EFFICACY OF LEOPARD TORTOISE *(GEOCHELONE PARDALIS BABCOCKI)* FARMING IN TANZANIA

Jonathan KABIGUMILA
Department of Zoology & Marine Biology, University of Dar es Salaam

ABSTRACT Assessment of the efficacy of leopard tortoise farming was made in Dar es Salaam and Arusha between June and July 1995. Three out of four farms held parental stocks in excess of the legal quota. Some farms also held stocks of mixed provenance, unsuitable for farming. None of the farms had suitable enclosures. Drinking and bathing water was not changed frequently resulting dirt contamination. Few grasses and no mineral supplements were included in the tortoise diet. No regular veterinary inspection was made for parasite removal. The farms underreported tortoise deaths.

The reproductive output of the captive tortoise was generally poor. Furthermore, farm owners lacked the expertise and commitment required for breeding tortoises in captivity. Farming cannot sustain the leopard tortoise export trade under the present breeding regime. The study concludes with recommendations for improving tortoise farming in Tanzania.

Key Words: Tanzania; Leopard tortoise; Farming; Export trade.

INTRODUCTION

Although Tanzania's tortoise fauna (family Testudinidae) is less diverse than that of southern Africa (Branch *et al.*, 1995), it is the most diverse in eastern Africa with four species (9.5%, N=42), in three genera (27.3%, N=11). The species found in Tanzania include *Geochelone pardalis babcocki* Loveridge (tropical leopard tortoise), *Kinixys belliana zombensis* Hewitt (southeastern hinge-back tortoise), *K. spekii* Gray (Speke's hinge-back tortoise), and *Malacochersus tornieri* (Siebenrock) (pancake tortoise). *Aldabrachelys elephantina* (Duméril & Bibron), the Aldabra giant tortoise was introduced from Aldabra Atoll to Changuu (Prison) Island, in Zanzibar (Loveridge & Williams, 1957). The species was recently brought to Tanzania mainland for farming (Kabigumila, 1995).

Since the trade liberalisation in 1985 there has been an increase in the scale of Tanzanian wildlife trade, including tortoises. In 1992 the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Animals Committee recommended a moratorium on exports of some species of reptiles following an increase in illegal trade (Klemens & Moll, 1995). The moratorium was imposed through a zero-quota system, subject to the results of a comprehensive population survey to develop a sustainable utilisation programme for wild populations. It was thought that enforcement of the moratorium would check the massive, indiscriminate exploitation of Tanzania's tortoise fauna (Klemens & Moll, 1995). All the species of tortoises are listed under Appendix II (CITES, 1997) which

includes species not necessarily threatened with extinction but which may become so unless trade is strictly regulated (Schouten, 1992). Since 1996 all the species have been categorised using the New IUCN Categories and Criteria for classifying the conservation status of animal species and subspecies (IUCN, 1996). The pancake tortoise has been listed as vulnerable under the threatened category, which includes animal species identified as globally threatened by trade. The other species have been categorised as near threatened, which includes all the taxa, which are not conservation dependent, but are close to the threshold of the vulnerable category.

Meanwhile in October 1993, Tanzania's Wildlife Division introduced tortoise farming in order to provide animals for trade, and as an incentive to maintain wild populations and their habitats (Rosser & Haywood, 1996). Under CITES regulations, farming is defined as "the rearing in a controlled environment of specimens taken from the wild with intent for trade in first-generation specimens" (Rosser & Haywood, 1996). Despite the introduction of tortoise farming six years ago, there is still no policy for managing tortoises either in the wild or in captivity. Such a policy is necessary in order to regulate farming operations and protocols for the export trade.

The study described in this paper focuses on the leopard tortoise, which is Tanzania's largest and most common species. Its variable, leopard-like carapacial colour pattern has made the leopard tortoise one of the most popular tortoises for the export trade (Kabigumila, 1998). Although the species is said to be widespread in Tanzania (Loveridge & Williams, 1957; Broadley, 1989), its current status is uncertain and it may no longer inhabit some of its former range. Four farms, three in Dar es Salaam and one in Arusha were licensed by the Wildlife Division to breed tortoises including *G.p. babcocki* for the export trade. Since Tanzania has little experience in tortoise farming, the present study was conducted to study the efficacy of tortoise farming and if the numbers bred would sustain the leopard tortoise export trade.

STUDY FARMS AND METHODS

I. Tortoise Farms

All the farms licensed by the Wildlife Division to breed tortoises for export were visited (Table 1). These were: a) A.F. Supplies & Services Tanzania Ltd., located in Boko village along the Bagamoyo Road, about 25 km from the Dar es Salaam City, b) Buibui Investments, in Mbezi Beach area along the Bagamoyo Road, 10 km from the City, c) Mbale Traders Ltd., located in Segerea village, about 4 km east of the

Table 1. Postal addresses of tortoise farms visited in the present study.

