Conservation Biology of Freshwater Turtles and Tortoises:
A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group
A.G.J. Rhodin, P.C.H. Pritchard, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, J.B. Iverson, and R.A. Mittermeier, Eds.
Chelonian Research Monographs (ISSN 1088-7105) No. 5, doi:10.3854/crm.5.028.arnoldi.v1.2009

Aldabrachelys arnoldi (Bour 1982) – Arnold's Giant Tortoise

Justin Gerlach[1]

[1]*133 Cherry Hinton Road, Cambridge CB1 7BX, United Kingdom [jstgerlach@aol.com]*

Summary. – Arnold's giant tortoise, *Aldabrachelys arnoldi (= Dipsochelys arnoldi)* (Family Testudinidae), from the granitic Seychelles, is a controversial species possibly distinct from the Aldabra giant tortoise, *A. gigantea* (= *D. dussumieri* of some authors). The species is a morphologically distinctive morphotype, but has so far not been genetically distinguishable from the Aldabra tortoise, and is considered synonymous with that species by many researchers. Captive reared juveniles suggest that there may be a genetic basis for the morphotype and more detailed genetic work is needed to elucidate these relationships. The species is the only living saddle-backed tortoise in the Seychelles islands. It was apparently extirpated from the wild in the 1800s and believed to be extinct until recently purportedly rediscovered in captivity. The current population of this morphotype is 23 adults, including 18 captive adult males on Mahé Island, 5 adults recently introduced to Silhouette Island, and one free-ranging female on Cousine Island. Successful captive breeding has produced 138 juveniles to date.

Distribution. – Seychelles. Restricted to the granitic islands, but original distribution unknown. Currently occurs as a small introduced population on Silhouette, a single female on Cousine, and several males in non-breeding captive groups on Mahé.

Synonymy. – *Dipsochelys arnoldi* Bour 1982, *Aldabrachelys arnoldi*.

Subspecies. – None.

Status. – IUCN 2008 Red List: Not Evaluated (proposed listing: Extinct in the Wild, EW); CITES: Appendix II (as Testudinidae spp.).

Taxonomy. — A stuffed specimen of this species presented by the 13th Earl of Derby was recognized as distinct from *Testudo elephantina* Duméril and Bibron 1835 (a subjective synonym of *Testudo dussumieri* Gray 1831 and *Testudo gigantea* Schweigger 1812, the Aldabra tortoise), by Günther (1877), but included under *Testudo daudinii* Duméril and Bibron 1835. Boulenger (1889) followed Günther. Later, in his review of the giant tortoises, Arnold

Figure 1. Adult male *Aldabrachelys arnoldi*, Seychelles. Photo by John Pemberton.

Figure 2. Adult male *Aldabrachelys arnoldi*, introduced on Silhouette Island, Seychelles. Photo by Justin Gerlach.

(1979) disregarded this taxon as an artifact of captive diets. On the other hand, with two other museum specimens, Lord Derby's tortoise was incorporated by Bour (1982) in his new species *Dipsochelys arnoldi*, described as an extinct taxon from the granitic Seychelles: the three identified specimens were collected before 1850; they show both morphological and osteological shared characters. *Dipsochelys arnoldi* was resurrected as a purportedly living species following the discovery of living captive specimens with similar morphology (Gerlach and Canning 1998a, b), based on morphological, osteological, and preliminary DNA studies.

Subsequent analysis of five mitochondrial and nuclear genes have failed to identify significant or consistent genetic differences among purported *Aldabrachelys* and *Dipsochelys* taxa (Palkovacs et al. 2002, 2003; Austin et al. 2003; Le et al. 2006; reviewed in Gerlach 2004, 2005). However, captive breeding has demonstrated that the morphological characteristics of the *A. arnoldi* morphotype are present at birth and not due to later environmental or dietary factors (Gerlach and Bour 2003).

