

# The Role of Local Taboos in Conservation and Management of Species: The Radiated Tortoise in Southern Madagascar

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*The radiated tortoise, Geochelone radiata, is endemic to the semi-arid region of southern Madagascar. Despite formal protection by law since 1960 and listing in CITES since 1975, tortoise populations have been reported to be in rapid decline, mainly due to illegal harvesting for food and commercial trade. The Tandroy people, inhabitants of the Androy region, which covers approximately half the tortoise distribution range, do not, however, exploit the species. The Tandroy prohibition against tortoise consumption is expressed as a taboo or fady. The aim of this study was to document the narratives, rules and enforcement mechanisms linked to the taboo, and to assess the potential role of the taboo for the protection and management of the radiated tortoise. Interviews revealed that the Tandroy perception of the animal as 'dirty' underlies the Tandroy taboo, although one informant suggested that the taboo once originated in notions of sacredness. Estimated tortoise abundances ranged from 20 tortoises per ha in an area with no harvesting to 0.6 per ha in an area where a significant proportion of residents were reported to violate the taboo. Infrastructure changes and increasing numbers of immigrants to the region are sources of new pressures on the tortoise. An official*

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acknowledgement of the fady custom and the transformation of this institution for the purpose of conservation and sustainable management of the tortoise may considerably reduce the current high costs of enforcement by formal institutions. The tortoise may constitute an important economic source of revenue if local communities are granted rights to a regulated small-scale trade for the pet market based on locally controlled farming of tortoises. Such actions may provide economic incentives for further transforming and building effective institutions for sustainable management. However, a local institutional strategy also needs to be nested with institutions across scales, for example, at regional and national levels, assisting in controlling harvest and trade.

## INTRODUCTION

THE ROLE of local communities and local ecological knowledge in the management of natural resources and ecosystems has received increasing attention in recent years (for example, Berkes and Folke 1998, 2002; Berkes et al. 2000, 2003; Gadgil et al. 1993; Olsson and Folke 2001; Ostrom 1990). Local ecological knowledge refers to a cumulative body of knowledge, practice and belief of the relationships of living beings (including humans) with one another and with their environment, reflecting the dynamic way in which people organise perceptions of flora, fauna, ecosystem processes, culture beliefs and history (for example, Berkes and Folke 1998; Berkes et al. 2003; Gadgil et al. 1993). Such knowledge is often tacit, and its transmission and practical implementation is frequently accomplished through the prescriptions of social institutions, such as rituals and taboos (Colding and Folke 2001). The institution of taboos is a universal regulator of human behaviour, and a taboo can be described as a social prohibition of something that is regarded holy or unclean, and is often connected to ritual. Colding and Folke (2001) consider some taboos to be integral parts of 'invisible' systems of resource management and refer to nature-related social taboos as *resource and habitat taboos* (Table 1).

Colding and Folke argue that, although not necessarily perceived as instruments of resource management by the people who practise them, taboos nevertheless

often show a functional similarity to the institutions of formal nature conservation. Specific-species taboos regulate the utilisation of particular species and are usually inclusive prohibitions, banning exploitation of a particular species at all times. The rationale behind the existence of specific-species taboos vary, ranging from notions of the species being toxic, being perceived as religious symbols, as well as being avoided due to their behavioural and physical appearance. In an analysis of seventy specific-species taboos, about 30 per cent, predominantly reptiles and mammals, were found to be involve species recognised as 'threatened' by the International Union for the Conservation of Nature (IUCN) (Colding and Folke 1997). While this may be an unintended consequence, the enforcement of taboos may have a direct impact on species conservation. Taboos and other forms of informal institutions have, however, seldom been incorporated in biological conservation schemes, partly due to narrow definitions of what constitutes conservation (Berkes et al. 2003; Colding et al. 2003).

The radiated tortoise, *Geochelone radiata*, is among the world's rarer tortoises and is one of four endemic tortoise species in Madagascar. It occurs in the semi-arid region of the southern part of the island. Populations of the radiated tortoise are reported to be in decline throughout much of its range (Durrell et al. 1989; Juvik 1975; Nussbaum and Raxworthy 2000; O'Brien et al. 2003). Over the past twenty-five years the geographic range of the tortoise is estimated to have decreased by approximately 20 per cent (O'Brien et al. 2003), and the IUCN has listed radiated tortoise as 'vulnerable' (Hilton-Taylor 2000). Humans have harvested tortoises at least since the arrival of Europeans. The giant tortoise, *Geochelone gigantea*, most likely went extinct in Madagascar as a consequence of heavy exploitation and trade in the past (Bourn et al. 1999). During the eighteenth and nineteenth centuries great numbers of radiated tortoise were exported to the islands of Réunion and Mauritius where the species was considered a delicacy. Malagasy authorities initially protected the radiated tortoise in 1960, and in 1975 the species was listed in Appendix I of the Convention on International Trade in Endangered Species (CITES). Despite these initiatives, great numbers of radiated tortoise are killed for food and for the manufacture of tourist items, as well as exported as part of the exotic pet trade (Durrell et al. 1989; Juvik 1975; Nussbaum and Raxworthy 2000). Basing their proposition on three pieces of evidence, O'Brien et al. (2003) suggested that over-exploitation by humans is currently the most important driver of the decline of the radiated tortoise, that is: (a) commercial harvesters travel increasingly far, up to 200 km, to find sufficient densities of tortoises; (b) tortoises are either completely absent or present at very low abundance at sites subject to commercial harvesting, while in remote regions with no harvesting, tortoises persist at densities of up to 2,500 tortoises per sq. km; and (c) tortoise abundance increases significantly with distance from urban centres of high demand for tortoise meat.