Tortoise Farm	Farmer's Name	Postal Address
Mbale Traders Ltd.	E. Msuya	PO Box 7995 Dar es Salaam
Buibu Investment Ltd.	K. Mwaipopo	PO Box 4787 Dar es Salaam
A.F. Supplies & Services	F. Rubibira	PO Box 5529 Dar es Salaam
Mountain Bird & Trophies Co. Ltd.	Joe Beraducci	PO Box 2282 Arusha

Dar es Salaam International Airport, and d) Mountain Birds & Trophies, in Ngongongare village, off the Usa River-Arusha National Park Road in Arusha. Their postal addresses are shown in Table 1.

A.F. Supplies & Services Tanzania Ltd. (Dar es Salaam) breeds various species of tortoises including *G.p. babcocki, K.b. zombensis, K. spekii, M. tornieri*, and *A. elephantina*. The tortoises are kept together in an orchard measuring 120×30 m. Buibui Investments keeps *G.p. babcocki, K.b. zombensis, K. spekii, M. tornieri* in a small pen measuring 21×11 m with various species of chameleons, lizards, snakes and birds. Mbale Traders Ltd. tortoise farm comprises an orchard about 50×50 m in which various species of tortoises (*G.p. babcocki, K.b. zombensis, K. spekii, M. tornieri*, and *A. elephantina*) are kept. Mountain Birds & Trophies is a Snake Park, which also keeps *G.p. babcocki, K. spekii, M. tornieri*, and *A. elephantina*. The tortoises are kept separately in two small pens.

II. Efficacy of Tortoise Farming

To assess the efficacy of tortoise farming, information was sought on the following aspects: a) current stock and status in captivity (number of tortoises by sex and age), b) source of parental stock, number of tortoises bred and techniques successfully used, and c) description of facilities used to house and care for captive animals.

Information on the animal stock and source of parental stock was obtained by interview with the respective ranch owners. For each ranch, a sample comprising the parental stock and at least 50% of juvenile animals was studied. Records were made of carapace length, mass and sex.

Tortoises were classified into juvenile, subadult and adult animals using carapace length as an index of age. The adult sex ratio was calculated for each farm. For each farm, the total number of tortoises hatched since farming started two years was recorded. The breeding performance was calculated as the number of hatchlings per adult female per annum expressed as a percentage of the theoretically possible number of hatchlings in that period. The latter was obtained by multiplying the average clutch size (N=10 eggs) by the average number of clutches per year (N=5 clutches) estimated from Broadley (1989), assuming that only 80% of eggs within a clutch were fertile (Highfield, 1994). Since the number of clutches per year varies across the range of the leopard tortoise (Broadley, 1989), the use of Broadley's data may be biased. However, since only an approximate figure of reproductive output was needed, the use of the data is considered justified. The overall reproductive output of the species in the farms was obtained by averaging the outputs at respective farms. Output was classified into five categories: poor, 0-20; fair, 21-40; good, 41-60; and excellent, >60%.

Particulars of the facilities used for keeping tortoises were obtained by interview with farm owners and personal observations. Information was sought on the following: enclosures used to house and care for captive animals, breeding records, diet, veterinary inspection, and causes of mortality and other losses such as thefts and escapes.

III. Effectiveness of Tortoise Farming to Sustain the Export Trade

Farming was assessed to see if the number of tortoises bred could sustain the demand for leopard tortoises. A conservative demand for leopard tortoises was obtained by summing the reported tortoises exported from Tanzania between 1983-96 (IUCN/SSC, in litt). The annual demand was calculated by averaging the number of tortoises over the period in question (14 years). The total number of tortoises bred annually in captivity was found to see if it could sustain the demand of leopard tortoises for the export trade.

IV. Statistical Analysis

The Goodness of Fit test, G (G-test) was used to test if sex ratios differed significantly from parity. Where appropriate, the 95% confidence limits for means are given (Zar, 1996). All probabilities are two-tailed and the results are recorded as significant at $P \leq 0.05$.

EFFICACY OF TORTOISE FARMING

I. Current Stock and Status in Farms

All the farms started breeding leopard tortoises with a legal parental stock quota of thirty animals. The farms were given permission to collect parental stock from Arusha, Shinyanga and Mara regions. However, all the farms held animals in excess of the legal stock (Table 2). Although the Dar es Salaam farms claim to have collected all their stock from upcountry, it is possible that part of it was obtained locally. Children are known to collect and sell tortoises to whomever is interested in acquiring them (F. Rubibira, pers. comm.). Table 3 summarises the records of body mass and size for leopard tortoises held at the farms. The mass ranges of juvenile, male and female animals were 0.02-0.63, 1.25-7.5 and 1.5-12.00 kg, respectively. For carapace length, the ranges of juvenile, male and female tortoises were 41-137, 177-353, and 169-406 mm, respectively. The percentage of juvenile animals at the ranches ranged from 31.4% (N=51) at Buibui Investments to 83.9% (N=224) at

Table 2. Stocks of *G.p. babcocki* held at the tortoise farms, and source of parental stocks in Tanzania.

