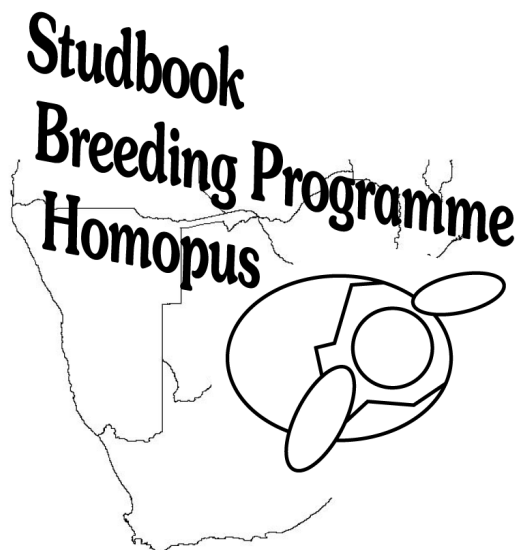


Studbook Breeding Programme *Homopus*



Annual Report 2000

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Since 1992 several Dutch herpetological societies have initiated a total of 60 studbook programmes on reptile and amphibian species. In 1997, all programmes were condensed into an independent foundation known as: 'Stichting Overkoepelend Orgaan Stamboekken' (SOOS). Early in its development, SOOS formulated the very important criteria that no studbook participant would jeopardise their important herpetological contributions and goals with any commercial enterprise from their specimens, either currently or in the future. The Studbook Breeding Programme *Homopus* is one of few studbooks operating world-wide.

The aims of the studbook programmes in general are:

- To inform the herpetological community with data and publications generated from captive situations and field studies
- Procuring, maintaining, and reproducing genetically healthy captive individuals for future loans to recognised individuals and institutions

These conservation goals are particularly relevant today as wild populations of many reptiles and amphibians experience increasing survival pressures. Establishing working programs that emphasise captive husbandry in conjunction with fieldwork is crucial in developing sound wildlife management. A significant contribution that captive animals may perform is through the concept of re-introduction of their potential offspring. Although re-introduction of species is at a very early stage and occasionally controversial, there may come a time when the offspring of captive animals are the sole source for re-introducing species into previously suitable habitat where the natural population has become extinct. More importantly re-introduction has the potential of insuring genetic diversity to populations that have become unnaturally isolated due to human interference.

From January 2001, all current activities on *Homopus* will condense in the *Homopus* Research Foundation.

1. INTRODUCTION AND ACTIVITIES IN 2000

This report is updating the 1999 annual report of the Studbook Breeding Programme *Homopus*, published in December 1999. The first annual report was published in 1997. The Studbook Breeding Programme *Homopus* is aiming to form captive populations and to study these, to carry out research in the field, and to gather and distribute as much information about species of the genus *Homopus* as possible. A more official organisation, the *Homopus* Research Foundation in which all activities will condense, will be founded on 1 January 2001 (see also chapter 2).

This report will summarise the activities of the programme in 2000, plans for 2001, and it will give an overview of the current composition and changes in the captive populations.

Additional information may be obtained from the internet site of the Studbook Breeding Programme *Homopus*, <http://www.homopus.org>, or from the studbook co-ordinator.

In the next paragraphs an overview of the main activities in 2000 is presented.

1.1. Publications and presentations Studbook Breeding Programme *Homopus* (see also chapter 9)

The review of a manuscript with detailed information about husbandry, behaviour and captive breeding of *H. s. signatus* (formerly known as *H. bergeri*), that was submitted for publication in *Chelonian Conservation and Biology* in September 1999, still has not been completed. This manuscript is a result of an increased co-operation with a Namibian keeper of this species, outside of the studbook. On request, the editor of *Chelonian Conservation and Biology* let us know in early 2000 that there has been a delay, but that we will be informed about the manuscript soon.

A similar manuscript dealing with *H. s. signatus* was published in *Chelonian Conservation and Biology* in December 1999, just after publication of the 1999 annual studbook report.

In 2000, only two articles were published within the Studbook Breeding Programme *Homopus*, both in Dutch. One of the articles was about the Studbook Breeding Programme *Homopus* in general, and was published in a special edition printed within the scope of the 25th anniversary of the Dutch Turtle/Tortoise Society. The second article provided information on the set-up of a field research project on *H. s. signatus*, set up within the Studbook Breeding Programme *Homopus*. The latter article was published in *De Schildpad*. Both articles have brief English summaries and are available from the internet site of the Studbook Breeding Programme *Homopus*. The first article will be translated for publication in the French magazine *Manouria*.

Translations of articles and notes on *H. s. signatus* that were published in *African Herp News*, started to appear in the French magazine *Tortuga* rather unexpectedly (without notifying the original authors in advance). The first translation was published in 2000, and the others will follow later.

An interview with one of the participants in a Studbook Breeding Programme *Homopus* field study on *H. s. signatus* was published in a local Rochester (USA) newspaper on 24 May.

Although only a limited number of articles was published in 2000, a much larger number of manuscripts has been written and submitted for publication. These are mainly life history notes, submitted for publication in *African Herp News*. They are on natural diet of *H. s. signatus*, autumn activity in *H. s. signatus cafer*, new maximum size record in *H. s. signatus*, atypical mating behaviour in captive female *H. s. signatus*, and natural diet of *Chersina angulata*, as recorded during observations on *H. s. signatus* in Namaqualand, South Africa. Moreover, manuscripts presenting data (population characteristics, activity patterns, diet and reproduction) gathered during a scientific field study on *H. s. signatus* are currently in preparation for publication in a number of international peer-reviewed journals.

The draft texts on *Homopus* species (as well as several other southern African species) for the CD-ROM *Turtles of the World* by Ernst, Altenburg and Barbour (2000), have been reviewed within the Studbook Breeding Programme *Homopus*, before publication. Furthermore, a large number of high quality colour slides have been placed to the authors' disposal.

At a symposium of the Swedish Scandian Reptile Society (Malmö, May 2000), as well as at a symposium of the German DGHT AG *Schildkröten* (Bergheim, March 2000), a lecture about captive management and observations in the wild of *H. s. signatus*, *H. s. cafer* and *H. s. signatus* was presented. Furthermore, two presentations about a field study on *H. s. signatus* set up within the Studbook Breeding Programme *Homopus* were presented. The first at Webster Rotary (USA) in September, 2000, the second at Seneca Park Zoo in Rochester (USA) on 30 October 2000.

A popular talk about the 2000 field research project on *H. s. signatus* has been presented at the Civil Engineering Division of the Ministry of Transport, Public Works and Water Management (Netherlands).

1.2. Internet site

Minor updates (new publications, changes in studbook composition, et cetera) have been performed throughout 2000. Major updates concern updated growth charts of *H. s. signatus* and *H. areolatus* (new), and additions on captive husbandry of *H. areolatus*. The annual reports are posted on the internet site annually, providing information on husbandry in the appendices, in addition to the husbandry information on the site.

Over 3800 page views have effected since June 1998 (approximately 1700 in 2000). It is striking that South Africa is ranked as high as the 10th position in terms of number of visitors per country.

1.3. Journeys

South Africa was visited for six weeks in August and September 2000, within the scope of the field research project on *H. s. signatus* that had been set up within the Studbook Breeding Programme *Homopus* (see also paragraph 1.4). The studbook co-ordinator and a studbook participant, as well as three external persons met in Springbok, South Africa.

Journeys to South Africa and Namibia have proved to be a good opportunity for studbook participants from different continents to meet in person occasionally.

1.4. Research

In 2000, the first field research project set up within the Studbook Breeding Programme *Homopus* took place. A field study on population dynamics, behaviour, natural diet and reproduction of *H. s. signatus* was conducted in August and September by two Dutch (Mark Klerks and Victor Loehr), two Americans (Chris Hobson and Tom Licitra) and a German (Fabian Schmidt). The fieldwork was very successful, and the first manuscript will be offered for publication in an international peer-reviewed journal in early 2001. After this, several other papers will follow. Details about the set-up of the study can be found in the project proposal. This proposal may be obtained from the studbook co-ordinator, or can be downloaded from the internet site of the Studbook Breeding Programme *Homopus*.

One part of exploration of the aspect reproduction has been carried out by Retha Hofmeyr and Brian Henen, both from the University of the Western Cape (South Africa). This has yielded invaluable information. Furthermore, the project would not have been possible without donations of money (Dutch Foundation for the Advancement of Herpetology, Tortoise Trust USA, Dutch Turtle/Tortoise Society, Bill Sawey (USA)), and research materials (Röbke Agenturen (Netherlands), Barbour-threads (Netherlands), South Africa OnLine, Roland's Uitspan (South Africa), Microscoop Service Rob Engelhard (Netherlands), Cellpack bv (Netherlands)). The offer to use facilities was gratefully accepted from Springbok Hospital (South Africa), Wageningen University and Utrecht University (both Netherlands). Permits were provided by Northern Cape Nature Conservation (South Africa) and the Department of Agriculture (South Africa and Netherlands). Ernst Baard (South Africa) has been encouraging us throughout the process of realising the project.