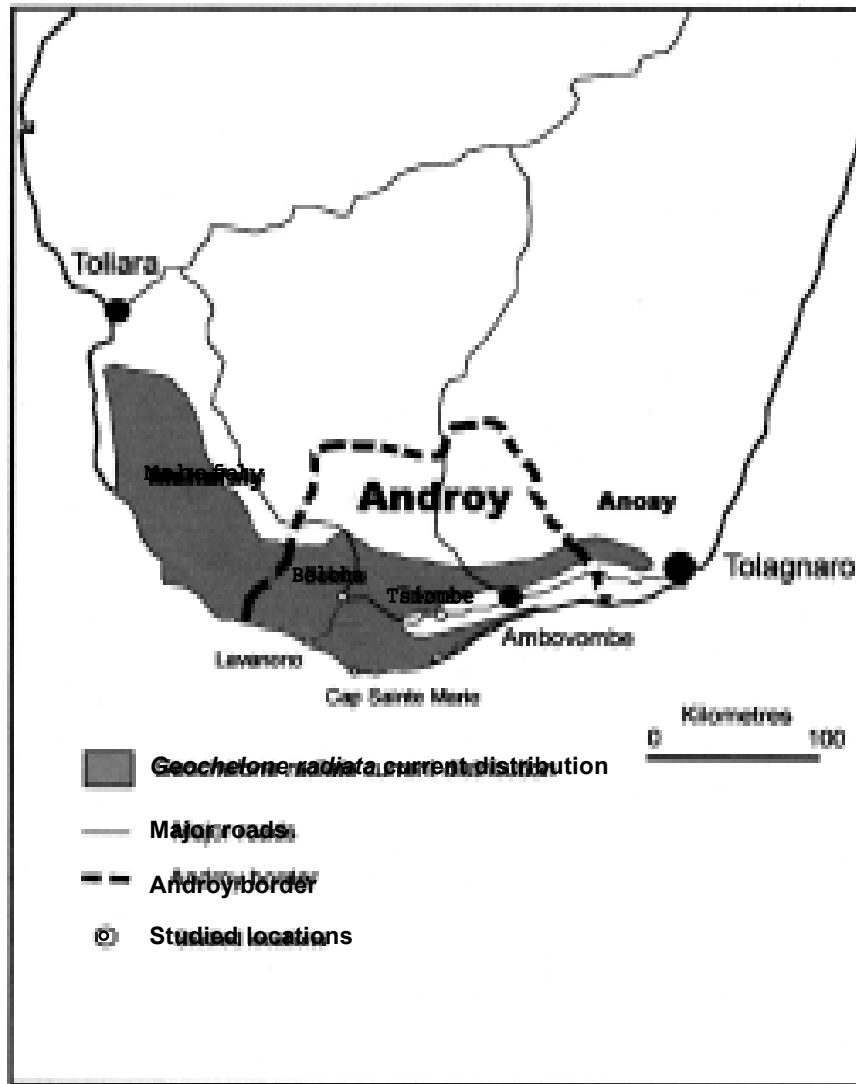
The Tandroy people, inhabitants of the Androy region (Figure 1), which covers approximately half of the tortoise distribution range, do not exploit the tortoise

**Table 1**  
*Resource and Habitat Taboos, and the Nature Conservation and Resource Management Functions of Each Category*

Category	Function
Segment taboos	Regulate resource withdrawal
Temporal taboos	Regulate access to resources in time
Method taboos	Regulate methods of resource withdrawal
Life history taboos	Regulate withdrawal of vulnerable life history stages of species
Specific-species taboos	Total protection of species in time and space
Habitat taboos	Restrict access and use of resources in time and space

Source: Colding and Folke (2001).

Figure 1  
Approximate Current Distribution of *Geochelone radiata* and Studied Locations in the Androy Region, Southern Madagascar



Source: Redrawn from O'Brien et al. (2003).

(*sokake*, or *sokatra*). The Tandrozy prohibition of eating the *sokake* is expressed as a taboo, or *fady*, a regulating social institution likewise present among the Mahafaly people living to the west of Androy. Ruud (1960) comments on the omnipresence of *fady* in Malagasy everyday life and of the wealth of tales that explain the history behind animal and plant taboos. Many of these tales show a marked similarity and the most common form of decree communicated is the imperative 'you shall not' (Bloch 2001). The tortoise *fady* of the Androy and Mahafaly regions is one example of this kind of regulation. Although the radiated tortoise recently has received increased conservation attention (Nussbaum and Raxworthy 2000; O'Brien et al. 2003), the potential of the taboo as a viable local institution for the future protection and management of the species has so far not been studied and assessed.

The principal questions addressed in the present study were:

1. What are the narratives, rules and enforcement mechanisms associated with the taboo?
2. Is the taboo subject to erosion, and, if so, what are the main factors associated with a decrease in adherence to the taboo?
3. To what extent is there a correlation between the local degree of adherence to the taboo and local tortoise abundance?
4. What is the role, if any, of the taboo in future management of the tortoise?

#### STUDIED SPECIES

*Geochelone radiata* is a large terrestrial tortoise; adults may weigh up to 13 kg and reach a carapace length of around 40 cm (Durrell et al. 1989; Glaw and Vences 1994). *G. radiata* is endemic to the extreme southern part of Madagascar and restricted to the xerophytic spiny forest of the Androy and Mahafaly regions (Figure 1). It has an oval, dark brown-black carapace, with a distinctive yellow star-shaped pattern radiating out from the centre of each scute (Figure 2). The head, feet and legs of the tortoise are yellow, with a variably sized black patch on the top of its head. Young tortoises are not as distinctively marked as mature individuals. The radiated tortoise commonly lays one to five eggs per nest, and the incubation period is thought to be approximately ten months. *G. radiata* is regarded as the closest relative of another of Madagascar's endemic, and likewise threatened, tortoises, *Geochelone yniphora* (Caccone et al. 1999). The tortoise is diurnal and is most active during the rainy months of November and December. Due to the cooler weather conditions and aridity, with a subsequent shortage of food, the tortoises stay less active during the winter months of April to November. *G. radiata* feeds on grass, flowers and leaves of different plants, and the fruits of *Quintia* spp. (Cactaceae).