Tortoise Farm	Current stock		Source of parental stock
	Parental	Juvenile	
A.F. Supplies & Services	31	73	Shinyanga, Mara
Buibui Investments	35	16	Source not given
Mbale Traders Ltd.(1)	36	189	Mara
Mountain Birds & Trophies	38	35	Arusha

(1) A total of 380 juvenile animals were exported prior to the survey under permission from the Wildlife Division. These were also included in the estimate of the species' reproductive output. Note that the animals were exported while the ban was still in effect.

Table 3. Ranges of body mass and size pooled for leopard tortoises held at the farms. Figures in parentheses indicate means and 95% confidence limits. N=number of tortoises.

Sex	Mass (kg)		Carapace length (mm)	
Juvenile	0.02−0.63 (0.12±0.02) N=142		41−137 (69.5±3.7)	
	Subadult	Adult	subadult	Adult
Male	1.25 N=1	2.25−7.50 (3.81±0.29) N=43	177	230−353 (276.7±6.9)
Female	1.50−5.00 (3.39±0.78) N=9	4.5−12.00 (7.79±0.44) N=64	169−285 (257.2±28.1)	300−406 (349.5±7.0)

Table 4. Adult sex ratio of parental stocks compared among the tortoise farms. N=number of tortoises; M=male; F=female.

Tortoise Farm	n	Sex ratio (M:F)	G test (DF=1)	
			G	P
A.F. Supplies Ltd.	27	2.0:1	3.056	NS
Buibui Investments	30	1.0:1	0.000	NS
Mbale Traders Ltd.	32	0.3:1	11.642	0.001
Mountain Birds & Trophies	33	0.3:1	11.644	0.001

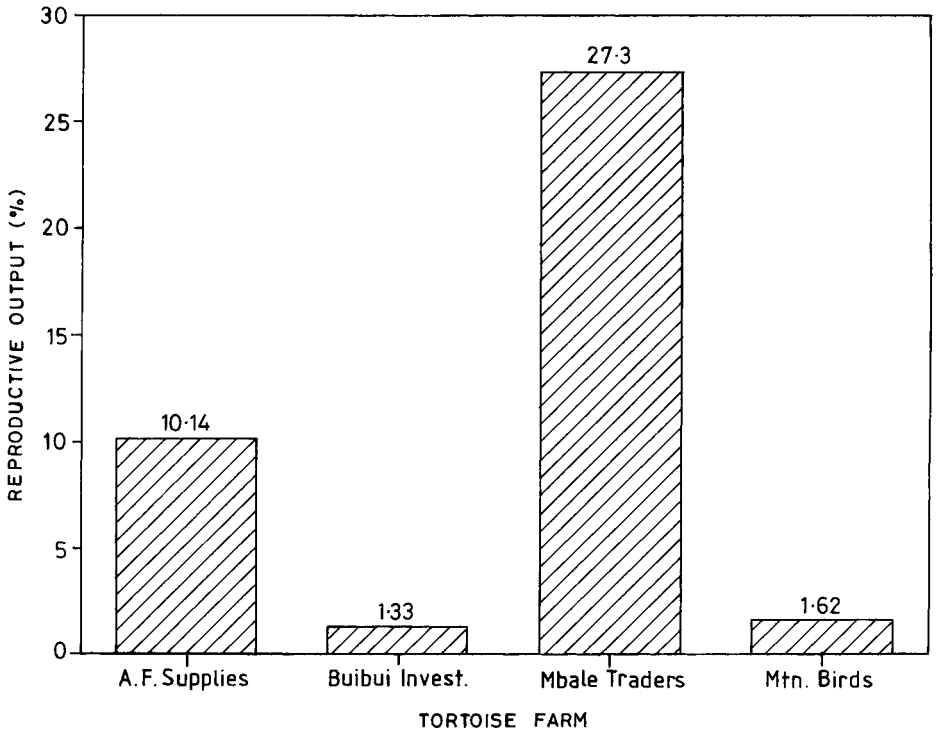

Fig. 1. Age-class composition of captive leopard tortoises compared among the tortoise farms.

Mbale Traders Ltd. (Fig. 1). All the farms held parental stocks of mostly adult tortoises. According to records at A.F. Supplies Ltd., juvenile animals measuring 41-60 mm carapace length were hatched between January and April 1995, while those measuring 61-93 mm were hatched between October 1994 and January 1995.