Apart from the field project, and the continuing long term captive study on *H. s. signatus* (as described in the 1999 annual studbook report), in 2000 the Studbook Breeding Programme *Homopus* was involved in the same two projects as in 1999:

- *Tortoise egg shells*
Declan Nolan from Nijmegen University (Netherlands) is studying shells of tortoise eggs. Experimental electron microscope scans from a small sample of shells of hatched and non-hatched *H. s. signatus* eggs, have revealed what appear to be signs of calcium mobilisation. Furthermore, pores in the egg shells looked 'different' if compared with those in shells of other species. Currently, all *H. s. signatus* egg shells produced in captivity are being collected and sent to Nijmegen University.
- *Microsatellite DNA and parent-offspring relationships*
Jessica Cunningham from the University of Cape Town (South Africa) is carrying out a project on microsatellite DNA in (African) tortoises. The captive population *H. s. signatus* served as a source of DNA-samples from specimens with known parent-offspring relationships. Blood samples were sent to South Africa and are currently being processed.

In order to expand the gathering of information on *Homopus* in the captive populations, in 2000 permits were applied to exchange *H. s. signatus* (Netherlands) captive-bred hatchlings against *H. s. signatus* (Namibia) captive-bred hatchlings. This would have allowed for comparison of behaviour and reproduction between these two related species at two different captive locations (outdoors and indoors), while kept under scientifically controlled environmental conditions. Unfortunately the Namibian government has not granted the permits required, since they have the opinion that the keeping should be done in the country of concern.

1.5. Contacts

It seems that people and organisations are increasingly successful in locating the Studbook Breeding Programme *Homopus*. A female *H. areolatus* that was found in northern South Africa, was spontaneously offered to the studbook on this species by the local museum. Currently the transfer is in preparation. In another instance, Cape Nature Conservation in the Western Cape, South Africa, has asked for the opinion of the Studbook Breeding Programme *Homopus* regarding an application for collecting and exporting *H. s. signatus* to the USA. Based on the starting point that specimens from different geographical locations should not be interbred in captive populations, the Studbook Breeding Programme *Homopus* has replied that additional wild-caught specimens would be very welcome in the studbook, as long as they would originate from the same location in the Northern Cape Province, South Africa, as the majority of the present specimens originates from. That would mean that collecting permits should be issued by Northern Cape Nature Conservation rather by Cape Nature Conservation. If specimens would be collected in the Western Cape, these could also be registered in the studbook, but they would not contribute to genetic diversity of the current population. A parallel population of Western Cape specimens would have to be set up.

The Studbook Breeding Programme *Homopus* has also been contacted regarding illegal exports of South African tortoises.

In 2000, reprints of papers produced within the Studbook Breeding Programme *Homopus* were applied for by Sao Paulo Zoo (Brazil), University of South Bohemia (Czech Republic), Faculté des Sciences Semlalia, Dept. de Biologie, Marrakech (Maroc), and Municipal Zoological Garden-Beer Sheva (Israel). Two publications (one in Dutch and one in English, both on captive husbandry and breeding of *H. s. signatus*) have been cited in a manual for the European and world zoo community, through Alastair Macdonald, Preclinical Veterinary Sciences, University of Edinburgh (UK).

In an experiment to improve the exchange of information regarding *Homopus*, a mailing list has been created at egroups.com. Everyone participating in the Studbook Breeding Programme *Homopus*, co-operating with it, or working on *Homopus*, or on related topics, may apply for membership. This can be done by sending a message (without body) to Homopus-subscribe@egroups.com.

Occasionally impolite e-mail messages were received that were sent from the internet site of the Studbook Breeding Programme *Homopus*. In these messages senders ask without any reluctance if they can purchase specimens. Usually even without mentioning their name.

1.6. Finances

The bank account of the Studbook Breeding Programme *Homopus* will change after foundation of the *Homopus* Research Foundation (see chapter 2). At this time, the new details of the bank account are not known. Since the *Homopus* Research Foundation will be a non-profit, tax-exempt organisation, tax-deductible donations will remain possible.

All expenses of the Studbook Breeding Programme *Homopus* have been funded by the co-ordinator privately so far. Only for the field study in 2000 additional funding was received from external parties, and a part was funded by the participants in the study.

2. PLANS FOR ACTIVITIES IN 2001

In the last couple of years, the activities of the Studbook Breeding Programme *Homopus* have expanded considerably, including much more than maintaining a studbook for *Homopus* species. Therefore, all activities will condense in a new, broader organisation, dealing with activities to enhance the knowledge on the genus *Homopus* in general. This organisation has been named *Homopus* Research Foundation, and is registered at the Chamber of Commerce in Utrecht, Netherlands. It will be active from 1 January 2001. The foundation will also facilitate financial donations from third parties, as it is non-profit tax-exempt.

The field research project on *H. s. signatus* conducted in 2000 yielded several questions that need further exploration. For that reason, a follow-up project is currently being prepared. As was the case in 2000, much of the available time in 2001 will be consumed by the preparations, field work and data processing in relation to these two research projects. Nevertheless, it will be attempted to pay attention to other activities related to *Homopus*.

2.1. Presentations

Except from a commitment to present a talk at Cornell Universities Herp Club in Ithaca, and for staff of Conservation International, both USA, in 2001, there are no promises for presentations within the Studbook Breeding Programme *Homopus*. However, it is expected that an already prepared general lecture (possibly including some results) on the field studies on *H. s. signatus* will be presented at several locations in Europe, and the USA.

In January 2002 a major European turtle symposium will take place in Vienna. The studbook co-ordinator will occupy a co-chair during the Africa-section of the symposium, and results of the field studies on *H. s. signatus* will be presented.

2.2. Internet site

The internet site of the Studbook Breeding Programme *Homopus* will continue to grow. All papers published within the Studbook Breeding Programme *Homopus* in 2001 will be posted on the site, and growth and climatic data will be updated. Moreover, it will be attempted to post information about *Homopus* from outside of the programme, when available.

A link between the husbandry and breeding information on the internet site, and the information in the annual studbook reports will be established. This will make it easier for visitors to locate this up to date information, and at the same time it will make (time-consuming) updating of the information on the site less urgent.

2.3. Journeys

In order to conduct the follow-up fieldwork on *H. s. signatus*, South Africa will be visited in September by the research participants.

2.4. Research

Main research focus in 2001 will remain the field studies on *H. s. signatus*. Preparations for a follow-up project on population dynamics, behaviour and reproduction will continue throughout the year, as will the preparations of manuscripts resulting from the first field project. The project proposal for the second project on *H. s. signatus* can be obtained from the studbook co-ordinator or the internet site. This project will be conducted by a German (Fabian Schmidt), a Dutch (Victor Loehr), and two research assistants who still need to be recruited.

Additional involvement in research on *H. s. signatus* may be present in 2001. Fabian Schmidt is currently investigating if it would be possible to conduct a research project on *H. s. signatus* for his Master's at Frankfurt University (Germany). This may be a laboratory study on physiology of *H. s. signatus*. In that case, the Studbook Breeding Programme *Homopus* will place captive-bred specimens at his disposal, since such a project may yield important information about the species.

2.5. Contacts

An increasing number of people and organisations find their way to the internet site of the Studbook

Breeding Programme *Homopus*. This will yield an increasing number of contacts with people with an interest in tortoises of the genus *Homopus* in 2001.

2.6. Imports

Now that survival of the captive population *H. s. signatus* is exceptionally high, and breeding has also commenced in the captive group in the USA, a strategy has been drawn up, how to manage the captive population as a whole on the longer run (see chapter 5). This has resulted in a desire to import a small number of genetically unrelated additional specimens from the same population the studbook population originates from. Northern Cape Nature Conservation (South Africa) will be contacted to discuss this.

In 2000, rather unexpectedly (but very welcome) a possibility occurred to import several captive *H. areolatus* from South Africa. This possibility is currently being further explored by one of the studbook participants.

Part 1:

Studbook *Homopus s. signatus*

3. CURRENT LIVING STUDBOOK POPULATION AND TRANSFERS

The number of locations where live *Homopus s. signatus* specimens were housed in 2000 remained stable at 4. These locations are in the Netherlands (1), Germany (1), USA (1), and Sweden (1). One location (Sweden) was added in 2000, but one of the (previously) 2 locations in Germany was removed. Unfortunately, the keeper at this location no longer has the possibility to work on captive tortoises, due to private circumstances.