Figure 3. Adult female *Aldabrachelys arnoldi*, Seychelles. Photo by Justin Gerlach.

Not all authorities recognize the validity and distinctiveness of *A. arnoldi*, and instead synonymize it with the Albabra tortoise, *A. gigantea* (= *Dipsochelys dussumieri* of some authors) (e.g., Palkovacs et al. 2002, 2003; Fritz and Havas 2007). However, others recognize the species as distinct based on the described morphological differences and incomplete genetic analysis (Gerlach and Canning 1998a,

Figure 4. Adult male *Aldabrachelys arnoldi*, Seychelles. Photo by Justin Gerlach.

Figure 5. Hatchling *Aldabrachelys arnoldi*, Seychelles. Photo by Justin Gerlach.

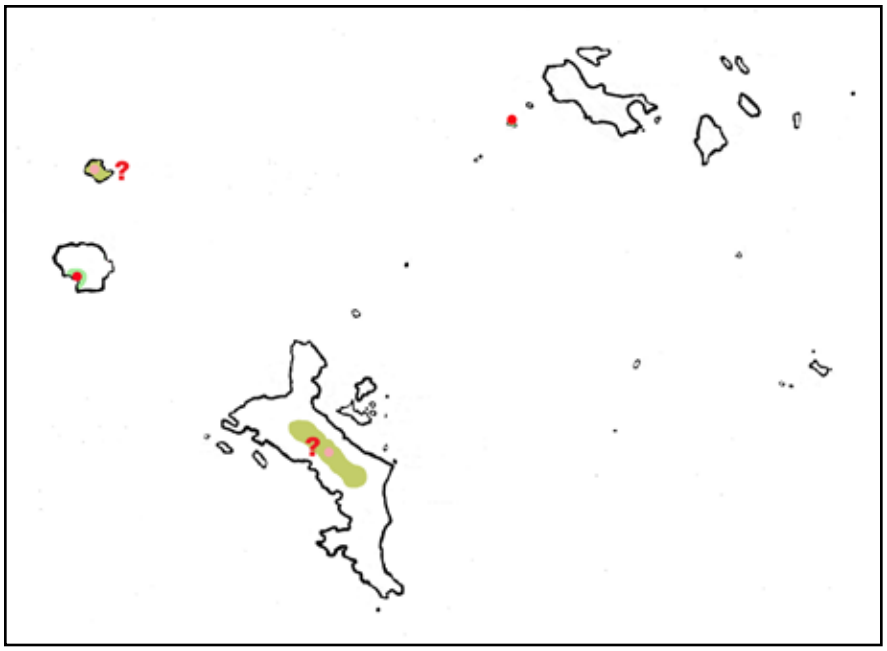

Figure 6. Distribution of *Aldabrachelys arnoldi* in the Seychelles islands, east of Africa in the Indian Ocean. Red points = occurrence records of introduced populations based on author's data; green shading = distributions of introduced populations based on author's data. Pink points = possible locations of extirpated populations; olive shading = possible areas of extirpated distribution.

Gerlach and Bour 2003, Bour 2006, Turtle Taxonomy Working Group 2007; Leuteritz et al. 2008; Rhodin et al. 2008). Further research is needed to identify the possible genetic distinctiveness underlying this morphotype.

The question of whether *Aldabrachelys gigantea* or *Dipsochelys dussumieri* is the valid name for the Aldabra giant tortoise bears directly on the generic nomenclature of Arnold's giant tortoise as well. This issue is currently being evaluated by the International Commission on Zoological Nomenclature (ICZN) following a petition by Frazier (2009) to designate *Testudo gigantea* Schweigger 1812 (= *Aldabrachelys gigantea*) as the valid name for the Aldabra tortoise and rejecting the use of *Testudo dussumieri* Gray 1831 (= *Dipsochelys dussumieri*). The ICZN has not yet ruled on the matter and until such a ruling is made, use of either *gigantea* or *dussumieri* or *Aldabrachelys* or *Dipsochelys* could be considered nomenclaturally correct. However, although I and some others have argued for the use of *dussumieri* and *Dipsochelys*, most commentary to the ICZN to date has supported the use of *gigantea* and *Aldabrachelys* (see multiple author comments pro- and con- in Zug et al. 2009, Bour et al. 2009, and Takahashi et al. 2009). Therefore, as an editorial compromise for this species account in this monograph series, the Aldabra giant tortoise is here provisionally referred to *gigantea* rather than *dussumieri*, and Arnold's giant tortoise to the genus *Aldabrachelys* rather than *Dipsochelys*.