Table 4 shows the adult sex ratio of parental stocks held at the farms. Comparison with the 1:1 sex ratio showed a significant difference for Mbale Traders Ltd. (0.3:1, $G=11.642$, $DF=1$, $P<0.001$) and Mountain Birds & Trophies (0.3:1, $G=11.644$, $DF=1$, $P<0.001$). No significant difference was detected in stocks held by other farms.

II. Particulars of Facilities at the Farms

Table 5 shows the particulars of facilities at the various farms, e.g. types of enclosures, incubation techniques, including information on diet, veterinary inspection and causes of mortality and other losses through theft and escape. Although most farms keep the hatchlings and juvenile animals separately outdoors, the pens were simple and open, with sand substrate unsuitable for hatchlings.

The diet regime included fruits (e.g. papaw *Carica papaya*, guava *Psidium guajava*, and mango *Mangifera indica*), vegetables (e.g. cabbage *Brassica spp*.,

Table 5. Particulars of the tortoise farms.

Particulars	Tortoise Farm			
	A.F. Supplies	Buibui Invest.	Mbale Traders Ltd.	Mtn. Birds & Trophies
Enclosures	Brick-fenced orchard with pool and rocky shelters for shade; juveniles kept indoors	Brick fence without elaborate shelters; pool provided; juveniles kept separately outdoors	Brick-fenced orchard with stony shelters; pools provided; juveniles kept separately outdoors	Two enclosures with natural vegetation; juveniles kept separately outdoors
Incubation technique	Natural	Natural	Natural	Artificial; three incubators at 30.6°C, eggs hatch after 5 months; proportion of eggs hatching is 67% (N=52 eggs)
Diet	*Brassica spp*., *Asystesia sp*., and *Ipomoea batatas* leaves; juveniles also given *Carica papaya* fruits	*Eleusine* sp., *Cyperus rotundus*, *Ipomoea aquatica* and occasionally *Psidium guajava* and *C. papaya* fruits; juveniles given *Paspalum paspaloides* and *I. Aquatica*	*I. batatas*, *I. aquatica*, *Brassica spp.*, *Mangifera indica* fruits	Natural graze supplemented with *I. Batatas*.
Veterinary inspection	None	None	None	None
Other checks	None	None	Occasional application of acaricides	Occasional Application of acaricides, manual tick removal
Mortality and other losses	Several hatchlings eaten by rats	Details not provided	Deaths: 5 animals	Deaths: 5 animals

spinach, sweet potato leaves *Ipomoea batatas*, and wild forbs (*Asystesia sp., Ipomoea aquatica* Forsk.), but very few grass items. No mineral supplements were included. All the pens had adequate provisions of water for drinking and bathing, but most lacked retreats for shade.

None of the farms had regular veterinary inspection on stocks. Two farms made regular application of acaricides and tick removal. Despite this, several animals examined at Mountain Birds & Trophies were infested with ticks in the femoral area, while two animals at A.F. Supplies Ltd. showed round worms in their faeces. Three out of four farms were reluctant to state the actual mortality, presumably for fear of having the ranching permits revoked. Therefore, the number of deaths that are reported in Table 5 could be considered a bare minimum.

III. Reproductive Output

Figure 2 shows the reproductive output of the leopard tortoise at the various farms. The output ranged from 1.33-27.3% with only one farm recording a fair performance. The overall output was poor (10.1%). The techniques used for incubating eggs are shown in Table 5. Only Mountain Birds & Trophies employed artificial egg incubation. The eggs were dug from the nests and taken to Arusha where three incubators are installed. The natural incubation length of times reported by the farms

