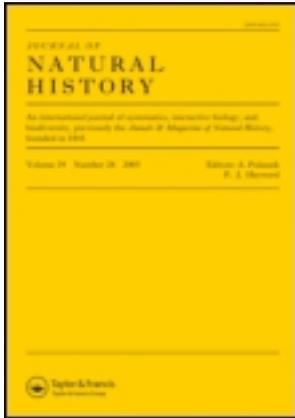


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SHORT COMMUNICATION

The first substantiated case of trans-oceanic tortoise dispersal

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Abstract

In December 2004 an Aldabra giant tortoise *Dipsochelys dussumieri* was washed ashore on the coast of east Africa, probably having been carried off the shore of Aldabra atoll, 740 km away. Although trans-oceanic dispersal is assumed to be the mechanism by which tortoises and many other animals became established on islands throughout the world, this is the first direct evidence of a tortoise surviving such a sea-crossing.

Keywords: *Dipsochelys dussumieri*, tortoise, trans-oceanic dispersal, Aldabra, Tanzania

Introduction

Land tortoises are present on several island groups, most notably the Galapagos and the Seychelles islands. These island populations are assumed to be descended from ancestors that rafted or drifted from mainland populations. There is some experimental and anecdotal support for the idea of tortoises floating for extended periods of time (Townsend 1936; Gerlach 2005) but no direct evidence of successful sea crossing. Here we report on a case of an Aldabra giant tortoise, *Dipsochelys dussumieri* (Gray, 1831), crossing several hundred kilometres of ocean and summarize past reports of others being found in the sea.

The Kimbiji tortoise

On 14 December 2004, an Aldabra giant tortoise was found walking out of the sea at 06:00 h at Kimbiji, 35 km south of Dar es Salaam, Tanzania. It was in an emaciated condition and with an extensive growth of goose barnacles (Lepadidae) (Figure 1). The animal was female and weighed 25 kg with a carapace measuring 77 cm long and 74 cm



Figure 1. The Aldabra tortoise at Kimbiji, shortly after its discovery in December 2004. Photograph: C. Muir.

wide (curved carapace measurements) and was taken to a breeding centre in Dar es Salaam (measurements were taken in December 2004). After 3 months, the tortoise had gained 2 kg.

There are three possible sources for this animal: the small Changuu Island in the Zanzibar Channel, a few miles west of Zanzibar Town; one of the introduced populations of the Seychelles islands (there being free-range or wild tortoises on several islands, most importantly Curieuse and Fregate islands); or Aldabra atoll (Figure 2), one of a few places where giant tortoise are still found in the wild.

Details of the spacing between shell scutes helps identify different populations and is related to diet. Tortoises from low-density populations (Changuu and the introduced Seychelles populations) have rapid growth, with pronounced and widely separated growth annuli on the scutes. On Aldabra this pattern is found in low-density populations such as on Picard and Malabar islands, but the high-density population on Grande Terre comprises relatively small tortoises with only weakly developed annuli. The Kimbiji tortoise has a smoother shell than tortoises from any of the introduced populations and resembles animals from Aldabra, specifically those from Grande Terre. Kimbiji and Aldabra are some 740 km apart.

The barnacles covering the fore-limbs of the tortoise were not measured in 2004 but comparing the photograph from 2004 with the size of the tortoise scales on the fore-legs, the white shell plates of the largest specimens can be estimated to have been up to 2 cm long and 0.8–1 cm wide. The barnacles strongly resemble *Lepas anserifera* Linnaeus, 1767 and are thickest in density on the lower legs and carapace. These will have settled and begun growth soon after the tortoise started its floating journey. Monitoring of marine fouling on offshore floats of Fish Aggregation Devices (FADs) off Tanzania during 2005 (Richmond and Mohamed 2006) has shown that this species of barnacle settles soon after immersion, with visible 2 mm long plates after 9 days, and 3 cm long plates after 11 weeks. These data, though meagre, suggest the Kimbiji tortoise barnacles to be about 6–7 weeks old.