The location codes were changed in 2000, because new studbook software had to be implemented after the change of the millennium:

Old location code	New location code
LOCATION 1	A12
LOCATION 2	A02
LOCATION 3	A06
LOCATION 4	A07
LOCATION 5	A03
LOCATION 6	A13

The total number of live specimens in the studbook population grew from 18 to 24: All specimens were born in the studbook population, at two locations. With the exception of one specimen (0017), all founder specimens originate from a single population in South Africa.

Specimens 0011 and 0014 (both males) were transferred from location A07 to new location A16. Prior to this, specimen number 0011, as well as 0007 (female), had been transferred from location A06 to A07. Reasons for these transfers were that location A06 was forced to stop keeping tortoises, and location A07 did not have sufficient room for housing as many as four males separately. Moreover, the new location may act as a new breeding location, when (genetically unrelated) females will become available. All transfers were in accordance with national and international legislation.

Table I: Current living studbook population *Homopus s. signatus* per location as registered in the studbook. M is male, F is female, U is unknown, D is donation, L is loan and B is birth. Cage numbers are relative numbers per location, indicating which specimens are housed together.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	CAGE	HOUSE NAME	FCOEF	SUB-SPECIES
LOCATION A02 (3.5.4)									
0001	M	WILD	WILD	30/09/95	A02 (D)	1	950930-I	0.000	<i>signatus</i>
0002	F	WILD	WILD	30/09/95	A02 (D)	1	950930-II	0.000	<i>signatus</i>
0003	F	WILD	WILD	30/09/95	A02 (D)	1	950930-III	0.000	<i>signatus</i>
0005	F	WILD	0003	27/02/96	A02 (B)	2	960227-III-1	0.000	<i>signatus</i>
0006	M	0001	0003	08/11/96	A02 (B)	3	961108-III-2	0.000	<i>signatus</i>
0009	F	0001	0002	30/11/96	A02 (B)	4	971130-II-1	0.000	<i>signatus</i>
0010	M	0001	0002	22/10/97	A02 (B)	5	971022-II-3	0.000	<i>signatus</i>
0015	F	0001	0002	20/09/99	A02 (B)	6	990920-II-6	0.000	<i>signatus</i>
0022	U	0001	0002	19/06/00	A02 (B)	7	000619-II-7	0.000	<i>signatus</i>
0023	U	0001	0002	19/07/00	A02 (B)	7	000719-II-8	0.000	<i>signatus</i>
0025	U	0001	0003	12/09/00	A02 (B)	8	000912-III-8	0.000	<i>signatus</i>
0026	U	0001	0002	07/10/00	A02 (B)	8	001007-II-9	0.000	<i>signatus</i>
LOCATION A07 (2.1.0)									
0007	F	0001	0003	24/12/96	A02 (B)	-	961224-III-3	0.000	<i>signatus</i>
				22/11/98	A06 (L)	-	-		
				05/07/00	A07 (L)	1	-		
0012	M	0001	0002	21/11/97	A02 (B)	-	971121-II-4	0.000	<i>signatus</i>
				22/11/98	A07 (L)	1+2	-		
0013	M	0001	0002	26/09/98	A02 (B)	-	980926-II-5	0.000	<i>signatus</i>
				22/11/98	A07 (L)	1+2	-		

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	CAGE	HOUSE NAME	FCOEF	SUB-SPECIES
LOCATION A12 (3.2.2)									
0017	M	WILD	WILD	? 08/09/99	UNKNOWN A12 (D)	- 1	- -	0.000	unknown ¹
0018	M	WILD	WILD	16/09/99 (?)	A12 (D)	2	Viejo	0.000	<i>signatus</i>
0019	M	WILD	WILD	16/09/99 (?)	A12 (D)	2	Stumpy	0.000	<i>signatus</i>
0020	F	WILD	WILD	16/09/99 (?)	A12 (D)	2	Midge	0.000	<i>signatus</i>
0021	F	WILD	WILD	16/09/99 (?)	A12 (D)	2	Bertha	0.000	<i>signatus</i>
0027	U	0018	0020	15/10/00	A12 (B)	3	Sashi	0.000	<i>signatus</i>
0028	U	0018	0020	15/11/00	A12 (B)	3	Peanut	0.000	<i>signatus</i>
		0019	0021						
		0019	0021						
LOCATION A16 (2.0.0)									
0011	M	0001	0003	10/11/97 22/11/98 05/07/00 16/09/00	A02 (B) A06 (L) A07 (L) A16 (L)	- - - 1	971110-III-4 - - -	0.000	<i>signatus</i>
0014	M	0001	0003	22/10/98 22/11/98 16/09/00	A02 (B) A07 (L) A16 (L)	- - 2	981022-III-5 - -	0.000	<i>signatus</i>

Total population: (10.8.6)

All specimens together make the total living studbook population 10 males, 8 females and 6 unknown, housed at 4 locations. One single female (0007) and 6 single males fit for breeding purposes are present, at locations A02 (0006 and 0010), A07 (0012 and 0013, and 0007), and A16 (0011 and 0014). These all originate from the same 1.2 founder population and thus are genetically related (same sire). Female 0007 and alternating males 0012 and 0013 (both offspring from the same founders) are nevertheless housed together at location A07. This is by no means an ideal situation, since F2 offspring would be inbred. Furthermore, matings at this moment, could make the female unsuitable for production of offspring without inbreeding when an unrelated male would become available, due to the possibility of sperm storage. This type of keeping of specimens 0007, 0012 and 0013 should be seriously reconsidered (see also chapter 5). All other related captive-bred couples are housed separately (location A02).

An additional single male (0017) fit for breeding is available at location A12. This male is originating from an unknown wild location, and therefore will only be paired with females that are from unknown original location, or with surplus females (see also chapter 5).

Table II: Current living studbook population *Homopus s. signatus* as registered in the studbook.

LOCATION	MALES	FEMALES	UNKNOWN
A02	3	5	4
A07	2	1	0
A12	3	2	2
A16	2	0	0
TOTAL	10	8	6

Wild-caught specimens 0018, 0019, 0020 and 0021 are housed as a 2.2 group at location A12. This has the consequence that all offspring must be considered related to both males. Since oviposition has not been noticed prior to hatching of the current two hatchlings at this location, the hatchlings furthermore should be considered related to both females. Housing of wild-caught specimens as a group does not fully exploit the genetic variability of the founder stock (one blood line is produced

¹ Originating from unknown wild location

where two could have been realised), and therefore should not be considered an optimal breeding technique. Especially since it is likely that group housing is not necessary for successful breeding in this species.

4. IMPORTS, BIRTHS AND DEATHS

In 2000 no imports of *H. s. signatus* have taken place within the studbook.

The studbook population *H. s. signatus* produced eggs at two locations in 2000. At location A02, female 0003 produced two eggs and female 0002 produced four eggs, a new highest egg number produced by these two females in one season. All eggs appeared normal when produced, indicating that the not fully calcified eggs produced in 1999 indeed were a result of stress due to renovation of the enclosure, as suggested in the 1999 annual report. The third egg of female 0002 did not start to develop, but the fourth egg hatched successfully. So far third and fourth clutches in *H. s. signatus* never hatched, suggesting that the species would not be capable of producing such large numbers of viable eggs per season. The results of this year prove otherwise.

In the first egg of female 0003 in 2000, a fully developed dead embryo was found, as was the case in one of the eggs of this female in 1999. Potentially tiny cracks in the egg shell may have been produced by initially excessive substrate humidity. Using the same vermiculite:water ratio, most eggs have developed and hatched successfully in the past. Additionally, the method has yielded a 100% hatching rate in *Malacochersus tornieri* eggs during the last five years (n=20). This species also produces hard-shelled eggs. All eggs were incubated in the same incubator. The initial substrate humidity will be decreased in the next breeding season (2001) for *H. s. signatus* from 1:3 weight based ratio vermiculite:water, to 1:2. This year's embryo has been donated with the egg shell to Declan Nolan at Nijmegen University, for examination of the egg shell.

In one of the hatchlings, a piece of eggshell was stuck at the location where normally the right hind limb would have been. Removing of this piece of shell was only possible after making it very wet and breaking it, and it revealed an extremely stiff and withdrawn limb. Initially it even seemed as if the shell was deformed in such a way, that the carapace and plastron had grown to one piece at this specific location. When the eggshell had been removed, the limb remained stiff and withdrawn. Since the shell of the tortoise seemed to have stretched quite a lot already, it was estimated that the tortoise had hatched (much?) earlier than it reached the top of the vermiculite. The tortoise was placed in warm water for 30 minutes, to stimulate blood circulation. After that, the limb seemed a little less stiff, but was still withdrawn. Fifteen minutes later, it was soaked again, for 15 minutes. Only then, the limb started to appear gradually. Soaking in warm water was continued from time to time, for 2 days. At this moment, the tortoise is using the limb normally, and it is no longer visible that there has been a problem. The initial soaking may have been very important to realise this recovery.