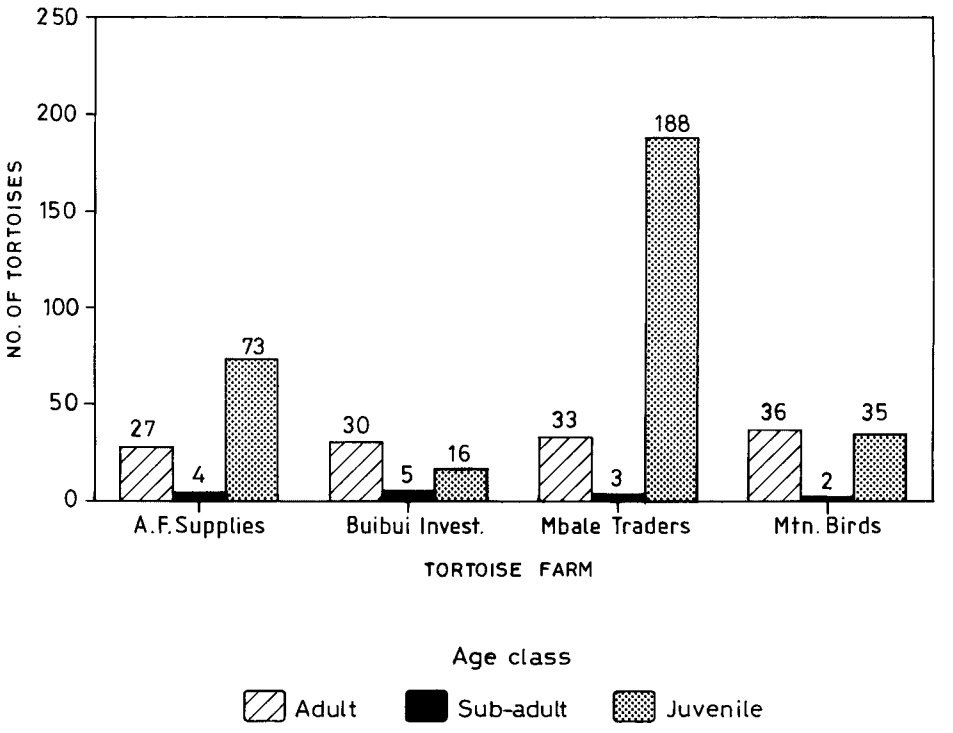

Fig. 2. Reproductive output (%) of captive leopard tortoises compared among the farms. N = number of animals hatched at the farm.

ranged between 6-8 months. It is noted from Table 5 that artificial incubation reduced the incubation period by one month.

IV. Sustainability of the Live Tortoise Export Trade

A total of 20,840 leopard tortoises were exported from Tanzania (IUCN/SSC, in litt.) between 1983-96, giving a conservative demand figure of 1,631 tortoises *per annum*. The annual supply of farmed tortoises was 346 animals *per annum* (estimated from Table 2), which is only 21.2% of the demand.

DISCUSSION

I. Efficacy of Ranching Operations

1. *Current stock and status in farms*

Three out of four farms held parental stocks in excess of the legal quota. This also included stocks for other species (Kabigumila, 1995), a further indication of illegal practices involved in the tortoise trade. Some farms held stocks of mixed provenance, which is considered bad for captive breeding, because the animals may differ genetically. It has been suggested that animals should be bred from individual populations rather than from different populations in order to avoid genetic contamination (Greig, 1979; Klemens, 1995). Two farms had stocks with biased sex ratios in favour of females. Patterson *et al.* (1989) have reported a comparable ratio (1:3) for captive leopard tortoises. A sex ratio in favour of females is recommended because it does not only promote breeding performance of the species, but also reduces intraspecific aggression between males (Highfield, 1994). Male leopard tortoises kept together will often fight which may result into injuries and stress (Highfield, 1994).

2. *Particulars of facilities at the farms*

The environment under which captive tortoises are maintained is very important and can influence their growth and survival (Highfield, 1994; Fenwick *et al.*, 1995). Provision of an adequate and suitable environment must be regarded as a major priority for all farms. The environment should be as diverse as possible by providing basking areas, a heavily overgrown area for shelter and shade, and a variety of rocks and local "vegetation" to imitate the animals' natural habitat (Coakley & Klemens, 1983; Patterson *et al.*, 1989; Highfield, 1994; Reid, 1995). In this context, none of the farms examined could be regarded as providing a conducive environment for captive tortoises. It appears that the enclosures were hastily constructed for farming operations following the moratorium on exports from the wild. The problem with the enclosures is not space but the lack of pens for different species (Fenwick *et al.*, 1995). This is very important because different tortoises species may harbour different pathogens (Highfield, 1994). In addition, separation of the species safeguards the smaller forms from injury and undue stress. Although most farms kept the hatchlings and juveniles separately outdoors, the pens were simple and open, with sand

substrate unsuitable for hatchlings (Highfield, 1994). Young tortoises in the open pens may also be prone to heat stress and predation by rats, birds of prey, corvids, and small carnivores.

The diet regime included a variety of food items, but with few grasses. As leopard tortoises have a diverse diet (Milton, 1992; Rall & Fairall, 1993; Kabigumila, 1998), their captive diet should include as many items from the wild as possible. Depending on the animal's requirements, fibre is very important in the tortoise diet, a lack of which may result in poor digestion, diarrhoea and an increased risk of colic (Highfield, 1994). It has been suggested that the fibrous tortoise foods in the wild might act as vermifuge for intestinal parasites (Highfield, 1994). Therefore, lack of fibre in the diet might partly account for the high incidence of intestinal parasites in captive animals (Highfield, 1994). As grass is a major source of fibre, it should be provided regularly in the animal's diet.

