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## Maximum Size and Mass of the Ploughshare Tortoise, *Geochelone yniphora*

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The ploughshare tortoise *Geochelone yniphora*, or angonoka, is restricted to a small area in northwest Madagascar. Until recently, very few individuals had ever been observed in the wild, and the species is rare in museum collections. Research into the ecology of the ploughshare tortoise carried out between 1993 and 1998 allowed us to examine 203 individuals, a large proportion of which were juveniles (Smith, 1999; Smith et al., 1999; Pedrono, 2000).

Mean adult male carapace length of *G. yniphora* is 414.8 mm ( $n=32$ ,  $SD=30.1$ , range = 361–486 mm), mean adult male mass is 10.3 kg ( $n=32$ ,  $SD=2.4$ , range = 7.2–18.9 kg), mean adult female carapace length is 370.1 mm ( $n=40$ ,  $SD=24.6$ , range = 307–426 mm), mean adult female mass is 8.8 kg ( $n=40$ ,  $SD=1.7$ , range = 5.5–12.0 kg). Adult male ploughshare tortoises are on average significantly larger ( $t=6.89$ ,  $p<0.0001$ ) and heavier ( $t=2.99$ ,  $p<0.004$ ) than adult females.

The largest known *G. yniphora* is a male (#1017) from a population west of Baly Bay near Ambatomainty. In April 1998 this tortoise measured 486 mm straight-line carapace length (carapace width 317 mm, shell height 269 mm, plastron length 462 mm). Body mass was 18.9 kg (Fig. 1).



**Figure 1.** Augustin Sarovy using a GPS to record the location of the largest known male *Geochelone yniphora* (#1017; CL = 486 mm) in its native habitat.

When this individual was first encountered in January 1995, it measured 481 mm carapace length with a body mass of 15 kg (Smith, 1999). Based on the two measures, the relative annual growth rate of this tortoise was 0.5%. At the time of the second encounter this individual was monitored by radio transmitter (AVM Instrument Co., Livermore, CA) for 6 months. Body mass was recorded monthly over this period and increased by as much as 1.2 kg per annum.

The largest known female (#1030) occurs in the same population. In April 1998 this tortoise measured 405 mm straight-line carapace length (carapace width 280 mm, shell height 235 mm, plastron length 379 mm) with a body mass of 13.1 kg. The relative annual growth rate of this animal was similar to that recorded for the largest known male.

Given the growth rates observed in this study, it seems likely that *G. yniphora* could attain dimensions still greater than the records mentioned above. Exploitation of ploughshare tortoises by the local Sakalava villagers seems to have ended after the near disappearance of the species about 40 years ago. Very old individuals (with worn, pale shells) are today very rare in remaining populations. The largest adults are probably those that were at one time too small to be taken by humans (Pedrono et al., 2000). If protection of the species is continued in the future, we may ultimately see adult individuals with a mean size greater than that currently found. The ploughshare tortoise is the largest extant endemic chelonian on Madagascar, following the extinction of the giant members of the genus *Dipsochelys* (Bour, 1994). Paradoxically, although the substantial size of the Madagascan chelonians at one time afforded them protection against predators, it became the principal cause of their decline after human colonization of the island.

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