For the first time since the foundation of the Studbook Breeding Programme *Homopus*, breeding results have been achieved at a second location, location A12. Two eggs were found between a rock ledge and plant within the vicinity of the heat lamp practically on top of one another, on 6 August 2000. It is of interest to note that the photoperiod and temperature have not been manipulated to simulate an annual cycle, prior to egg production (this will be done after one first year of acclimation). Unfortunately it remains unknown whether the eggs have been produced by the two females in the enclosure, or by one. The period of time between hatching of both eggs (31 days) suggests that the eggs at least were produced as separate clutches. Since there are two males in the enclosure, also the sire of each of the hatchlings remains unknown.

The first hatchling took a full day to emerge, and still had a good sized yolk sack. It weighed 8 g. After it emerged it was placed in a deli container with a thin coat of Vaseline (to keep the yolk sack from sticking to the container), and was covered with a damp paper towel and placed back in the incubator. After 2 days the yolk sack was almost completely absorbed, the plastron was nearly flattened out and it took its first drink. It was then placed in an aquarium. It did not eat a significant meal until 28 October. The second hatchling had no yolk sac at hatching and weighed 7 g. It drank water on 16 November and ate on 18 November.

Information about incubation methods and periods can be found on the internet site of the Studbook Breeding Programme *Homopus*. Additional husbandry information is present in the appendices.

A single egg (35 x 22.5 mm, 10 g) was furthermore found in the enclosure of female 0007 at location A06 on 24 June 2000. This female was housed together with male 0011, meaning that a hatching result would have provided an inbred specimen. The egg turned out not to develop. The female was born at location A02 on 24 December 1996, reaching an age of 3.5 years before production of this first egg.

Table III: Births of *Homopus s. signatus* in 2000. U is unknown.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	FCOEF	DATE OF DEATH dd/mm/yy
0022	U	0001	0002	19/06/00	A02 (B)	000619-II-7	0.000	
0023	U	0001	0002	19/07/00	A02 (B)	000719-II-8	0.000	
0024	U	0001	0003	02/08/00	A02 (B)	000802-III-7	0.000	02/08/00
0025	U	0001	0003	12/09/00	A02 (B)	000912-III-8	0.000	
0026	U	0001	0002	07/10/00	A02 (B)	001007-II-9	0.000	
0027	U	0018 0019	0020 0021	15/10/00	A12 (B)	Sashi	0.000	
0028	U	0018 0019	0020 0021	15/11/00	A12 (B)	Peanut	0.000	

Total number of births: (0.0.6)

Except for the embryo that was found dead in the egg, no specimens of *H. s. signatus* have died in 2000.

Table IV: Deaths of *Homopus s. signatus* in 2000. U is unknown and B is birth.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	DATE OF DEATH dd/mm/yy	AGE AT DEATH yy/mm	PRIMARY CAUSE
0024	U	0001	0003	02/08/00	A02 (B)	02/08/00	0 d	Fully developed embryo died in egg

Total number of deaths: (0.0.1)

5. TOTAL STUDBOOK POPULATION AND FUTURE PERSPECTIVES

The current total studbook population of the studbook *H. s. signatus* consists of 28 specimens. From these, 9 are wild-caught specimens (8 collected and imported by the Studbook Breeding Programme *Homopus*) and 19 are captive-bred. Twenty-four tortoises are currently alive, housed at 4 locations.

In 1999 2.2 additional wild-caught *H. s. signatus* have been imported from South Africa, in order to consolidate the genetic basis of the studbook population. These specimens have been imported into the USA, where they currently are being kept and bred at location A12. The exceptionally high survival rates in the captive population as a whole, and the continuing breeding results, causing rapid growth of the captive population, show that additional genetically unrelated specimens will be necessary more rapidly than expected. In order to prevent that ad hoc decisions regarding the future of the captive population remain necessary, a longer term strategy has been evolved in 2000.

The current founder population exists of 3.4 specimens, 1.2 housed at location A02 in Europe, and 2.2 housed at location A12 in the USA. An additional sub-adult female with a wild sire is available at location A02. The growth of this first captive-bred *H. s. signatus* has always been problematic, and it is doubtful whether it will ever be suitable for breeding.

Genetic variability of the founder population should be exploited as efficiently as possible. That means that the two adult couples at location A12 should be separated, providing two blood lines. Hatchlings bred in the next three years will be marked as 'possibly resulting from sperm storage', with the second male as sire. Hatchlings produced after these three years can be interbred, supposedly without increasing the inbreeding coefficient. At that time, techniques for determination of parent-offspring relationships by DNA-analysis may also be more readily available for tortoise studbooks, to evaluate the sperm storage hypothesis. Only when sire and dam are known, specimens bred in the first three years may be interbred (without inbreeding). Alternatively, they are available for interbreeding with European captive-bred specimens.

The 1.2 founder specimens in Europe do not offer a possibility to realise two blood lines. All current European hatchlings have the same sire. In order to delay relatively impractical exchanges of specimens with offspring from the founder specimens in the USA, it would be worthwhile setting up additional bloodlines in Europe first. By importing an additional 2.2 founder specimens into Europe, 3 blood lines could be formed, and F1 captive-bred hatchlings could be interbred without inbreeding in Europe too. It is important not to interbreed new founder stock with already available F1 captive-bred specimens, to maintain genetic diversity. After approximately 8-10 years from now, F2 captive-bred specimens could be exchanged between the European and USA populations. At that time exchanges would be more practical, since larger groups of specimens could be exchanged.

Only after an additional 4-6 years (about 15 years from now), additional unrelated specimens would be necessary to prevent inbreeding, unless disaster in the captive population or new visions would make this earlier or later.

Since tortoises are long-lived species, efforts should be made to have patience and not to inbreed current related F1 specimens. That means that female 0007 at location A07 should be separated from the related males at that location, until it will be possible to house it with a captive-bred male from another blood line (this should be possible within 4-5 years from now).

Moving forward it will be attempted to import and own new wild-caught specimens through the *Homopus* Research Foundation, rather than as private individuals. This will provide an extra insurance that potential conflicts regarding breeding strategies will be solved in the interest of the studbook population. In this construction, it is the studbook co-ordinator who is authorised to make final decisions. The studbook co-ordinator is supervised by the European overall studbook foundation, to reassure that decisions are based on sound studbook management. The foundation has recently installed a (scientific) genetics advisory board in order to determine the best strategies regarding future species genetics. Obviously, conflicts within the studbook will be avoided by acting as a team, sharing the same general view on studbooks and studbook management.

Apart from the population that originates from the founder specimens collected from one population in Namaqualand, a single adult male of unknown origin is present at location A12. In 2001 efforts will be made to find a female for this male. Contacts with Knoxville Zoological Gardens have shown that this zoo maintains a breeding pair of *H. signatus* of unknown subspecies or origin. In 2000 the zoo was contacted to determine whether or not it would be possible to transfer a female as a mate for the single male *H. signatus* of unknown origin within the studbook on this species. Unfortunately, the zoo

population consists of 1.1 adults and four sub-adult males, therefore no such transfer will be possible. Further attempts will be made to find a female throughout 2001. Breeding results with this obscure male would be the start of a sub-population that will remain isolated from the main population *H. s. signatus* in the studbook.