No mineral supplements were given to the tortoises, although captive herbivorous reptiles are susceptible to nutritional disorders from lack of minerals in the diet (Esque & Peters, 1994). The supply of mineral supplements such as calcium and vitamins is very important for captive animals in order to simulate the animal's balanced diet in the wild (Highfield, 1994). The lack of dietary supplements in captive-bred hatchlings could result in early-stage calcium deficiencies such as the "soft-shell" syndrome, and carapace deformities so common in captive-bred chelonians (Highfield, 1994; Reid, 1995). Breeding females also require calcium for eggshell development, the lack of which could result in reduced nesting, or small clutches of soft-shelled eggs (Reid, 1995). Calcium can be obtained easily from crushed chicken egg shell, powdered cattle bone (Reid, 1995), and weathered bones (Kabigumila, 1998), while vitamins can be obtained from secondary sources such as fruits, and vegetables (Highfield, 1994). It is recommended that animals should not be fed excessive quantities of protein since this can seriously interfere with calcium metabolism, and in addition can lead to massively accelerated growth and early sexual maturity as frequently observed in many captive-bred hatchlings (Highfield, 1994). Animals feeding on protein-rich items may often show deformed "pyramidal-like" scutes and grossly distorted carapaces (Highfield, 1994; pers. obs.). Such deformed animals have no export market (E. Msuya, pers. comm.).

It was reported earlier that wild tortoises require intestinal flora for digesting cellulose. It is possible that captive animals may obtain such microsymbionts from ingesting soils in their enclosures.

All the farms had adequate provisions of water for drinking and bathing. However, the water was not changed frequently resulting in tortoises using water contaminated with dirt. It has been recommended that the water should be changed at least daily since tortoises tend to wade through while bathing or drinking (Coakley & Klemens, 1983).

None of the farms had regular veterinary inspection of their tortoises, although parasites are known to present a major health hazard to captive tortoises (Highfield, 1994; Fenwick *et al.*, 1995). Parasites, which affect tortoises, include ectoparasites such as ticks, and endoparasites such as worms and protozoa. Two out of four farms kept animals other than tortoises in their farms, including lizards, chameleons, crocodiles and birds. Therefore, regular veterinary inspection may be important because

leopard tortoises may acquire pathogens from other captive animals (Klemens *et al.*, 1993). The farmers also underreported hatchling mortality for fear of cessation of the farming licenses.

The poor farm facilities observed in the present study suggest that no background preparations were made by the Wildlife Division regarding the minimum standards to be observed by the ranch operators. The lack of a policy to guide farming activities may account for this anomaly. It is also possible that some farmers do not have adequate financial resources and expertise to conduct farming operations. These issues are addressed in detail below.

3. *Reproductive output*

Leopard tortoises adapt readily to captive conditions (Pritchard, 1995) under which they are known to breed prolifically (Patterson *et al.*, 1987; Highfield, 1994; Fenwick *et al.*, 1995; Jauch, 1995). However, the reproductive output of the leopard tortoises among the surveyed farms was generally poor. Most farms employed natural incubation, leaving the eggs *in situ* to hatch.

The reproductive output for other species was also generally poor except for *M. tornieri* (100%) and *K. spekii* (71.6%) at the Mbale Traders Ltd and Buibui Investments farms, respectively Table 6. As nests were unprotected from predation (Kabigumila, 1998) and from other females nesting at the same site, it is possible that some eggs failed to hatch because the incubation process was disrupted. Nests could be protected by means of a wire mesh dome staked into the ground (Patterson *et al.*, 1987; Reid, 1995), and placing obstacles around the nests to keep away other nesting females (Reid, 1995).

The poor reproductive output could also be ascribed to various factors including lack of experienced and committed ranch operators, biased sex ratios in favour of males, lack of a balanced diet, lack of regular veterinary inspection, and inadequate farm facilities.

Only one farm employed artificial egg incubation. If used properly, artificial incubation can improve the reproductive output of the species by shortening the incubation of eggs (Highfield, 1994; Fenwick *et al.*, 1995). However, there are various essential conditions to be met, such as constant positioning of eggs, control of temperature and humidity, no intense light shining on the eggs, and no banging of the incubator (Fenwick *et al.*, 1995). It is not surprising that the farm using artificial incubation recorded the poorest output. However, the incubation period reported here is comparable to those observed elsewhere on leopard tortoises, namely 135-

Table 6. Reproductive output of *Geochelone pardalis babcocki* compared with that of other species at the various farms

Species	Reproductive output (%) at each farm			
	Buibui Investments	A.F. Supplies	Mbale Traders	Mtn. Birds and Trophies
G.p. babcocki	1.33	10.14	27.30	1.62
K.b. zombensis	0	Not stocked	0	Not stocked
M. tornieri	100	27.7	33.3	1.8
K. spekii	0	Not stocked	71.61	0
A. elephantina	Not stocked	11.03	26.42	Juveniles

202 days at 30˚C (Coakley & Klemens, 1983), and 125-135 days at 27-34˚C (Coles, 1985). But longer incubation periods (228 days at 28˚C) for the same species have been recorded at Witwatersrand, South Africa (Patterson *et al.*, 1987).