The prevailing ocean current along this portion of the east African coast is the north-flowing East Africa Coastal Current. Between Aldabra and Kimbiji the prevailing current is the South Equatorial Current (SEC) which would have carried the tortoise westward at

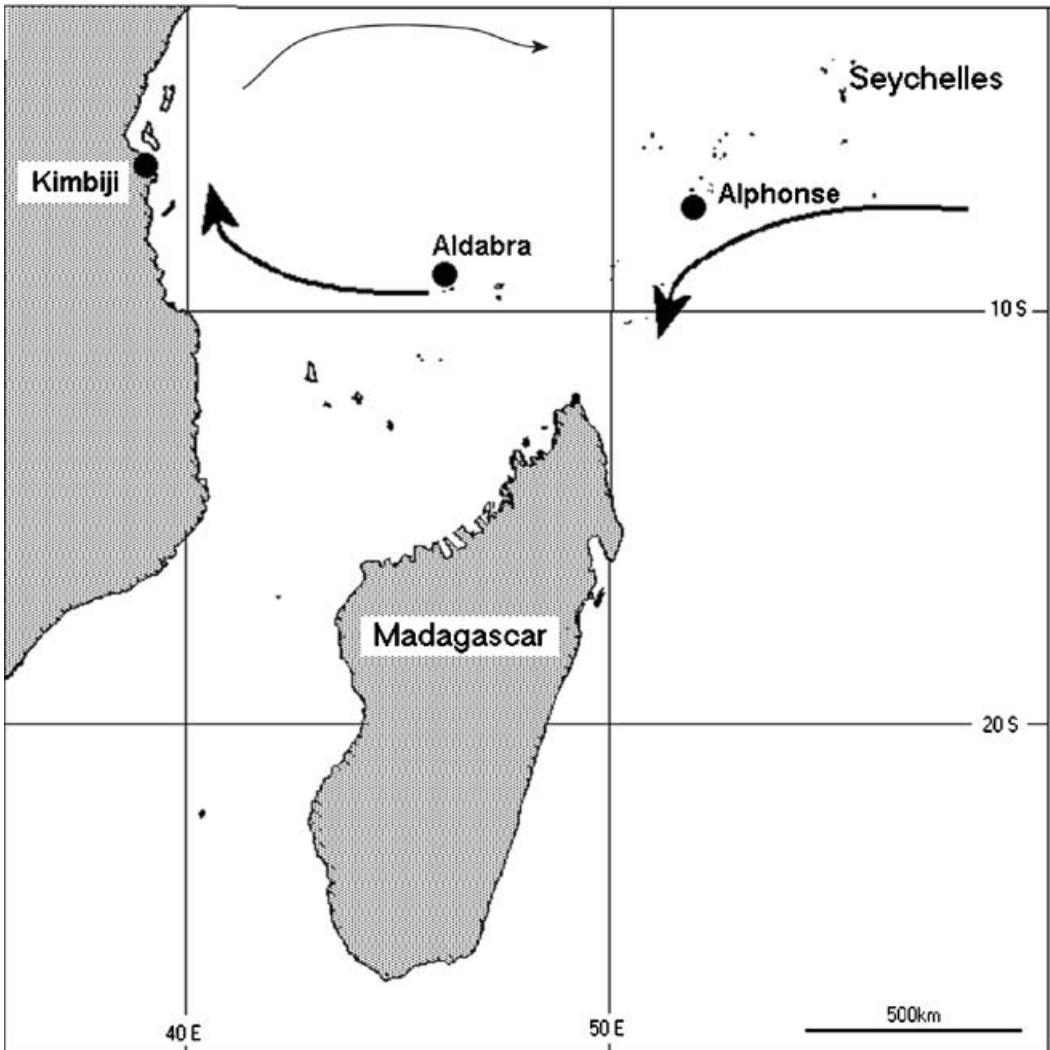


Figure 2. Map showing probable dispersal route.

speeds of 1–3 knots (Admiralty Chart 4701 *Maputo to Muqdisho*). This current speed equates to a drifting time of between 6 and 17 days to reach Africa. The northeast monsoon would be blowing during this period which probably slows the SEC, hence the 3-week extreme seems more likely. A floating tortoise will only have a very low windage, however, it may have at some point been actively swimming either with, or against the current, potentially further slowing its progress westward. Off Changuu Island further north, in contrast, the prevailing currents are northerly, away from Kimbiji, thus discounting this alternative origin. Ocean currents from Alphonse would also carry the tortoise to Africa, taking at least twice as long. The above evidence, which in conjunction includes shell annuli details, ocean currents, and suggested time at sea from barnacle growth, strongly support a sea-crossing from Aldabra atoll west to Africa that lasted several weeks, or months.