Table V: Total studbook population *Homopus s. signatus*. M is male, F is female, U is unknown, D is donation, L is loan, B is birth and P is purchase.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	FCOEF	DATE OF DEATH
0001	M	WILD	WILD	30/09/95	A02 (D)	950930-I	0.000	
0002	F	WILD	WILD	30/09/95	A02 (D)	950930-II	0.000	
0003	F	WILD	WILD	30/09/95	A02 (D)	950930-III	0.000	
0004	M	WILD	WILD	30/09/95	A02 (D)	950930-IV	0.000	24/12/95
				02/09/96	NNM (D)	RMNH27497		
0005	F	WILD	0003	27/02/96	A02 (B)	960227-III-1	0.000	
0006	M	0001	0003	08/11/96	A02 (B)	961108-III-2	0.000	
0007	F	0001	0003	24/12/96	A02 (B)	961224-III-3	0.000	
				22/11/98	A06 (L)	-		
				05/07/00	A07 (L)	-		
0008	U	0001	0002	26/01/97	A02 (B)	970126-II-2	0.000	02/02/97
				24/03/99	NNM (D)	RMNH28042		
0009	F	0001	0002	30/11/96	A02 (B)	971130-II-1	0.000	
0010	M	0001	0002	22/10/97	A02 (B)	971022-II-3	0.000	
0011	M	0001	0003	10/11/97	A02 (B)	971110-III-4	0.000	
				22/11/98	A06 (L)	-		
				05/07/00	A07 (L)	-		
				16/09/00	A16 (L)	-		
0012	M	0001	0002	21/11/97	A02 (B)	971121-II-4	0.000	
				22/11/98	A07 (L)	-		
0013	M	0001	0002	26/09/98	A02 (B)	980926-II-5	0.000	
				22/11/98	A07 (L)	-		
0014	M	0001	0003	22/10/98	A02 (B)	981022-III-5	0.000	
				22/11/98	A07 (L)	-		
				16/09/00	A16 (L)	-		
0015	F	0001	0002	20/09/99	A02 (B)	990920-II-6	0.000	
0016	U	0001	0003	04/10/99	A02 (B)	991004-III-6	0.000	04/10/99
				16/10/99	NU (D)	-		
0017	M	WILD	WILD	?	UNKOWN	-	0.000	
				08/09/99	A12 (D)	-		
0018	M	WILD	WILD	16/09/99 (?)	A12 (D)	Viejo	0.000	
0019	M	WILD	WILD	16/09/99 (?)	A12 (D)	Stumpy	0.000	
0020	F	WILD	0003	16/09/99 (?)	A12 (D)	Midge	0.000	
0021	F	WILD	WILD	16/09/99 (?)	A12 (D)	Bertha	0.000	
0022	U	0001	0002	19/06/00	A02 (B)	000619-II-7	0.000	
0023	U	0001	0002	19/07/00	A02 (B)	000719-II-8	0.000	
0024	U	0001	0003	02/08/00	A02 (B)	000802-III-7	0.000	02/08/00
				14/10/00	NU (D)	-		
0025	U	0001	0003	12/09/00	A02 (B)	000912-III-8	0.000	
0026	U	0001	0002	07/10/00	A02 (B)	001007-II-9	0.000	
0027	U	0018	0020	15/10/00	A12 (B)	Sashi	0.000	
		0019	0021					
0028	U	0018	0020	15/11/00	A12 (B)	Peanut	0.000	
		0019	0021					

Total studbook population: (11.8.9)

NNM = Natural History Museum, Leiden (Netherlands)
NU = Nijmegen University, Nijmegen (Netherlands)

Part 2:

Studbook *Homopus areolatus*

6. CURRENT LIVING STUDBOOK POPULATION AND TRANSFERS

Live *Homopus areolatus* in the studbook are located at 3 locations, an increase of one since last year: A02 (Netherlands), A12 (USA), and A16 (Sweden). Registration of specimens at a fourth location is currently in progress. Locations A13 and KRAAIFTN-ZOO have transferred several specimens, but do not have their collections registered in the studbook registration.

The total number of live specimens decreased from 11 to 10 in 2000. Two new specimens were registered by a new participant, and a third specimen is captive-bred from these two. Four adult specimens at location A12 died, and three hatchlings died just prior to hatching at the same location. Husbandry conditions and additional information is available in appendix 2.

Table I: Current living studbook population *Homopus areolatus* as registered in the studbook. F is female, M is male, U is unknown, B is birth and D is donation. Cage numbers are relative numbers per location, indicating what specimens are housed together.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	CAGE	FCOEF	SUB-SPECIES
LOCATION A02 (1.2.0)									
0004	F	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-IV	1	0.000	-
0005	M	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-V	2	0.000	-
0006	F	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-VI	1	0.000	-
LOCATION A12 (1.2.1)									
0010	M	WILD	WILD	? 16/09/99 (?)	A13 (D) A12 (D)	- Ernst (A3)	1	0.000	-
0011	F	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A5	1	0.000	-
0012	F	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A6	1	0.000	-
0014	U	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- Baby	3	0.000	-
LOCATION A16 (1.1.1)									
0016	M	WILD	WILD	30/08/94	A16 (P)	-	1	0.000	-
0017	F	WILD	WILD	30/08/94	A16 (P)	-	1	0.000	-
0018	U	0016	0017	23/05/00	A16 (B)	-	2	0.000	-

Total population: (3.5.2)

All specimens together make the total living studbook population 10 specimens. There are no solitary specimens fit for breeding available. Adult specimens are housed as a couple at location A16, and in a breeding group with one male at location A12. The remaining specimens (location A02) are too small for breeding.

Table II: Current living studbook population *Homopus areolatus* as registered in the studbook.

LOCATION	MALES	FEMALES	UNKNOWN
A02	1	2	0
A12	1	2	1
A16	1	1	1
TOTAL	3	5	2

7. IMPORTS, BIRTHS AND DEATHS

In 2000 no *H. areolatus* were imported.

A (long-term captive) breeding couple of *H. areolatus* was registered in the studbook population in 2000. The first successfully hatched specimen from this couple appeared on 23 May 2000, from a clutch of two eggs (the second egg did not show development).

At location A12, eggs were produced by females 0008 (2; 23 October 2000) and 0011 (3; 15 October 2000). The eggs from the first specimen did not develop, and the adult female died later. The eggs of specimens 0011 contained dehydrated dead, but fully grown embryos when opened. Hatchling number 0019 had tried to open the egg previously. The reason for the death of these specimens remains unknown, but the incubation substrate may have been too dry. This will be corrected in 2001.

Table III: Births of *Homopus areolatus* in 2000. U is unknown.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	FCOEF	DATE OF DEATH dd/mm/yy
0019	U	0013	0011	05/02/00	A12 (B)	-	0.000	05/02/00
0020	U	0013	0011	16/03/00	A12 (B)	-	0.000	16/03/00
0021	U	0013	0011	16/03/00	A12 (B)	-	0.000	16/03/00
0018	U	0016	0017	23/05/00	A16 (B)	-	0.000	

Total number of births: (0.0.4)

Four of the *H. areolatus* imported from captive locations in South Africa in the end of 1999 died in 2000. Red rings with hard centres, which later proved to be abscesses, were generally the first symptom later followed by decrease in appetite and eventual death despite force feeding efforts. One developed upper respiratory, possibly from stress and a weakened immune system. The cause of the initial skin problems, encountered in all but one *H. areolatus* specimens at location A12, is not clear. Possibly it was caused by hypersensitivity to vitamin A and/or clogged pores from sand/dirt substrate.

The misting regimen has been changed to every other day and animals are now kept on gravel substrate with only one area of soil for depositing eggs (similar to location A02). Only calcium and vitamin D₃ is supplemented. All symptoms seem to be 'under control' at this point. The very young hatchling of the group (now at least one year old) has been maintained on long leaf sphagnum without any vitamin supplements (other than the D₃ in the calcium) since it was imported. It has never exhibited any of the symptoms of the adults.

Apart from the deaths of the four adult tortoises, three hatchlings were found dead in the egg shells.

Table IV: Deaths of *Homopus areolatus* in 2000. U is unknown, F is female, M is male, B is birth and D is donation.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	DATE OF DEATH dd/mm/yy	AGE AT DEATH yy/mm	PRIMARY CAUSE
0008	F	WILD	WILD	? 16/09/00	KRAAIFTN-Z (D) A12 (D)	19/03/00 (?)	?	Abscesses, weakened immune system
0009	F	WILD	WILD	? 16/09/00	A13 (D) A12 (D)	30/04/00 (?)	?	Abscesses, weakened immune system
0013	M	WILD	WILD	? 16/09/00	KRAAIFTN-Z (D) A12 (D)	15/02/00 (?)	?	Abscesses, weakened immune system

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	DATE OF DEATH dd/mm/yy	AGE AT DEATH yy/mm	PRIMARY CAUSE
0015	F	WILD	WILD	? 16/09/00	A13 (D) A12 (D)	15/02/00 (?)	?	Abscesses, weakened immune system
0019	U	0013	0011	05/02/00	A12 (B)	05/02/00	0	Presumably suboptimal incubation method
0020	U	0013	0011	16/03/00	A12 (B)	16/03/00	0	Presumably suboptimal incubation method
0021	U	0013	0011	16/03/00	A12 (B)	16/03/00	0	Presumably suboptimal incubation method

Total number of deaths: (1.3.3)

8. TOTAL STUDBOOK POPULATION AND FUTURE PERSPECTIVES

The current studbook population of the studbook *H. areolatus* consists of 21 specimens. From these, 13 are wild-caught (7 handed to Tygerberg Zoopark by visitors, 1 had been in captivity in the Netherlands for about 15 years, and 5 originate from unknown locations) and 8 are captive-bred. Ten tortoises are alive, housed at 3 locations.

It is obvious that the studbook population *H. areolatus* is not safe. Mortality is high, and reproduction is low. From the specimens imported from South Africa in 1999, it once more has become clear that this can be very problematic. In fact, it seems to be more problematic than adjusting wild-caught *H. s. signatus* to captive conditions (see previous chapter), although the latter species is usually being referred to as more fragile! Adjusting (South African) captive-bred juvenile specimens *H. areolatus* seems to be far less problematic (locations A02 and A12), and therefore should be preferred.