4. *Sustainability of the live tortoise export trade*

In 1996, Tanzania applied to CITES for permission to resume tortoise exports, to clear farmed animals stockpiled during the moratorium. Permission was granted *vide* Notification No. 980 of 2 June, 1997 for export of 2,000 leopard tortoises covering the 1997 export quota (CITES, 1997). The quota was fixed on the basis of animals stockpiled by the farms over a period of nearly four years of operation (O. Mbangwa, in litt.). Subsequent quotas will also depend on the actual number of animals in the farms, rather than that requested by the farms. Three farms managed to export some animals before leopard tortoise exports from Tanzania were suspended in September 1997 pending verification of captive stocks (O. Mbangwa, in litt.).

However, my survey found that under the present breeding regime, farming could not sustain the tortoise trade. The factors responsible for the poor reproductive output of leopard tortoises are not difficult to address considering that the species breeds readily in captivity. If tortoise farming is to be successful, it also will need as high a profile as that given to crocodile ranching (Wildlife Division, 1993). But has the Crocodile Policy been successful? This is not clear as its effectiveness to sustain the crocodile trade has not been evaluated. However, the lack of a Tortoise Policy suggests that farming has been conducted haphazardly. The policy may not only provide legitimacy but also a long-term perspective for tortoise farming in Tanzania. Before being issued permits, the dealers should have been asked to show a detailed project proposal indicating that they have sufficient financial resources and expertise to operate tortoise farms. This would have ensured that the applicants had the ability to handle, keep and feed tortoises according to animal welfare standards. While studying the proposals, the Wildlife Division should have made a physical inspection of the proposed farm site to ensure that there were sufficient facilities for the animals. However, it is not clear if such an elaborate procedure was followed.

The farming policy must be part of a broader policy relating to tortoises, their habitats and the export trade. The policy should: a) establish the objectives of farming, i.e. breeding animals for trade as an incentive to manage wild populations and their habitats, sustaining tortoise trade, and providing employment; b) identify components of a management plan by setting the minimum standards for all aspects of farming, such as financial resources, expertise, ranch facilities, animal welfare, veterinary care, number and sex ratio of parental stocks, and security measures to safeguard against theft and escape of captive stock into the wild; and c) enforce the standards by monitoring farming operations. As farming is intended to provide animals for the export, a policy relating to trade should also be formulated. The policy should address issues such as export control (adherence to quotas, and trade monitoring), animal welfare standards during shipment, pricing mechanisms, and trade statistics.

5. *Conclusion and recommendations*

Unless the present breeding regime is improved, farming cannot sustain the leop-

ard tortoise export trade. Since the conditions necessary for successful farming are not difficult to attain, a policy to guide farming activities needs to be formulated. The policy should be part of a broader policy for managing tortoises and their habitats in Tanzania. The policy should also address issues related to tortoise farming as a conservation tool. This should include minimum animal welfare standards, accountability of farm operators, and export controls (pricing mechanisms, surveillance at airports).

In order to improve tortoise farming the following suggestions are made:

- Training workshops should be conducted by the Wildlife Division to educate farm owners on current techniques of raising tortoises in captivity;
- Regular veterinary inspection should be made by the Wildlife Division to ensure that captive stocks are kept healthy.
- The Wildlife Division should establish security measures to be taken to safeguard against escape of the captive stocks into the wild and contingency measures for the safe disposal of stocks in the event that the operation is closed (Brautigam, 1994). This is important because captive tortoises are known to harbour diseases. In addition, such measures would prevent genetic contamination of the neighbouring wild populations. In the event that reintroduction or repatriation measures are considered, prior studies should be made to determine if the animals are genetically compatible with those in the wild.

ACKNOWLEDGEMENTS This study could not have been completed without the assistance of Messrs. B. Andulege and J. Kibebe of the Wildlife Division. Mr. E. Severre kindly arranged for the study to be undertaken. I am grateful to the Director of Wildlife for financial assistance and permission to publish this study. Dr. C.O.F. Mlingwa availed the time to review the manuscript.

REFERENCES

Branch, W.R., G.A. Benn & A.T. Lombard 1995. The tortoises (Testudinidae) and terrapins (Pelomedusidae) of southern Africa: their diversity, distribution and conservation. *S. Afr. J. Zool.*, 30: 91-102.

Brautigam, A. 1994. CITES: A conservation tool. A guide to amending appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora. 4th Ed. IUCN/SSC, Cambridge.