Description. — Adults have an elongate, low and slightly saddle-backed carapace, highest at vertebral 1 or 2 and broader posteriorly than anteriorly, with smooth to only slightly serrated marginals. Some animals are markedly saddle-backed. A large cervical scute is present, but no cervical indentation. The vertebrals are wider than long, vertebral 3 is shorter than 2 and 4. The first pleural scute is longer than the second, and a depression is usually present along the suture of these two scutes. There are 11 marginals; the supracaudal may be divided or entire and curves downwards. The carapace and plastron are grayish-brown to black. The plastron is relatively short (61–89% of carapace length), with a moderate sized bridge (45–65% of the carapace length), and lacks an anal notch. Its forelobe is narrower than the hindlobe; the humero-pectoral suture is distinctly angled. The skin is uniformly grayish-black. The tail bears a large terminal scale in males. Males are somewhat larger than females, reaching 88 cm straight carapace length (CL) as compared to the females that reach 85 cm. Males have longer tails than females, a distinctly concave plastron, and more elongate shape than females. Hatchlings are light yellow-brown upon hatching, with darker carapace scute margins (Gerlach and Bour 2003). After a week, they darken to a black color.

Neurals 3 and 5 are constricted; neurals 2 and 4 are octagonal, distinctively widened anteriorly and with curved posterior margins (Gerlach 1999). The skull has a small processus frontalis circumolfactorius, a well-developed anteriorly directed process on the upper posterior margin of the tympanic aperture of the quadrate, and an anteromedially directed flange on the quadrate. Moreover, there is a vertical ridge on the descending process of the parietals. The tympanic cavity is distinctly inflated; the processus trochlearis oticum is well-developed and broad. The dentary is unique in having a well-developed horizontal flange on the ventral margin of the lingual symphysial surface for the insertion of the geniohyoideus muscle. The articulars are not truncated. The post-cranial anatomy is typical of the genus except that the scapulo-acromial angle is less obtuse than

in *A. gigantea* and in having a strongly curved humerus, a triangular coronoid fossa, a straight ulna, and no groove on the tibia.

This species can be distinguished from other *Aldabrachelys* species in having a flat, or saddle-backed carapace, with the third vertebral scute shorter than the second, the first costal scute much longer than the second, a humero-pectoral suture with a relatively pronounced angle laterally (shared with *A. hololissa,* but more gently curved in *A. gigantea*), and absence of a deep anal notch (Gerlach 2004).

Distribution. — Endemic to the granitic Seychelles islands. Probably originally found on many islands, with evidence for former populations on Mahé and North islands (Gerlach 2004). The introduced population is now restricted to five individuals on Silhouette Island and one on Cousine, with most animals in captivity also held on Silhouette, but a few also on Mahé.

Habitat and Ecology. — Historical records (reviewed in Gerlach 2004) suggest that this was a forest species, recorded inland and on mountain tops with scrubby vegetation. This agrees with studies of morphology and captive ecology indicating that the species is a browsing specialist (Gerlach 1999, 2005). The diet includes creepers and shrubs; grazing on grass in captivity occurs only when the former are not available (pers. obs.). Observations of the wild diet of recently released adults recorded feeding on 18 plant species (out of an available 26 species), with a selective preference for 9 species, and males and females showed different dietary preferences (Pemberton and Gilchrist 2009). Browsing behavior was not found to be more significant than grazing in the released animals, although recent habitat changes resulting in an increase in creeper abundance may have reversed this pattern (pers. obs.). Adults are active in the early morning, with the saddle-backed males basking in late morning to increase body temperature due to rapid cooling from extensive exposed skin of the saddle-backed morphology (Gerlach 2005).