Figure 2  
The *Geochelone radiata*

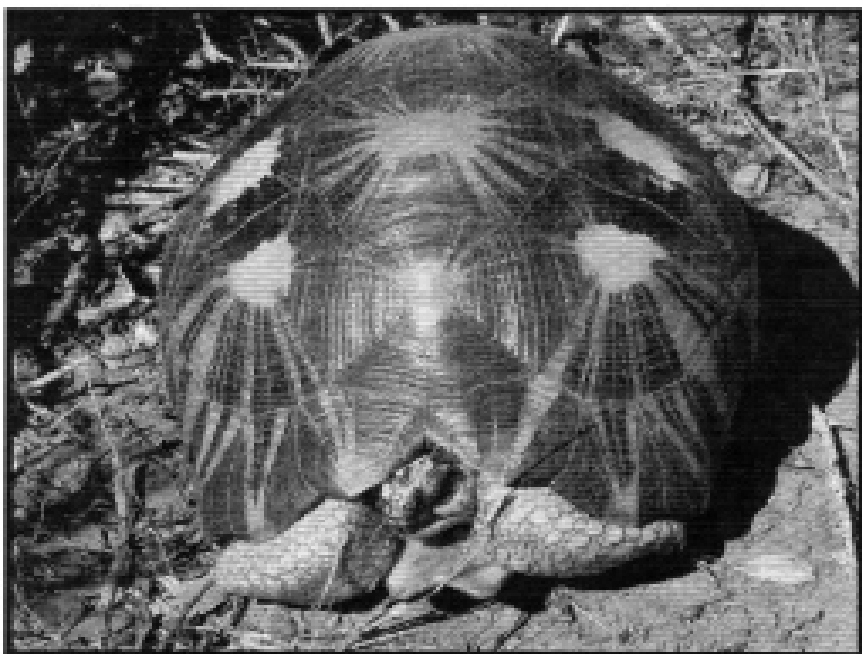


Photo: M. Lingard

The tortoise has been protected by Malagasy national law (Decree no. 60-26) since 1960 and is receiving further official protection in the nature reserves of Tsimanampetsotsa Réserve Naturelle Intégrale, Cap Sainte Marie Réserve Spéciale, Beza-Mahafaly Réserve Spéciale and Andohahela Réserve Naturelle Intégrale (Nussbaum and Raxworthy 2000).

#### STUDY SITES IN THE ANDROY REGION

The Androy region is situated in the very southern part of Madagascar, roughly located between the rivers Menarandra and Mandrare. This area represents the central area of distribution for the tortoise (Figure 1). The south is characterised by semi-arid climatic conditions with very irregular rainfall averaging less than 500 mm per year.

The annual rainfall declines from north to south and from north-east to south-west (Battistini and Richard-Vindard 1972), and the seasonal character of the precipitation is particularly pronounced in the south. There is a great irregularity of precipitation from year to year and long periods of drought may occur in this area. Violent rainstorms, which may bring almost half the total annual rainfall in

one day, are not unusual (ibid.). The dry season usually lasts eight to nine months, but can extend over several years locally (Dewar and Wallis 1999; Richard et al. 2002).

The southern dry spiny forest is dominated by the endemic plant family Didiereaceae, and has the highest level of plant endemism in all of Madagascar at the generic (48 per cent) as well as the species level (95 per cent) (Koechlin 1972). Recently, the spiny forest was listed as one of the 200 most important ecological regions in the world (Olson and Dinerstein 1998). The range of the spiny forest has declined since the early 1970s, principally due to cattle herding, timber harvest and charcoal production (Sussman et al. 1994). However, in Androy there are still numerous small patches of forest, which for sacred reasons have remained relatively untouched, even in the most intensively used areas. These sacred forests are often sub-circular, 300 m to 400 m in diameter and often contain tombs (Clark et al. 1998). However, due to the *fady* and entering restrictions, very little is known about these forests.

This study was conducted during seven weeks of fieldwork in the Androy region between June and July 2001. Three principal locations were selected on the basis of differences in infrastructural and demographic characteristics, key factors that we assumed influenced Androy observance of customs and traditions, such as the directive of the tortoise *fady*. A fourth location, Cap Sainte Marie, a 1,750 ha Réserve Spéciale (administered by the Association Nationale pour la Gestion des Aires Protégées [ANGAP]) was selected as a control.

#### Studied Locations

**Lavanono** Lavanono is a small coastal community with a population of approximately 500 permanent residents (personal communication of village elders). The capture and sale of fish and lobsters is one of the major sources of revenue for the people of this village. Lavanono is situated approximately 39 km south of Beloha. There is a small and very basic resort here, run by villagers as part of a development project. However, the roads that lead to the village are in poor condition, and Lavanono's out-of-the-way location is a factor that limits the number of visitors.

Lavanono study sites:

1. Ambohibovo, S25°24.231', E044°56.975': Characterised by *Euphorbia stenoclada*, *Croton* sp., *Quintia* spp., *Psiadia angustifolia* and a few *Alluaudia comosa*.
2. Anandimby, S25°24.593', E044°57.411': Characterised by *Alluaudia dumosa*, *Euphorbia fiherenensis* and *E. stenoclada*.
3. Betainbolo, S25°20.330', E044°52.190', c. 11.8 km north-west of Lavanono: Characterised by *Alluaudia dumosa*, *Euphorbia fiherenensis* and *Jatropha mahafaliensis*, with a few *A. comosa*.

**Beloha** Beloha is a small town situated on National Route 10 between Tsiombe and Anpanihy. Due to size and location, Beloha has a slightly more heterogeneous population than Lavanono. The taxi *brousse* (bus) stops here on its way from Toliara (Tuléar) to Tolagnaro (Fort Dauphin), and there is a lively but rather poorly stocked weekly market selling foodstuff and paraphernalia. The road leading to and from Beloha, National Route 10, is in very bad condition.

Beloha study sites:

1. Ambaro, S25°04.491', E045°01.605': Characterised by *Alluaudia procera*, *A. dumosa*, *Didierea trollii* and *Operculicarya decaryi*.
2. Andrambalo, S24°59.172', E044°54.787': Characterised by *Alluaudia procera*, *A. dumosa* and *Euphorbia fiherenensis*.
3. Andombiry, S25°13.880', E045°06.291': Characterised by *Alluaudia procera*, *Euphorbia fiherenensis*, *Salvadora angustifolia* and *Ommocarpopsis parvifolia*.

**Tsiombe** The town of Tsiombe is situated approximately 55 km south-east of Beloha. The people of Tsiombe make up a more heterogeneous population than Beloha. The road east of Tsiombe, leading to Anboasary and Tolagnaro, is in better condition than the westward extension. Easier accessibility to larger trade centres is reflected in a slightly better stocked market than the one in Beloha. There are restaurants offering tortoise, if not on the menu then on request.

Tsiombe study sites:

1. Analamena, S25°21.316', E045°31.672': Characterised by *Alluaudia dumosa*, *Euphorbia plantagynae*, *E. fiherenensis*, *E. stenoclada*, and a few *Alluaudia humbertii* and *A. procera*.
2. Sakamasy, S25°17.870', E045°34.140': Characterised by *Alluaudia dumosa*, *Euphorbia fiherenensis*, *E. stenoclada*, *Operculicarya decaryi*, and a few *Alluaudia humbertii*.
3. Evazy, S25°17.215', E045°22.009': Characterised by *Alluaudia procera*, *Euphorbia* sp., *Mimosa delicatula*, *Ommocarpopsis parvifolia* and *Opuntia* sp.

**Cap Sainte Marie** *Geochelone radiata* is protected within the Cap Sainte Marie reserve, but there are reports of locals poaching tortoises from the reserve, and both zebu and goats graze within its limits. The tortoise is said to be abundant here despite these activities (Nussbaum and Raxworthy 2000).

