in the western Indian Ocean where there appear to be early records, such as the Amirante Islands. Some other problems relating to the former distribution and the contemporaneity or otherwise of the different species of giant tortoise may also be amenable to radiocarbon dating.