Mating occurs in December to March. Eggs are laid throughout the year (peaking in July–September), hatching 3–4 months later. From 6 to17 eggs are laid in a 30–35 cm deep, sock-shaped nest. Eggs are spherical and hard-shelled, 50 mm in diameter, and weighing 54–87 g (Gerlach 2003, 2007). Sex determination is temperature dependent, with males produced at 29–31ºC after 109–135 days and females at 31–33ºC after 94–115 days (Gerlach 2007).

Hatchlings are distinctive (Gerlach and Bour 2003) and start to develop characteristic features of the adult morphology from the age of 2 yrs, with the curved supracaudal and vertebral scute proportions apparent at 5–6 yrs of age (pers. obs.). Growth is rapid, reaching 15–20 kg after 5 yrs (pers. obs.). The age of sexual maturity is not known, but is assumed to be 16–25 yrs, as in other *Aldabrachelys* species (Gerlach 2004). Similarly, longevity is estimated to be over 100 yrs, based on data from *A. gigantea*.

Population Status. — This species has been extinct in the wild since the mid 1800s. Currently there is one free-ranging female introduced on Cousine Island and five adults were introduced to Silhouette Island in December 2006. Two nests were recorded in 2007 and several in 2009, but no wild hatchlings have been found to date. As of June 2009 there are 138 juveniles in captivity (all less than 7 yrs old).

Threats to Survival. — Historically threatened by hunting for food and export. Habitat loss has not been a significant factor for this species, as most original populations had been lost before habitat destruction became significant. Many plantations established in former tortoise habitat are now abandoned and have reverted to habitat that is ideal for tortoise survival. Currently the only active threats are those presumed to be present as a result of the restricted population, principally inbreeding. The adult sex ratio is male biased (1 female : 7 males). The juvenile sex ratio is balanced but has been bred from only two females.

Conservation Measures Taken. — Most tortoises are listed on CITES Appendix II as "Testudinidae spp.", which by default includes all species of *Aldabrachelys*. Arnold's tortoise is not currently included on the IUCN Red List, as it has never been formally assessed. The introduced population on Silhouette is not currently protected, although proposed National Park status for Silhouette may include at least part of this area. The species has been bred in captivity by the Seychelles Giant Tortoise Conservation Project of the Nature Protection Trust of Seychelles. As of June 2008 this project had produced 138 juveniles that are being reared for future introductions; these are planned to start in 2010.

Conservation Measures Proposed. — The species should be listed on the IUCN Red List as Extinct in the Wild (EW) since the original wild populations have been extirpated and only captive and introduced animals remain. The proposed Silhouette National Park should include some degree of legal protection for the coastal woodland of Grande Barbe. Further introductions need to take place to build a viable breeding population as quickly as possible.

Captive Husbandry. — The species has been bred in captivity by the Nature Protection Trust of Seychelles on Silhouette island, Seychelles. A small number of captive individuals are known elsewhere, but none are in breeding groups (Gerlach 2004). Successful breeding has required the use of large, natural enclosures, and the provision of abundant natural plant food (pers. obs.). Social aspects are important for breeding with competition between males stimulating successful mating behavior (pers. obs.). Egg incubation has been successful at 27-32ºC and at a humidity of over 80% (Gerlach 2007).

Current Research. — Research on growth patterns and behavior is continuing. Detailed genetic research is needed to elucidate the genetic controls of the morphological features of this taxon, allowing its taxonomic status to be clarified.