1. Cap Sainte Marie Reserve, S25°32.094', E045°07.195': Characterised by *Euphorbia stenoclada*, *E. leucodendron* and *Croton* sp.

## SOCIAL SURVEY

Interviews were held with members of the local Tandroy community to learn about the nature and strength of the tortoise *fady*, sanctions and enforcement mechanisms, and about if and to what extent the prohibition is thought to influence the survival of the tortoise population. To analyse the impact of tortoise harvesting, questions regarding exploitation, as well as pertaining to local knowledge of the tortoise and its habitat were put to key informants.

The social organisation of rural Madagascar is based on the *fanjakana* on the one hand, representing the formal institutions of Malagasy society, whereas traditions and customs constitute the more informal aspects of the institutional framework. Informal agreements combine the two sets of code, which together form the base for the management of all natural resources. Identification of the person(s) in control of management functions is crucial, and includes in addition to the *fokantany* (administrative level), the *fokanolana*, led by clan leaders. The informants of this study were key persons in each locality, such as representatives of *fokantany*, *fokanolana* leaders, mayors, local guides as well as ordinary people. Due to immigration, the population of Tsiombe is more heterogeneous than the populations of both Lavanono and Beloha. This variation in demography motivated interviews with representatives of the Tanosy community here, whose members openly admit to consuming tortoises. There was a conscious effort to choose informants from as many different sub-groups within the community as possible, including women and old people. Interviews were also held with public service officials in Beloha, Tsiombe and in the coastal town of Tolagnaro (Fort Dauphin), which is the region's administrative centre.

To shed light on the tortoise *fady* and on the culture and religious life of the Tandroy people from a different angle, interviews were held with the Christian clergy in Beloha and Tsiombe, two Catholic priests and two Protestant pastors. Three of these were immigrants to the region, albeit of long-standing residence, and could therefore contribute interesting insights from the 'outsiders' point of view. These interviews were also important for understanding the impact of Christianity, and whether this relatively recent influence on the Tandroy culture has affected the *fady* or the observance of this social regulation.

Most of the information was obtained through semi-structured and fairly informal conversations with informants, in line with the qualitative research interview approach described by Agar (1996) and Kvale (1996). The informants were all briefed on the subject and objectives of the research. The interviewers also communicated to the interviewees their interest in the Tandroy world-view and folklore. The interviewers invited informants to elaborate on subjects of religion, such as ancestors, burial traditions, etc. One of the two persons conducting the interviews was native Malagasy, and acted as an interpreter to the non-Malagasy interviewer throughout the surveys. Apart from the apparent dilemma of entering a region where most people speak no language other than the local Tandroy, a dialectal

version of Malagasy, there were a great number of other practicalities that needed to be tackled in line with local customs. Local guides were also engaged, on recommendation of the president of the *fokontany* in Iavanono, and of the mayors of Beloha and Tsiombe. Local guides escorted the research team during all excursions to the countryside, and their presence constituted an unconditional requirement for obtaining the local research permit. The ANGAP guides of Cap Sainte Marie who accompanied the research team during the survey within the reserve were also interviewed. Most transportation within the region, and always when travelling to and from tortoise survey areas and villages, was by foot or by zebu-cart. Interviews with public servants and other representatives of government were conducted using a more structured and formal interview method than the one described earlier. The information attained through the interviews has been complemented with literature studies.

#### TORTOISE SURVEY

The radiated tortoise is a relatively large and slow animal, and population surveys are usually based on counting along transects. We used a combination of a circular plot and line transect survey (see Buckland et al. 1993; Sutherland 2000) to estimate the relative abundances of tortoises. We considered this method as most suitable to counting tortoises during the dry and relatively cool winter months of June to August, a time when the tortoises are less active. A further advantage of this combined method was that it permitted a larger sampling of variation in habitats compared to a sampling scheme based on a few large plots. Plots could in this way be considered independent sampling units, which permitted statistical comparisons between different habitat types. During these surveys we actively searched for animals since during dry periods they frequently hide in dense vegetation and may be difficult to spot. Five 400 m long transects were walked once at each study site. The starting point of the first transect was identified after consultations with local guides, and located to permit a corridor (approximately 2 km  $\times$  1 km), that is, an extended stretch of tortoise habitat, free from any intersecting agricultural areas, roads, settlements, etc. Five separate stops were made along each transect, counting the starting point as number one, with four subsequent stops at intervals of 100 m. A limited time (five to eight minutes depending on type and density of vegetation) was spent at each stop in active search of tortoises. Each search was carried out by three persons, of whom two participated in the entire study, and covered a circular area with a radius of 20 m, making the total search area at each stop approximately 1,250 sq. m and 0,625 ha at each transect. A handheld GPS unit was employed to navigate and to determine the positions of the transect stops. The length of the transect lines were approximated by pacing in combination with the GPS odometer function. Each encountered tortoise was classified according to sex and size; carapace length (CL) determined the three size categories: small CL < 15 cm, medium 15 > CL < 30 cm and large CL > 30 cm). An approximate area of 3.1 ha was actively searched at each study site, making the total for

each location approximately 9.3 ha, with the exception of Cap Sainte Marie, where the search was limited to an area of 3.1 ha.

A multitude of factors may have generated biases in the survey, such as time of day of search (tortoises may be active during a certain time of day); large tortoises being more easily detected than small; tortoises being more difficult to detect in some habitat types than others, etc. Efforts were made to perform surveys at the same time of day, but this was not always possible. Furthermore, it was difficult to adjust for differences in habitat structure. Due to thorny vegetation some of the sites visited were extremely difficult to walk through, whereas others were surveyed at leisure. To account for this and to reduce biases the length of search time at each stop was adjusted depending on type and density of vegetation. Given these uncertainties, the reported estimates here should only be interpreted as indices of abundances.

The different vegetation types of the circular plots were classified into grasslands (G), shrub (S) and forest (F) to allow comparisons to be made between different habitats.

G = Grasses dominate (*Cenchrus ciliaris*, *Aristida congesta*, *Panicum voeltzkowii* and *Eragrostis* sp.) with sparse stands of shrub or cacti (*Quintia ficus-indica*); mean height <1.5 m.

S = Ground covered by stands of shrubby plants (several members of Euphorbiaceae, Acanthaceae, Rubiaceae, Anacardiaceae and Combretaceae, and/or cacti (*Quintia ficus-indica*); mean height >1.5 m <4 m.

F = Trees (predominantly *Allaudia dumosa*, *A. comosa*, *A. procera*, *Euphorbia stenoclada*) making up the dominant (>80 per cent) vegetation cover; mean height >4 m.