Broadley, D.G. 1989. *Geochelone pardalis* Leopard Tortoise. In (I.R. Swingland & M.W. Klemens, eds.) *The Conservation Biology of Tortoises*, pp. 43-46, IUCN/SSC Occ. Pap. No. 5, Gland.

CITES 1997. Notification to the Parties, No. 980: Export quotas for 1997. CITES Secretariat, Geneva.

Coles, R.W. 1985. The leopard tortoise (*Geochelone pardalis*). *Herptile News*, 10: 28-29.

Coakley, J. & M. Klemens 1983. Two generations of captive-hatched leopard tortoises *Geochelone pardalis babcocki. Herpetol. Review*, 14: 108-114.

Fenwick, H., A.J. Pearson, C. Tilley & J. Thorpe 1995. *Taking care of tortoises, their eggs and hatchlings*. Elitian Ltd, Cambridge.

Greig, J.C. 1979. Principles of genetic conservation in relation to wildlife management in

Southern Africa. *South African Journal of Wildlife Research*, 9: 57-78.
Highfield, A.C. 1994. *Keeping and breeding tortoises in captivity*. The Longdunn Press Ltd., London.
IUCN 1996. *1996 IUCN Red List of Threatened Animals*. IUCN, Gland.
Jauch, H. 1995. Incubation of leopard tortoise *Geochelone pardalis* eggs under natural conditions. *Afr. Herp. News*, 23: 36-37.
Kabigumila, J. 1995. Assessment of the breeding performance of tortoises in captive breeding farms in Dar es Salaam and Arusha, October 1995. Report to Director of Wildlife, Ministry of Natural Resources & Tourism, Dar es Salaam.
Kabigumila, J. 1998. Aspects of the ecology and management of the tropical leopard tortoise *Geochelone pardalis babcocki* (Loveridge) in northeastern Tanzania. Ph.D. Thesis, University of Dar es Salaam.
Klemens, M.W. 1995. Repatriation of confiscated tortoises: conscience-clearing expediency or sound wildlife management? *Re-Introduction News*, 10: 5-6.
Klemens, M.W. & D. Moll 1995. An assessment of the effects of commercial exploitation on the pancake tortoise, *Malacochersus tornieri*, in Tanzania. *Chelonian Conservation and Biology*, 1: 197-206.
Klemens, M.W., B.L. Raphael, W.B. Karesh, P.D. Moehleman & R.T. Mwaya 1993. Baseline health parameters of free ranging pancake tortoises, *Malacochersus tornieri*, in Tanzania. Abstract. *International Conference on Conservation, Restoration and Management of tortoises and Turtles*. State University of New York, 11-16 July, 1993. New York.
Loveridge, A. & E.E. Williams 1957. Revision of the African tortoises and turtles of the suborder Cryptodira. *Bull. Mus.Comp. Zool. Harvard.*, 115: 161-557.
Milton, S.J. 1992. Plants eaten and dispersed by adult leopard tortoises *Geochelone pardalis* (Reptilia: Chelonii) in the southern Karoo. *S. Afr. J. Zool.*, 27: 45-49.
Patterson, R.W., R.C. Boycott & D.R. Morgan 1989. Reproduction and husbandry of the leopard tortoise (*Geochelone pardalis*) in an alien habitat. *Herp. Assoc. Afr.*, 36: 75.
Pritchard, P.C.H. 1995. Tortoise life. In (B. Devaux, ed.) *Proceedings-International Congress of Chelonian Conservation*, pp. 329-333, Editions Soptom, Gonfaron.
Rall, M. & N. Fairall 1993. Diets and food preferences of two South African tortoises *Geochelone pardalis* and *Psammobates oculifer. S. Afr. J. Wildl. Res.*, 23: 63-70.
Reid, D. 1995. The captive breeding project for the ploughshare tortoise *Gechelone yniphora* in Madagascar. *Proc. Int. Cong. Chel. Cons.*, 6-10 July 1995, Gonfaron, 119-140.
Rosser, A. & M. Haywood, (eds.) 1996. *CITES: A guide to amending the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora*. 5th Edn. IUCN/SSC, Cambridge.
Schouten, K. 1992. *Checklist of CITES Fauna and Flora*. IUCN Secretariat, Lausanne.
Wildlife Division 1993. *Policy and management plan for the Nile crocodile*. Ministry of Tourism, Natural Resources and Environment, Dar es Salaam.
Zar, J.H. 1996. *Biostatistical analysis*. 3rd Ed. Prentice-Hall, Inc., New Jersey.

———— Accepted *December 27, 1998*

Author's Name and Address: Jonathan KABIGUMILA, *Department of Zoology & Marine Biology, University of Dar es Salaam, P.O. Box 35064, Dar es Salaam, TANZANIA. (jkabigu@ucc.udsm.ac.tz)*