Acknowledgments. — The initial genetic work on this species was supported by the Linnaeus Fund of the Chelonian Research Foundation. The captive breeding project has been supported by the British Chelonia Group, Conservation International and the Nederlandse Schildpadden Vereniging.

LITERATURE CITED

Arnold, E.N. 1979. Indian Ocean giant tortoises: their systematics and island adaptations. Philosophical Transactions of the Royal Society, London B 286:127-145.

Austin, J.J., Arnold, E.N., and Bour, R. 2003. Was there a second adaptive radiation of giant tortoises in the Indian Ocean? Molecular Ecology 12:1396-1402.

Bour, R. 2006. Identity of *Testudo gigantea* Schweigger, 1812 and rediscovery of the type specimen. Emys 13:12-23.

Bour, R., Pritchard, P., Cheke, A., Collie, J., Arnold, E.N., Meylan, P.A., Bury, R.B., Dodd, C.K., Jr., Kraus, O., McCarthy, C., Fleischer-Dogley, F., et al., Casale, P., Gaffney, E.S., Tatayah, V., Jones, C., Reynolds, R.P., Howell, K.M., Ng, P.K.L., Chellam, R., Palkovacs, E.P., and Gerlach, J. 2009. Comments on the proposed conservation of usage of *Testudo gigantea* Schweigger, 1812 (currently *Geochelone* (*Aldabrachelys*) *gigantea*; Reptilia, Testudines) (Case 3463; see BZN 66: 34-50, 80-87). Bulletin of Zoological Nomenclature 66(2):169-186.

Frazier, J. 2009. Case 3463: *Testudo gigantea* Schweigger, 1812 (currently *Geochelone* (*Aldabrachelys*) *gigantea*; Reptilia, Testudines): proposed conservation of usage of the specific name by maintenance of a designated neotype, and suppression of *Testudo dussumieri* Gray, 1831 (currently *Dipsochelys dussumieri*). Bulletin of Zoological Nomenclature 66(1):34-50.

Fritz, U. and Havas, P. 2007. Checklist of chelonians of the world. Vertebrate Zoology 57(2):149-368.

Gerlach, J. 1999. Distinctive neural bones in *Dipsochelys* giant tortoises. Journal of Morphology 240:33-38.

Gerlach, J. 2003. Five years of conserving Seychelles Chelonia. Testudo 5:30-41.

Gerlach, J. 2004. Giant Tortoises of the Indian Ocean. Edition Chimaira, Frankfurt am Main, 207 pp.

Gerlach, J. 2005. Thermoregulation in captive Indian Ocean giant tortoises. Chelonian Conservation and Biology 4:937-941.

Gerlach, J. (Ed.). 2007 Terrestrial and Freshwater Vertebrates of Seychelles. Backhuys Publishers, Leiden, 154 pp.

Gerlach, J. and Bour, R. 2003. Morphology of hatchling *Dipsochelys* giant tortoises. Radiata 12:11-20.

Gerlach, J. and Canning, L. 1998a. Taxonomy of Indian Ocean giant tortoises (*Dipsochelys*). Chelonian Conservation and Biology 3:3-19.

Gerlach, J. and Canning, L. 1998b. Identification of Seychelles giant tortoises. Linnaeus Fund research report. Chelonian Conservation and Biology 3:133-135.

Günther, A.C.L.G. 1877. The gigantic land Tortoises (living and extinct) in the Collection of the British Museum. British Museum, London, 96 pp.

Le, M., Raxworthy, C.J., McCord, W.P., and Mertz, L. 2006. A molecular phylogeny of tortoises (Testudines: Testudinidae) based on mitochondrial and nuclear genes. Molecular Phylogenetics and Evolution 40:517-531.

Leuteritz, T.E., Gerlach, J., Mittermeier, R.A., Rhodin, A.G.J., van Dijk, P.P., Lewis, R., and Randriamahazo, H. 2008. Turtles and Tortoises of Madagascar and Adjacent Indian Ocean Islands. Pocket Identification Guide. Conservation International, Tropical Pocket Guide Series, 19 pp.