This long period of uncertain drifting presents four potential threats to a floating tortoise—desiccation from the tropical sun, drowning during storms and attack from sharks

or collision with shipping. The ability for tortoises to survive in starved condition (e.g. in the hulls of ships) is well known with records for many months. Crossing a reef during low tide with heavy sea may be dangerous for a tortoise, but at high tide it would easily wash over the shallow rocky grounds and on to the beach.

About a year and half after its arrival in Africa, after being kept and well fed in a breeding centre in Dar es Salaam, on 8 May 2006 the tortoise measured 85.5 cm curved length, 83.0 cm curved width, 55.0 cm plastron length, and 42.5 kg in weight. In a simple manner, these measurements reflect an increase in body length of about 10% but a more significant increase in body weight of about 60%. It appears the tortoise continued to add weight but at a faster rate than over the first 3 months, perhaps indicating that recovery from the floating journey requires many months.

Other records

There are several records of tortoises from the Aldabra population entering the atoll's lagoon (Grubb 1971). These may drift to other islands in the atoll, as indicated by the movement of marked individuals (Gibson and Hamilton 1984) and the colonization of Esprit island between 1975 and 2000 (Blackmore 2001). There is one record of a live tortoise being found in the open ocean. This was found by a passing ship, examined, and returned to the ocean (Gerlach 2005). The eventual fate of this animal is unknown.

On 20 December 2005 a giant tortoise was seen in the sea off Alphonse island at the south of the Amirantes group (Figure 3). Fortunately, the tortoise was spotted by a boat arriving at the island, this was able to stop and rescue the tortoise. It was lifted into a net, transferred to a launch, and returned to the island's tortoise enclosure. The tortoise was exhausted by its ordeal and spent several hours resting before making any movement but appeared to recover with no long-term effects. When found, this tortoise was swimming strongly but as it was over 1 km from the island it stood little chance of saving itself. It would have been unable to see any land from its low position in the water and had probably scant indication of a direction in which to head.

It seems that the tortoise had escaped from the enclosure some time before. In its wanderings it must have ended up on the beach or on the reef flat at low tide and



Figure 3. Aldabra tortoise at sea off Alphonse in December 2005. Photograph: J. Gerlach.

then been unable to return to land as the tide rose, sweeping it out of the lagoon and out to sea.

Discussion

In addition to the Aldabra tortoise records summarized above there are also records of Galapagos giant tortoises (*Chelonoidis nigra* (Quoy and Gaimard, 1824)=*Geochelone elephantopus* (Harlan, 1827)) being swept 32 km into the sea by hurricanes (Townsend 1936). Despite these observations, there have been no observations of a giant tortoise making a successful crossing between islands.

Rafting or drifting between isolated land masses is the only mechanism of dispersal open to many animals. There is a record of a tree trunk carrying a boa constrictor to St Vincent island in 1827 (Thornton 1971) but the details of this are not clear. The first direct evidence in support of the practicality of rafting was the sighting of green iguanas (*Iguana iguana* Linnaeus, 1758) landing on a vegetation raft on Anguilla in 1995 (Censky et al. 1998). This appears to have resulted in colonization, at least temporarily, following a month-long journey of some 230 km (assuming the source population to have been on Guadeloupe, although this has been questioned; Breuil 1999). The 740 km journey covered by the Kimbiji tortoise is remarkable in that this was covered by a land animal floating without the aid of a raft, normally assumed for trans-oceanic colonization. In the case of giant tortoises their large size would preclude the use of all but the very largest of rafts, but they have long been recognized as being well adapted to dispersal. In the present case the restriction of barnacles to the lower half of the carapace supports previous assumptions that the large lungs underlying the carapace would provide buoyancy, allowing tortoises to float for extended periods of time, with the head reaching above the surface at least periodically (Pritchard 1996).

This colonization ability and their morphological variability led to their central influence on Darwin's development of his ideas on evolution. It is thus particularly significant that a giant tortoise can be demonstrated to have made the crossing between a continent and an oceanic island. It is ironic that the first documented trans-oceanic movement of a tortoise occurred from an island to a continent, rather than the reverse direction that is so important to island biogeography.

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