#### RESULTS

##### Social Survey

*Iavanono* Informants in and around Iavanono ( $n = 30$ ) maintain a strict adherence to the tortoise taboo. There are few immigrants living permanently in the area, and although there is both a Catholic and a Protestant church, with their respective influences of Christian ideals and of practices and customs of external origin, traditional values and institutions still seem to be predominant regulators of everyday life. All Iavanono informants said that the Tandroy regard the radiated tortoise as 'dirty' (*maloto*) and some persons stated that they would never even consider touching the animal. As the animal was thought of as 'dirty', none of the informants considered the tortoise habitats as in any way special or sacred. The estimates of the informants indicate that approximately 99 per cent of the people living in and around Iavanono adhere to the *fady* (Table 2). Some informants related the background story of the tortoise *fady* (see *sokake fady* 1 in the appendix)

Table 2  
Structure and Composition of Informants at Lavanono, Beloha and Tsionbe

Area	Total number informants (including key informants)	Number of key informants	Informants who say they follow fady (%)	Population stated to follow fady (%) (approximation by key informants)		
				Tandroy informants (%)	Tanosy informants (%)	Other informants (%)
Lavanono	30	6	93	99	93	0
Beloha	40	7	90	85	85	5
Tsionbe	40	6	75	80	65	30

to try to explain why the tortoise is so thoroughly despised, while others considered the story to be too embarrassing to be told.

According to one informant, an elderly man who has lived all his life in Lavanono, tortoises have always been abundant in the area, and are so still. However, large numbers of tortoises are harvested by outsiders visiting the area. The fish and lobster collectors who visit Lavanono twice weekly are stated to comprise the greatest threat to tortoise survival in the Lavanono vicinity. According to an informant with a central position in the trade with the lobster collectors, this harvesting of tortoises may be as high as 100 individuals a week.

**Beloha** The Catholic and Protestant churches have a strong representation in Beloha. The majority of people questioned here ( $n = 40$ ) said that the *fady* was grounded in superstitions, and that they did not really believe that breaking it would lead to any repercussions in the form of ancestral punishment. Some people said that the ancestors were poorly educated as they had not been to school, and that this would explain why they believed in the tortoise *fady*. They did, however, state that they followed the traditional principles out of respect for family and relatives. All respondents swore that they had never tasted *sokake*. Paradoxically, most people thought that there are Tandroy in Beloha who do eat the tortoise and key informants estimated that about 15 per cent of the population violate the taboo (Table 2). In the villages outside Beloha informants showed a notable disgust when asked about the *sokake*. Many informants said that people from outside come and harvest *sokake* in great numbers. Lorries on the way to coastal towns stop on their way and pick up every animal in sight. During the rainy season great numbers of tortoise come out on the roads to drink, at which time they are an easy catch for anyone who happens to pass by. There is also a more active search for tortoises by people systematically rummaging through shrub land and forest areas. Tortoise numbers were reported to have declined over the past years.

**Tsionbe** Exploitation seems to have had a greater impact on the tortoise population around Tsionbe than in the area of Beloha. Tsionbe is situated closer to the centres of Amboasary and Tolagnaro (Fort Dauphin), and the road leading here from the east coast is in better condition than the one extending westwards. The people of Tsionbe are a more heterogeneous population than the one in Beloha, and many Tanosy (people from the east) live in and around the town. Most informants ( $n = 40$ ) said that *sokake* had been abundant in the area until very recently. Now, they said, there are hardly any tortoises to be found in the vicinity of Tsionbe. Many expressed satisfaction at being rid of the animal, because '*sokake* eat our food', referring to the animal's preference for grazing in cultivated fields. There were informants from the Tanosy community who proudly showed their captured tortoises. Overcrowded pens housed live tortoises in wait of household consumption or transport to the town centre for sale. One informant estimated that on average he and his family consumed one medium-sized individual per day. To them the meat of the animal was considered a delicacy and the restaurants of

Tsionbe served *sokake*. As in Beloha, most Tandroy say that they never touch *sokake* themselves, but that many others do. The six key informants estimated that 20 per cent of the population violate the taboo (Table 2).

**Dead Sokake Encountered** Empty carapaces were encountered during the surveys along transects and along the roads, sometimes in great numbers (twenty to thirty carapaces). These were the remains of tortoises said to have died for one of several reasons: lobster collectors stopping on their way from the coast and collecting the meat of *sokake* to boost their earnings; lobster collectors feasting on tortoises during their stay in the area; tortoises dying in the flames of the annual 'slash-and-burn' fires, which are a part of the customary cultivation practices; dogs killing young tortoises; children throwing stones on tortoises.

### Tortoise Survey

The respective areas showed significant differences in the estimates of relative abundances of tortoises (ANOVA,  $F_{3,234} = 30.40$ ,  $P < 0.000$ ). In Lavanono a total of 102 tortoises were encountered with a mean of 10.8 per ha, in Beloha, fifty-nine tortoises were observed with a mean of 7.7 per ha, and in Tsionbe, a total of six individuals were recorded with a mean of 0.6 per ha (Table 3). In Cap Sainte Marie fifty-eight individuals were recorded with an estimated density of 20 individuals per ha (based on one site only).

An analysis of the proportion of large tortoises (CL > 30 cm) in relation to distances from major roads (that is, roads used by motor vehicles) revealed a significant positive correlation (Spearman  $r = 0.706$ ,  $P < 0.05$ ,  $n = 7$ ) (Figure 3).

No significant deviations in sex ratios from an expected 1:1 were observed at any of the sites (Chi-square test,  $df = 1$ ,  $P > 0.05$  in all tests). The total numbers observed in Tsionbe were too low to permit statistical analyses of sex ratio deviations (Table 3).

An average of more than twice as many tortoise individuals per ha were found in shrub and grassland habitats compared to the forests, a difference that was significant (ANOVA,  $F_{2,235} = 11.4$ ,  $P < 0.0001$ ) (Figure 4). There was no significant difference between the average proportions of habitats in the samples: forest 39 per cent, shrub 31 per cent and grassland 30 per cent (Chi-square test,  $df = 2$ ,  $P > 0.05$ ).

Sampling and analyses of tortoise droppings, and personal communication with local guides, revealed that the dominant part of the tortoise's diet during the dry months of June and July seems to consist of grasses (for example, *Cenchrus ciliaris*, *Aristida congesta* and *Eragrostis* sp.) and the fruits of *Opuntia* spp. Interviews indicated that several other species are consumed by *sokake* at other times of the year (Table 4).