Palkovacs, E.P., Gerlach, J., and Caccone, A. 2002. The evolutionary origin of Indian Ocean tortoises (*Dipsochelys*). Molecular Phylogenetics and Evolution 24:216-227.

Palkovacs, E.P., Maschner, M., Ciofi, C., Gerlach, J., and Caccone, A. 2003. Are the native giant tortoises from the Seychelles really extinct? Molecular Ecology 12:1403-1414.

Pemberton, J.W. and Gilchrist, J.S. 2009. Foraging behavior and diet preferences of a released population of giant tortoises in the Seychelles. Chelonian Conservation and Biology 8(1):57-65.

Rhodin, A.G.J., van Dijk, P.P., and Parham, J.F. 2008. Turtles of the world: annotated checklist of taxonomy and synonymy. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A. and Iverson, J.B. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 000.1-000.38

Rothschild, W. 1915. On the gigantic land tortoises of the Seychelles and Aldabra-Madagascar group with some notes on certain forms of the Mascarene group. Novitates Zoologicae 22:418-442.

Takahashi, A., Hirayama, R., Alcala, A.C., Carretero, M.A., Danilov, I.G., Ernst, C.H., Honegger, R., Lovich, J.E., Malonza, P.K., Moravec, J., Penny, M., Praschag, P., Siroky, P., Spinks, P.Q., Griffiths, C., Hansen, D., Bauerfeld, K., Glaw, F., Fong, J.F., Fritz, U., Kraus, O., Hailey, A., Vences, M., Wanless, R.M., Williams, E.H., Jr., Nieves-Rivera, A.M., Bunkley-Williams, L., Grimm, U., Iverson, J.B., Mortimer, J.A., Buskirk, J., Morgan, J., Schmidt, F., and Miller, J. 2009. Comments on the proposed conservation of usage of *Testudo gigantea* Schweigger, 1812 (currently *Geochelone* (*Aldabrachelys*) *gigantea*; Reptilia, Testudines) (Case 3463; see BZN 66: 34-50, 80-87, 169-186). Bulletin of Zoological Nomenclature 66(3):274-290.

Turtle Taxonomy Working Group, [Bickham, J.W., Iverson, J.B., Parham, J.F., Philippen, H.-D., Rhodin, A.G.J., Shaffer, H.B., Spinks, P.Q., and van Dijk, P.P. 2007. An annotated list of modern turtle terminal taxa with comments on areas of taxonomic instability and recent change. In: Shaffer, H.B., FitzSimmons, N.N., Georges, A., and Rhodin, A.G.J. (Eds.). Defining Turtle Diversity: Proceedings of a Workshop on Genetics, Ethics, and Taxonomy of Freshwater Turtles and Tortoises. Chelonian Research Monographs No. 4, pp. 173-199.

Zug, G.R., Beaver, K., Bjorndal, K.A., Crumly, C.R., Das, I., Diamond, A.W., Hambler, C., Leuteritz, T., Shah, N.J., Murphy, J.B., Swingland, I.R., Bourn, D., Turkozan, O., Savage, J.M., Caccone, G., Parham, J.F., and Rhodin, A.G.J. 2009. Comments on the proposed conservation of usage of *Testudo gigantea* Schweigger, 1812 (currently *Geochelone* (*Aldabrachelys*) *gigantea*; Reptilia, Testudines) (Case 3463; see BZN 66: 34). Bulletin of Zoological Nomenclature 66(1):80-87.

Citation Format for this Account:

Gerlach, J. 2009. *Aldabrachelys arnoldi* (Bour 1982) – Arnold's giant tortoise. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 028.1-028.5, doi:10.3854/crm.5.028.arnoldi.v1.2009, http://www.iucn-tftsg.org/cbftt/.