The cause of the high mortality among newly imported adult *H. areolatus* so far has been examined exclusively in terms of sub-optimal husbandry practises at the receiving locations. However, all these specimens have unknown husbandry histories: They have been picked up in the wild by South Africans, and after a while, that may be a long time, they have been donated to a zoo. Later (sometimes much later), they have been transferred to the studbook locations. It is likely that the husbandry conditions between collecting in the wild, and placing them in the studbook, often will be far from optimal. For instance, Tygerberg Zoopark houses relatively large numbers of *H. areolatus* in enclosures, together with other species of tortoises. And it is questionable if the people that initially picked up the tortoises in the wild are aware of the specific requirements of tortoises. Therefore, it seems inevitable that eventual mortality rate will be high, if *H. areolatus* with histories as described are to be imported. It is likely that mortality would have been equally high, had they not been transferred to the studbook population.

At this moment, there are two initiatives to enlarge the captive population *H. areolatus* with additional locations. Location A03, that used to keep *H. areolatus*, is working on acquisition of a new breeding from South Africa. These specimens would originate from captive populations, and the Studbook Breeding Programme *Homopus* is supporting the initiative. Secondly, registration of long-term captive specimens from Germany is in progress. These specimens have bred previously at another location.

Table V: Total studbook population *Homopus areolatus*. M is male, F is female, U is unknown, D is donation, B is birth, L is loan and P is purchase.

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	FCOEF	DATE OF DEATH
0001	F	WILD	WILD	? 14/12/97	KRAAIFTN-ZOO (D) LOCATION 5 (D)	- HZ0525	0.000	09/11/98
0002	F	WILD	WILD	? 14/12/97	KRAAIFTN-ZOO (D) LOCATION 5 (D)	-	0.000	13/08/99
0003	U	UNKN	UNKN	? 21/11/97 15/12/99	KRAAIFTN-ZOO (B) A02 (D) UU (D)	- 971121-III -	0.000	29/10/99
0004	F	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-IV	0.000	
0005	M	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-V	0.000	
0006	F	UNKN	UNKN	? 21/11/97	KRAAIFTN-ZOO (B) A02 (D)	- 971121-VI	0.000	
0007	M	WILD	WILD	? ?	ROTTERD-ZOO (?) LOCATION 5 (L)	- HZ0457	0.000	05/07/98
0008	F	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A1	0.000	19/03/00 (?)
0009	F	WILD	WILD	? 16/09/99 (?)	A13 (D) A12 (D)	- Blacky (A2)	0.000	30/04/00 (?)
0010	M	WILD	WILD	? 16/09/99 (?)	A13 (D) A12 (D)	- Ernst (A3)	0.000	

STUD ID	SEX	SIRE ID	DAM ID	DATE OF ARRIVAL dd/mm/yy	LOCATION	HOUSE NAME	FCOEF	DATE OF DEATH
0011	F	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A5	0.000	
0012	F	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A6	0.000	
0013	M	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- A7	0.000	15/02/00 (?)
0014	U	WILD	WILD	? 16/09/99 (?)	KRAAIFTN-ZOO (D) A12 (D)	- Baby	0.000	
0015	F	WILD	WILD	? 16/09/99 (?)	A13 (D) A12 (D)	- A4	0.000	15/02/00 (?)
0016	M	WILD	WILD	30/08/94	A16 (P)	-	0.000	
0017	F	WILD	WILD	30/08/94	A16 (P)	-	0.000	
0018	U	0016	0017	23/05/00	A16 (B)	-	0.000	
0019	U	0013	0011	05/02/00	A12 (B)	-	0.000	05/02/00
0020	U	0013	0011	16/03/00	A12 (B)	-	0.000	16/03/00
0021	U	0013	0011	16/03/00	A12 (B)	-	0.000	16/03/00

Total studbook population: (5.11.5)

UU = Utrecht University, Utrecht (Netherlands)

9. LITERATURE ABOUT *HOMOPUS*

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Appendix 1

Husbandry conditions and additional information per location *Homopus s. signatus*

The information below is the same as presented in the previous annual report, with additional information/replacements in case there were changes in the current year.

Location A02

Husbandry conditions have been described in detail and have been published in several articles by Loehr (see chapter 9). It is attempted to change the conditions as little as possible. Currently, climatic conditions in the adult enclosure are maintained as shown in the following table.

Temperatures and humidity of hatchling enclosures are maintained at a higher level for the first year. Photoperiod is the same as in the enclosure of the adult tortoises. Adults are fed four times weekly, hatchlings six times weekly, until they reach an age of one year. A water bowl is available in all enclosures at all times.

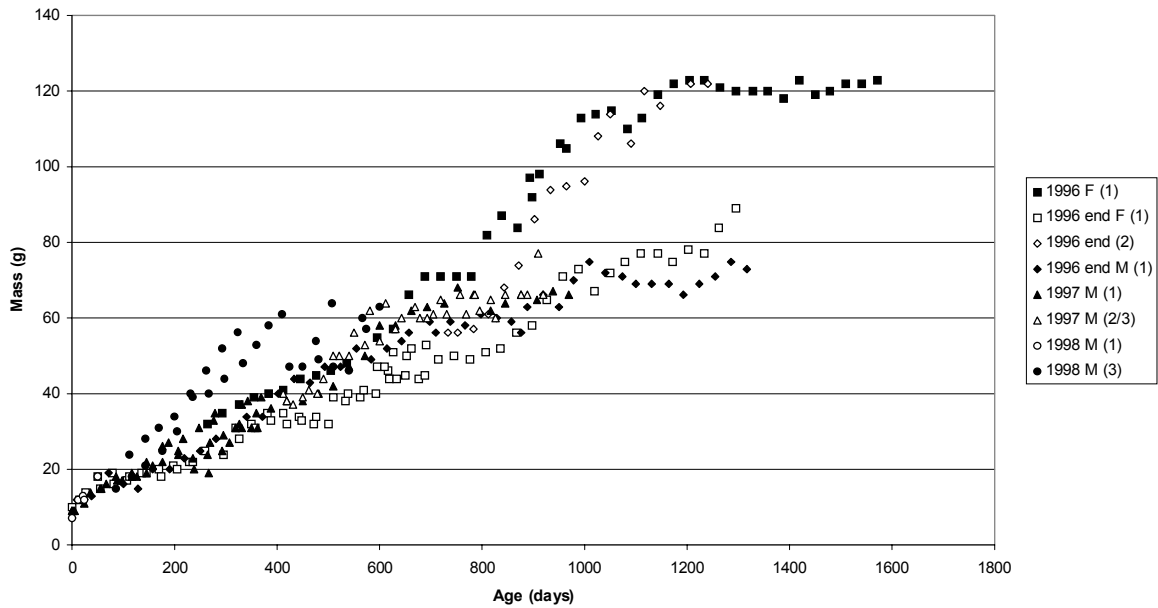
Apparently the adult tortoises have gradually adapted to the much more favourable climatic conditions in captivity. They are more active throughout the year, if compared to the period just after importing.

In order to monitor temperature more detailed in the enclosure of the adult *H. s. signatus*, an electronic device has been constructed to monitor and log temperature by means of a personal computer. A manuscript describing this method has been submitted for publication in *Turtle and Tortoise Newsletter* in 2000.

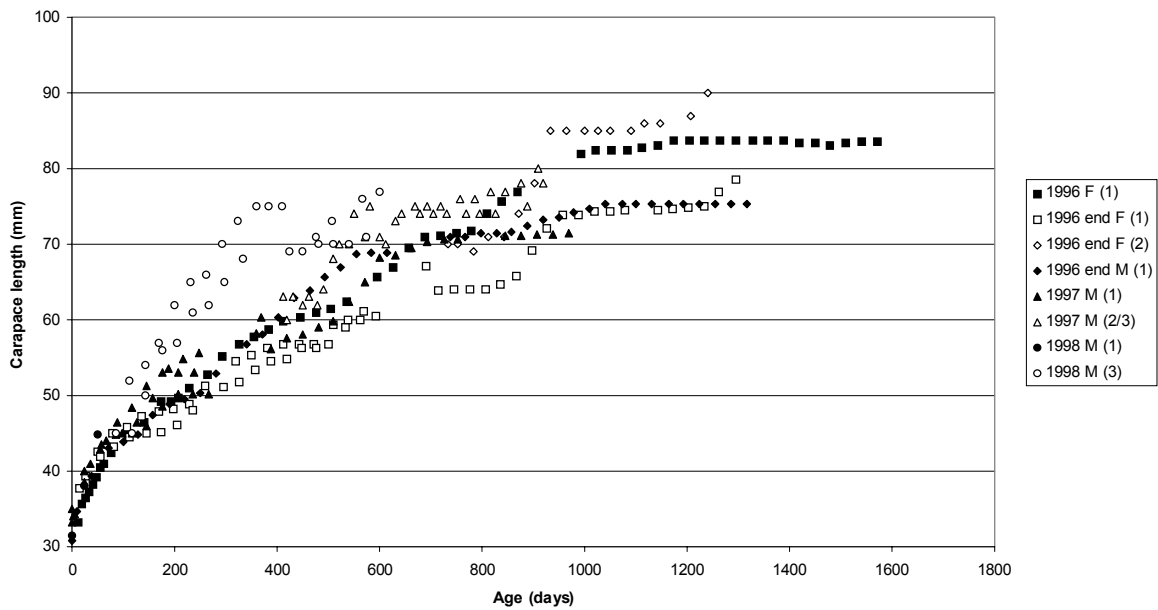
Growth results are shown below the table on the next page.