**Table 3**  
**Relative Abundance of Tortoises Observed during the Survey of Sites in the Three Areas in Southern Madagascar**

Principal study area	Study site	Total number of tortoises	Female	Male	Percentage of population (CL > 30 cm)	Mean number of tortoises per ha ( $\pm SE$ )
Lavanono	Ambohibovo	36	12	24	19	11.46
	Betainbolo	34	22	12	58	10.82
	Anandemby	32	11	21	44	10.18
	Total	102	45	57	-	10.8 $\pm$ 0.15
Beloha	Andrambalo	21	6	15	52	11.14
	Ambaro	18	8	10	72	5.73
	Andombiry	20	14	6	25	6.36
	Total	59	28	31	-	7.7 $\pm$ 0.13
Tsionbe	Analamena	1	-	1	-	0.32
	Sakasmasy	0	-	-	-	0.00
	Evazy	5	1	4	40	1.59
	Total	6	1	5	-	0.6 $\pm$ 0.04
Cap Sainte Marie	58	31	27	-	20.06 $\pm$ 0.51	

**Notes:** In each area (except Cap Sainte Marie) three sites were surveyed using a combined plot and line transect method; CL = carapace length.

**Figure 3**  
**The Proportion of Large Tortoises in Relation to Distances from Major Roads**

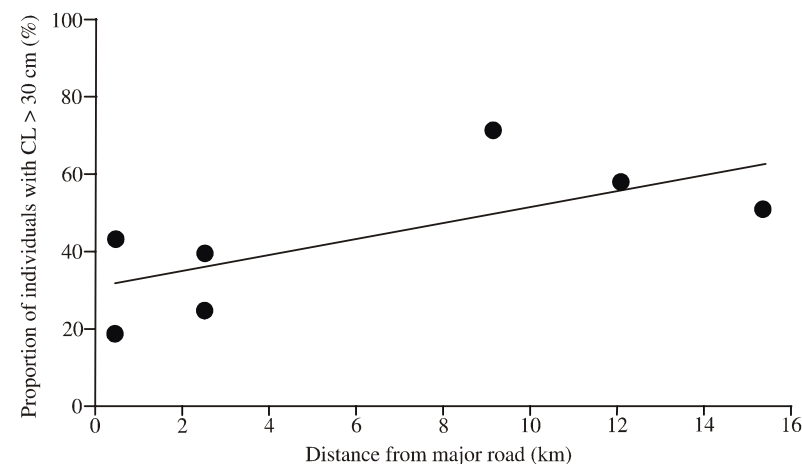




Figure 4

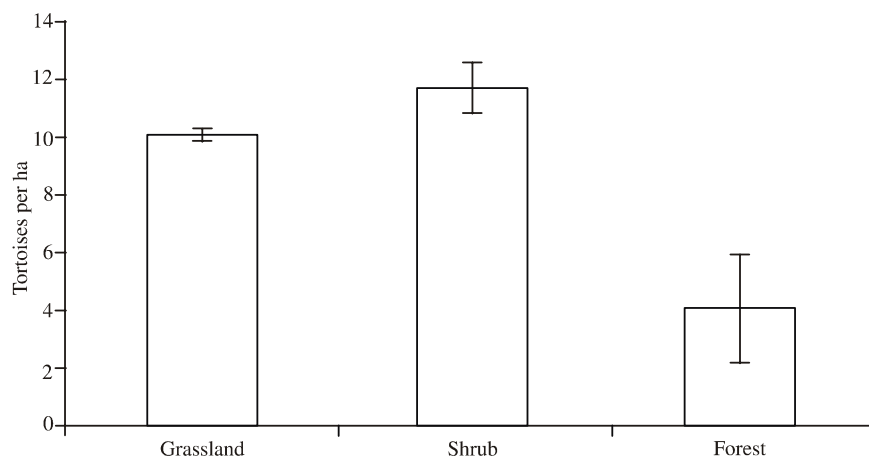
The Average Number of Tortoises Observed per ha in Each Vegetation Type (Mean  $\pm$  SE)

Table 4

Plants Consumed by *Geochelone radiata* According to Key Informants in Lavanono and Beloha

Species	Vernacular name	Parts eaten
<i>Opuntia</i> spp., Cactaceae	Raketa	Fruits,* cladodes
<i>Perulicarya decaryi</i> , Anacardiaceae	Jabilhy	Fruits
<i>Euphorbia fiharenensis</i> , Euphorbiaceae	Fihana	Stems
<i>Helmipopsis</i> sp., Sterculiaceae	Hily	Flowers

Note: \*Own observation.

## DISCUSSION

The most common narrative associated with the *fady* is tied to myths relating incidents between ancestors and the tortoise and was told in similar versions throughout the study area (*sokake fady* 1 in the appendix). The narrative does not contain any clear element of the tortoise carrying a spiritual value, and today most Tandroy consider the tortoise 'dirty', an animal of no use. However, one key informant referred to a narrative of potential significance. This narrative (the second one in the appendix), a story claimed to be largely forgotten by the Tandroy today, describes the *fady* as originating in the animal's once-sacred status. Further research should look into the origin and significance of this story (cf. Juvik 1975).

The Androy region was previously a rather isolated part of Madagascar, and customs and traditions were long lived and in all probability mostly followed (Parker Pearson 1997). Wherever the traditional Tandroy social practices and customs were followed, the *fady* with its 'no touch' principle has most likely offered the tortoise effective protection (Juvik 1975). Nussbaum and Raxworthy

(2000) even expressed the opinion that the *fady* has prevented the *sokake* from going extinct. According to the findings of our interviews, violations of the *fady* still appear to be rare among Tandroy living in rural areas, the common sanction being community exclusion. In Lavanono and in the rural areas of Beloha informants reported of one or two cases of offenders who, as a result of the *fady*, had been driven away from their families and ultimately forced to move to areas where there was no knowledge of the offence. The *fady* also appears to carry a strong element of self-enforcement since many Tandroy informants, especially inhabitants of the more remote tracts, explained that not even in critical situations, such as during occasional famines caused by drought or locust outbreaks (for example, during 1996 and 1997), would they consider eating the tortoise (but see O'Brien et al. 2003). A different attitude was observed among the urban Tandroy population of Beloha and Tsionibe, where a common view was that the *fady* was grounded in superstitions and that breaking it would not lead to any repercussions in the form of ancestral punishment. However, all informants stated that they did follow the traditional principles out of respect for family and relatives. Intensified contacts with the surrounding world bring new impulses to the people who live in the region. One consequence of this scenario is erosion of the institution of the *fady* with increased rates of both local subsistence harvest and harvest related to commercial trade of the tortoise. Immigration is clearly one factor influencing the erosion of the *fady*. In contrast to the Tandroy, Tanosy immigrants in Beloha and Tsionibe openly admitted that they harvest and consume large quantities of tortoise, and in both Beloha and Tsionibe key informants reported that a substantial portion of the population do in fact violate the taboo.

All people questioned appeared to be aware of a recent decline in numbers of tortoises, and according to the majority of informants, illegal harvesting constitutes the major driver of this decrease. The significant difference between Lavanono and Tsionibe (Table 3) in estimates of tortoise abundance may thus be interpreted as reflecting different harvesting pressures in areas with different degrees of adherence to the taboo within the human population. However, O'Brien et al. (2003) correctly pointed out that without careful experimental and comparative studies it is difficult to identify with certainty which factor is causing the decline, that is, whether it is human harvesting or some other factor influencing population dynamics. Nevertheless, they suggested that all available evidence points to human harvest as the primary driver of tortoise decline during the last twenty-five years. In our study a harvesting pressure was evident from the numerous empty carapaces observed along the roads, but was also indicated by the observation that the proportion of large tortoises (CL > 30 cm) decreased significantly with proximity to major roads. Tortoises are on average smaller in harvested areas, since harvesters actively search out and harvest the large adult tortoises (O'Brien 2002).

Although there are some inevitable biases connected to our method for estimating tortoise abundances, other studies in the region, using different survey methods, have produced similar relative abundance estimates. O'Brien (ibid.) made a study west of our area during the wet season and estimates ranged from

15.5 tortoises per ha in an area with no harvesting to 4 to 5 tortoises per ha in areas with some commercial and subsistence harvesting of the tortoise. Lewis (1995) reported densities of up to 10.7 tortoises per ha in south-western Madagascar, whereas Leuteritz (2002) found a mean density of 25.2 tortoises per ha across seven sites in southern Madagascar. O'Brien et al. (2003) reported that in remote regions with no harvesting, tortoises may persist at densities of up to 25 tortoises per ha. In our study the highest relative abundance, 20 tortoises per ha, was found in the preserve Cap Sainte Marie where, at least officially, no harvesting occurs.

The interviews did not indicate that the *fady* incorporates the tortoise habitat. This may hypothetically have been the case if the tortoise represented strong spiritual values. However, there are numerous small sacred forest patches in Androy that are informally protected (Clark et al. 1998). Some of these *ala faly* may be up to 5 ha large and subject to complete entry restrictions (Elmqvist, personal observation). Tortoise populations found within the limits of these sanctuaries are probably effectively protected, and the role of these sacred forests in maintaining biodiversity throughout the Androy region deserves more detailed studies.

The tortoise occurs within the geographic range of the dry spiny forest; however, it is not clear to what extent decreases in forest cover (Sussman et al. 1994) contributes to tortoise decline. The results of our study suggest that declining forest cover may have relatively minor effects on tortoise viability. The tortoises appear to prefer the open spaces of low shrub and grassland, probably because these environments offer a better food supply than densely forested area. Juvik (1975) also points out that tortoises prefer low vegetation, such as shrub and grassland. Both O'Brien et al. (2003) and Lewis (1995) found that the radiated tortoise persisted at low abundance in relatively pristine forest habitats when exposed to harvest pressure, and at high densities in some regions characterised as heavily degraded open habitats.

It is yet unknown if the extinction of the tortoise would result in changed dynamics for plant species consumed or potentially dispersed. Durrell et al. (1989) reported that radiated tortoises have been observed to feed on at least eighteen plant species, and in our study we recorded at least seven species. The large herbivore *Geochelone gigantea*, once present in Madagascar, is known to have dramatic impacts on the vegetation dynamics on the Aldabra atoll, where it is still present (Boun et al. 1999; Merton et al. 1976). *G. radiata*, which may reach very high densities locally (Leuteritz 2002; O'Brien et al. 2003), is now the only representative in southern Madagascar of a once larger group of reptile herbivores (Arnold 1979; Burleigh and Arnold 1986). To what extent the radiated tortoise, at least partially, maintains crucial functions as a browser, grazer or seed disperser in ecosystems remains to be studied.

At the time of our study, the tortoise's diet consisted almost entirely of the fruits of the cacti *Opuntia* (*O. ficus-indica* and *O. monacantha*). To what extent these widespread introduced species (cover exceeding 20 per cent in some areas

in southern Androy [Elmqvist, personal observation]) have increased the capacity of the environment to support tortoise populations deserves further research, particularly since the cacti produce an abundance of fruits at a time of the year when there is very little else to feed on.

A large proportion of harvested tortoises probably end up in the illegal markets of the coastal towns of Toliara and Tolagnaro. O'Brien et al. (2003) estimated that annually up to 45,000 tortoises are collected from Toliara alone. The tortoise trade is virtually unchecked, and in Tolagnaro the price varies between 15,000 and 25,000 Malagasy francs (personal communication with informants in Tolagnaro), which equals approximately US\$ 2.50 to 4.50. Prices for tortoises reaching the illegal pet market may, however, be considerably higher (Nussbaum and Raxworthy 2000). Despite current official national legislation and international trade regulation, the high exploitation rate of the radiated tortoise is predicted to continue due to very high costs of enforcement. In addition, improvements in infrastructure, such as the repair of existing roads and the construction of new ones, will without doubt lead to intensified tortoise exploitation in presently isolated areas. The *fady* in its present form and in isolation from other measures will only to a minor degree slow this process. It is important to stress that the institution of the *fady* does not in itself contain any principle of discouragement other than the regulation of tortoise exploitation by the Tandroy themselves. The *fady* does not protect the tortoise from exploitation by outsiders, nor from subsistence utilisation by other inhabitants than the Tandroy, that is, there are no rights of exclusion (see Ostrom 1990). This represents a weak institutional framework for the protection and management of species, likely to be vulnerable to even small social and demographic changes. Our study, although limited, suggests that even small increases in the proportion of the human population violating the *fady* will result in a sharp decline in tortoise abundance.