Week	Photoperiod (+/- 15 minutes, max/min=14/10 hrs)	Temperature (°C) in hiding place	Sprayings (day of week)
41	switch on later	28	thu
42	switch off earlier	28	thu
43	switch on later	28	thu
44	switch off earlier	28	thu
45	switch on later	26	thu
46	switch off earlier	26	thu
47	switch on later	26	thu
48	switch off earlier	26	thu
49	switch on later	24	thu
50	switch off earlier	24	thu
51	switch on later	24	thu
52	switch off earlier	24	thu
1	switch on later	22	thu, sun
2	switch off earlier	22	thu, sun
3	switch on later	22	thu, sun
4	switch off earlier	22	thu, sun
	constant	20	thu, sun
9	switch off later	22	thu, sun
10	switch on earlier	22	thu, sun
11	switch off later	22	thu, sun
12	switch on earlier	22	thu, sun
13	switch off later	24	tue, thu, sun
14	switch on earlier	24	tue, thu, sun
15	switch off later	24	tue, thu, sun
16	switch on earlier	24	tue, thu, sun
17	switch off later	26	thu, sun
18	switch on earlier	26	thu, sun
19	switch off later	26	thu, sun
20	switch on earlier	26	thu, sun
21	switch off later	28	thu
22	switch on earlier	28	thu
23	switch off later	28	thu
24	switch on earlier	28	thu
	constant	30	-

Growth of four cohorts *Homopus s. signatus*, at locations 1 (A02), 2 (A06) and 3 (A07)
M is male, F is female



Growth of four cohorts *Homopus s. signatus*, at locations 1 (A02), 2 (A06) and 3 (A07)
M is male, F is female



Location A06 (until July 2000)

Terrarium studbook numbers 0007, 0011 and 0013

Size: 120 x 70 cm

Decoration: Back constructed from artificial rocks, and additional rocks with several hiding places

Soil: Sand with calcium gravel, approximately 3-6 cm deep; rock plate as feeding site and water bowl

Illumination: 1x 36 W tube light + 2 x 23 W energy-saving lamps + 1 x 40 W spot light
In the afternoon sun via window in room with enclosure

Photoperiod: Summer (July-September): 13,5 hrs; winter (October-June): 9 hrs (gradual increase/decrease)

Heating: The total soil surface is heated up to a day temperature of approximately 29-37°C by the illumination of the enclosure under the one with *H. s. signatus*
 Temperature: Summer: 20-24°C (night) and 34°C (day); winter: 16-18°C (night) and 29°C (day); locally up to 45°C
 Rel. humidity: Night: 75-85%; day: 55%

Feeding

The tortoises are fed daily on fresh green leaves collected outside (*Taraxacum*, *Trifolium*, grasses, et cetera), endive, romaine lettuce, cut fruits (apple, pear, melon, berries) and legumes (cucumber, zucchini, paprika). A small amount (0.5-1 g) of a calcium/vitamin supplement (Vitakalk, Vitakraft) is always added.

Water

The tortoises receive (plain) water, three times weekly in a water bowl. During the dry (summer) season, the tortoises receive water once weekly, and feeding is decreased.

Behaviour

The specimens were kept at lower photoperiod (minimum 9 hours in December) and higher humidity between October 1999 and March 2000. Food and water were available daily.

Specimen 0007 fed daily and produced faeces every other day. Also during the period of aestivation, the specimen appeared infrequently and fed. In spring activity increased. On 24 June 2000 an egg (35 x 22 mm, 9 g) was produced. It was produced at a site under a root, reaching a soil temperature of 32-37°C. The soil consisted of 6 cm sand, kept slightly humid.

The egg showed a red blotch on the underside, that gradually grew. Probably the membrane was defect at this site, admitting water between the egg shell and membrane. After 3-4 weeks of incubation in humid 'Bimsgranulate' at 32°C no development could be detected. The content of the egg remained homogeneously yellow and gas bubbles started to appear.

Specimen 0011 showed increased activity after releasing second male number 0013 in the same enclosure. It also started to mate with female 0007, as did male 0013. Both males interacted by head bobbing, at encounters. However, aggressive behaviour was observed only occasionally.

Before summer climatic conditions were offered, all specimens were transferred to location A07.

Date	0007		0011		0013	
	Mass (g)	SCL (mm)	Mass (g)	SCL (mm)	Mass (g)	SCL (mm)
15/01/00	120	86	62	74	54	71
15/02/00	116	86	60	74	64	73
15/03/00						
15/04/00	122	87	66	75	60	76
15/05/00	125	90				
15/06/00	130	90			66	78

Location A07

Enclosure

The enclosure of female specimen 0007 and alternating males number 0012 and 0013 measures 120 x 60 cm, and has a soil consisting of sand. Further decoration consists of a pile of stones. The enclosure is illuminated by means of 1 36 W tube light, and 2 50 W halogen spots. These keep the temperature at 30°C, and under the spots >45°C. Using an Astrotimer, photoperiod in autumn is automatically reduced to 9 hours, and in summer it gradually increases to 13 hours.

When one of the males is not housed in the enclosure described above, it is housed in a separate enclosure measuring 60 x 27 cm, with a soil layer consisting of sand. In this enclosure there is also a pile of stones available. The enclosure is illuminated and heated using a 50 W halogen spot, providing the same temperatures as in the first enclosure. Photoperiod is also controlled in the same way. Males are exchanged every week.

Feeding

The tortoises are fed daily on fresh green leaves collected outside (*Taraxacum*, *Trifolium*, grasses, et cetera), endive, romaine lettuce, cut fruits (apple, pear, melon, berries) and legumes (cucumber, zucchini, paprika). A calcium/vitamin supplement (Vitakalk, Vitakraft) is always added.

Water

Plain water is provided once weekly in a water bowl. In summer a dry season is simulated, with water being provided only once every 2 weeks. During this period they are also fed less frequently, with food items containing less water.

Climate

May-June: Introduction to dry season, with reduction of food and water

July-October: High temperatures and dry conditions

November-May: Gradually decreasing (till approximately 30°C) temperatures. Spraying of the enclosure. Water and food available.

Date	0012 Mass (g)	SCL (mm)	0013 Mass (g)	SCL (mm)	0014 Mass (g)	SCL (mm)	0007 Mass (g)	SCL (mm)
15/01/00	66	76	62	75	48	69		
15/02/00	65	77	63	75	49	70		
15/03/00	66	77	65	75	47	70		
15/04/00	66	78	67	75	46	70		
15/05/00	77	80	67	75	57	71		
15/06/00	78	82	66	75	55	72		
15/07/00	79	82	66	75	55	72		
15/08/00	80	78	66	75	56	74		
15/09/00	82	82	68	76	57	76		
18/10/00	70	82	68	78			133	90.1

Location A12

The tortoises are being kept in a wooden enclosure 183 x 61 x 61 cm. Overhead lighting is provided via 2 122 cm Vitalite Power twists. At this point the lights are left on for 12 hours per day. This will be changed annually to provide a seasonal light cycle, after a first year of acclimation. I am using a coarse sand substrate similar in texture to that found in their natural environment, but different in color (brown/grey not reddish). Five shelters/hides are located throughout the habitat. They are constructed by stacking flat rocks. All are used at one point or another, often communally.

Heat is provided via basking lights only. There is a primary 25 W red basking light that goes on 1 hour prior to overhead lighting, and goes off one hour prior to the end of the photoperiod. A second basking light in the tank kicks on for 3 hours per day at mid day (this will also be changed to provide seasonal variation). The temperature at this end of the tank during those hours reaches above 37°C. This is being done to simulate mid day high temperatures experienced in their natural environment. The tortoises have been observed basking at this time. Using this method, the tortoises are provided with a night time gradient of 24-25°C degrees at night, and 31-39°C during the day.