Measures to prevent a future extinction of the radiated tortoise must nonetheless include the active involvement of local representatives of the Tandroy (and Mahafaly) communities, also incorporating an official recognition of the *fady* custom as a legitimate institution, for example, through a conversion into a formal by-law (see Johannes 2002). A number of studies have emphasised the crucial importance of local institutions for improving management of natural resources and ecosystems (Alcorn and Toledo 1998; Berks and Folke 1998; Ostrom 1990; Turner et al. 2000), including reinforcement of specific-species taboos (Horowitz 1998). The rationale for this is simple: environmental regulations that are based on traditional customs and sanctioned by local institutions are more likely to be respected than those imposed by external administrative agencies, even where the regulations themselves are very similar (Berkes and Folke 1998). A transformation of the *fady* for the purpose of conservation and sustainable management of the tortoise may thus considerably reduce transaction costs, that is, costs for protecting rights and enforcing agreements (Baland and Platteau 1996; Colding and Folke 2001). It has been pointed out that local actors may detect environmental changes faster than external administrative agencies due to close proximity to the resource base

and ecosystems, as well as performing such monitoring at significantly lower costs (Baland and Platteau 1996).

Johannes (2002) reports on several cases in Oceania where traditional marine resource management practices such as closed areas, closed seasons and specific-species taboos have gone through a renaissance during the past two decades. Factors contributing to this process include a growing perception of scarcity, a secured marine tenure system by means of legal recognition, and effective assistance and advice from regional and national governments and NGOs. The process was further reinforced by increased economic incentives due to improved fish stocks and income from tourist-related activities. Ruttan and Bergerhoff Mulder (1999) used a game theoretical approach to analyse conditions under which sound management of common property resources is likely to evolve. They demonstrated that under certain conditions conservation can be the result of narrow self-interest and economically motivated decisions may have the fortuitous but important consequence of conserving resources. Presently, the Tandroys do not consider the tortoise to represent any significant spiritual or economic value. It may, however, constitute an important economic source of revenue if local communities are granted rights to a regulated small-scale tortoise trade, further providing economic incentives for transforming and building effective institutions for sustainable management. In building local incentives for management it is, however, crucial that an institutional transformation also grants local communities the right to exclude outside harvesters in order to avoid the current partial open-access situation. Johannes (2002) reported of one case in Samoa where a strong incentive for local conservation and re-establishment of traditional marine management practices emerged only after rights were given to village councils to exclude outsiders from their fishing grounds. Previously, with a weak or non-existent authority to exclude outsiders, local incentives to conserve marine resources were weak since outsiders could always appropriate the benefits.

Harvest of large adult tortoises (the ones preferred in the meat market) on a sustainable basis is not realistic (O'Brien 2002). Due to the life history characteristics of the tortoise, including slow growth rate and very long-lived individuals, harvest of large adults may easily lead to over-harvesting and rapid population decline (*ibid.*). On the other hand, it is possible to develop a sustainable locally controlled farming of tortoises where juveniles are sold on the pet market. The economic incentives for entering the pet trade are considerable, since a single juvenile may currently be valued up to US\$ 5,000 (Nussbaum and Raxworthy 2000). The prospects for the development of a legal and strongly regulated commercial pet trade based on local farming and body size limits should be thoroughly investigated, including its institutional requirements. This course of action would require an amendment of the radiated tortoise CITES listing from Appendix I to Appendix II as suggested by Nussbaum and Raxworthy (*ibid.*).

However, there are reasons to believe that local institutions cannot carry out all enforcement and regulation alone, and therefore are in need of assistance from institutions existing at other hierarchical levels and across scales, for example, at

the regional and national levels (Johannes 2002). Such cross-scale linkages are referred to as nested institutions. The simplest kind connects local-level management with governmental-level management in partnerships, for example, co-management. Gadgil et al. (2003) report on several encouraging instances of successful management of ecosystems and species based on local institutions nested with other institutions both vertically (regional and national) and horizontally (other local institutions). In Androy other local institutions, such as *fady* customs related to lemurs (*Propithecus verreauxi* and *Lemur catta*) and forest habitats (*ala faly*), may likewise be incorporated in nested institutions for sustainable landscape management. There is clearly a large and untapped potential in many regions of similarly trying to incorporate and strengthen local institutions, which may not necessarily have been instruments of resource management in the past. However, based on culturally accepted norms and values they may now be used to fulfil new purposes in conservation and sustainable management of species and ecosystems (Berkes et al. 2000, 2003; Colding and Folke 2000, 2001; Colding et al. 2003; Johannes 2002).

## APPENDIX

### Sokake Fady 1

A Tandroys man had two wives, the first one Tandroys like himself and the second Tanosy. One day when the man came home with food he had collected, the first wife noted that this day the catch included an exceptionally large *sokake*. She certainly did not want to share this fine animal with the second wife. Before anyone caught sight of it she hid it under her *lanibahary* (skirt). This move turned out to be fatal for the poor woman. In a flash the reptile, which was normally of a slow and placid nature, took advantage of the delicate and irresistible situation, and seized her most precious belongings by its jaws. The woman died, and of course the family was heartbroken. They wanted to warn other people and tell them not to eat *sokake*, but felt too embarrassed to tell them what had actually happened. Instead of telling them the truth, they made up another story, a story that up to this day is the one most commonly cited by members of the Tandroys community when asked about the origins of the *sokake fady*. In this version the man came home with the large *sokake*, and again the first wife did not want to share the tortoise with the second wife. She decided to cook it herself, but being Tandroys she did not know what everybody else knew: *sokake* has to be killed before it is put in the pot. The family owned only one pot, made out of clay, and consequently fragile. Before the water had come to a boil, the tortoise had kicked the pot to pieces! From this day, the Tandroys people refuse to eat *sokake*.

### Sokake Fady 2

One ancestor, a woman who lived a long, long time ago, was at the time of her funeral wrapped in a very beautiful and unique piece of cloth. Her children had bought it and they knew that this cloth was of exceptional quality and that it was the only one of its kind.

Shortly after the funeral they saw a woman wearing a *lambahoany* made out of exactly the same material as their mother's burial wrapping. When confronted, the woman defended herself and said that the cloth was her own and that she knew nothing of their mother's shroud. To be on the safe side the children decided to go along to the mother's grave to have a look for themselves. They were startled by the sight. The grave had been opened, and when they looked inside they could not see the remains of their mother anywhere, but instead two strange animals residing in the grave. They did not know what to think. At this time there were no tortoises in Androy, no man or woman had ever laid eye on such a curious creature. The children concluded that the only reasonable explanation was that these two weird but wonderful beings must embody the spirit of their deceased mother. They also decided that because the tortoise is the spirit of the ancestor, it is good and must always be respected. Water and the leaves of tasty plants must be offered the animal each time it is encountered, and favours may be asked to endorse its sacred position.

The story was told by Mon Père Calvin at the Catholic mission in Beloha and he claims that this story is the origin of the tortoise *fady*, but that most people have forgotten about it, and so they only know the first tale. Today the *sokake* has lost its spiritual qualities.

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