Water is left in the tank at all times and is changed (at least) daily. They have been observed drinking from it. My animals are fed every other day. Their diet consists of fresh and dried greens (dandelion, kale, romaine, et cetera with chopped timothy hay for the dry portion) and some type of vegetable. All meals are supplemented with Miner-all brand calcium. This calcium has no vitamins in it, so Nekton Rep Color vitamins are provided once a week (sprinkled over food stuffs). They show a fondness for green beans, seedless cucumber, grated carrot, yellow and green squash, bean sprouts and the occasional piece of fruit (strawberry or grated apple) I have also fed them rose, dandelion and Rose of Sharon blossoms on occasion.

I have a long term captive male *H. signatus* that I am housing individually in a glass aquarium under the same conditions. I am hoping to find a female of unknown origin over the next year that this individual could be paired to.

I have de-parasitized all specimens at this point. All are doing well.

As described in chapter 7, two eggs were found on 6 August 2000. Both showed signs of fertility (well formed veins) when found. They were incubated 1:3 water to vermiculite and placed in two different incubators in case either incubator failed. At one point our power was disconnected for about 8 hours

by the local power authority for repairs. Luckily I had purchased a generator for just such occasions, so the incubators never lost power.

The first hatchling was placed in an aquarium after the yolk sac had disappeared upon hatching (see also chapter 7). It did not eat a significant meal until 28 October. The second hatchling was placed with the first one in a 76 l (20 gallon long) aquarium with paper towel substrate, overhead florescent lighting and a 60 W incandescent heat lamp in one corner. The first week a damp rolled up paper towel was kept in with them to provide a high humidity retreat. Fresh water is provided at all times. Each hatchling is physically placed in the water dish at least twice a week to assure proper hydration, but they seem to have no problems finding or drinking from standing water.

Their daily diet consists primarily of dandelion greens supplemented with calcium and vitamin D₃. Either grated carrot, tomato, grated apple, broccoli, sliced green beans or chopped peaches are offered twice a week. The first hatchling is up to 15 g, the other one 9 g.

Appendix 2

Husbandry conditions and additional information per location *Homopus areolatus*

Location A02

One subadult male and two subadult females are housed indoors in a 150 x 60 x 40 cm (l x w x h) glass enclosure, integrated in a scaffolding of enclosures. Front pane is transparent glass, all other sides are painted with sky blue paint. The enclosure is split in two approximately equal parts, separating male and females. The enclosure is illuminated using a 36 W tube light (no UV emission). Heating occurs by means of two 40 W spot lights and heating mats under the enclosure, all switched via dimmers. Climatic conditions are as described for *H. s. signatus* at location A02 (appendix 1), but winter temperatures are maintained at a higher level and humidity is slightly higher due to longer sprayings throughout the year, and a deeper soil layer, that is relatively humid at the bottom at specific sites. It is planned to provide lower winter temperatures as soon as all tortoises have reached sexual maturity.

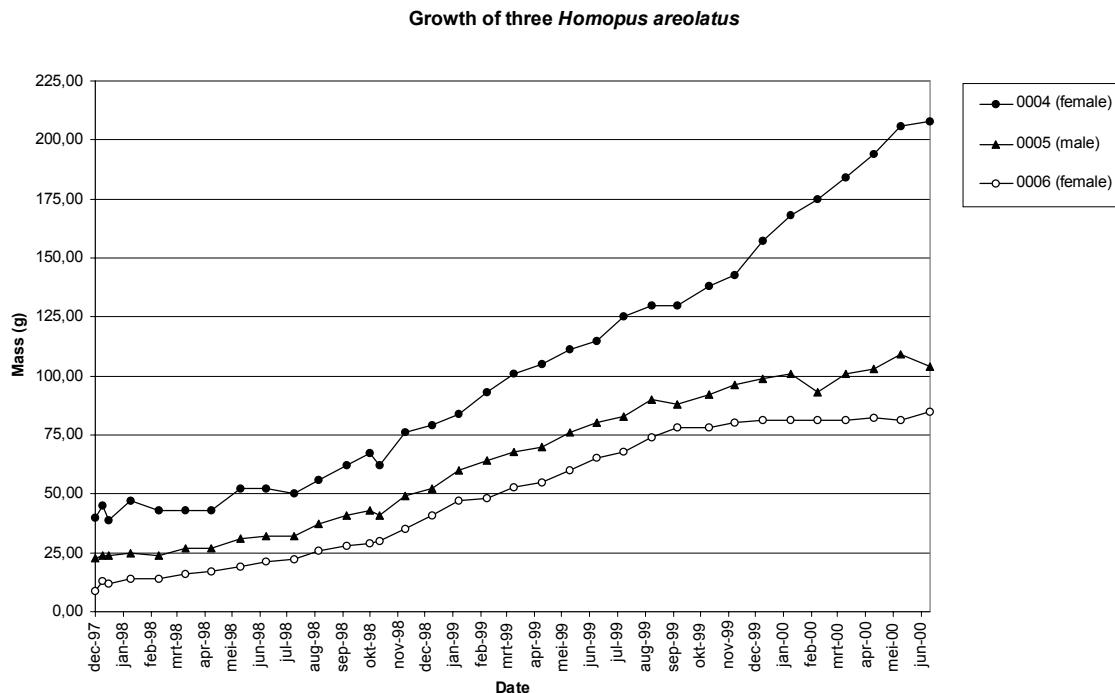
Soil consists of a 4 cm layer of fine gravel (ϕ 5 mm) and sand. The enclosure is furthermore decorated with wood, dried and artificial plants and some stones, providing hiding places.

Tortoises are fed four times weekly, on green leaves (collected outside in summer, in winter endive and chicory). Twice per week cucumber and carrot is added, once per week also tomato or orange and apple is provided. In all cases a calcium/vitamin (Gistocal) supplement is added. A water bowl is available permanently, with water supplemented with 23 μ g vitamin D₃ per litre.

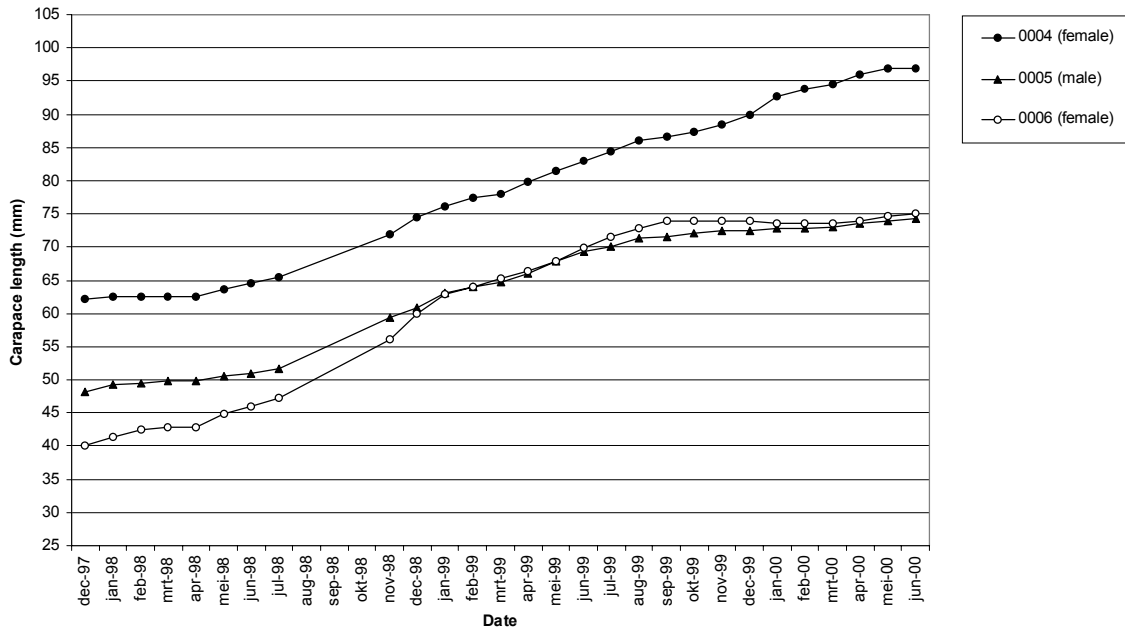
The tortoises typically spend mornings basking under the spot lights, after which they become very active and start searching for food. They are fed in the morning, before the lights switch on. After feeding they tend to retreat. Both at that time, and during the night, they sometimes dig into the soil for a few centimetres, under a log or artificial plant.

When the male was still housed together with the two females, occasional mating activity has been observed. Since the females are considered too small for sexual activity, the male has been separated.

Growth results are shown below.



Growth of three *Homopus areolatus*



Location A12

The adult group at this location is housed in an 152 x 61 x 30 cm (l x w x h) enclosure. Temperature is maintained at 38.3°C during the day, and 23.9°C during the night. Relative humidity fluctuates between 19-37%.

A single juvenile specimens is kept separately, in an enclosure measuring 76 x 30 x 30 cm (l x w x h), at the same temperatures and relative humidity.

Some additional information regarding husbandry practises at location A12 is presented in chapter 7.