Nr. 14, January to March 2008

FSM-TIMES

FourStripedMouse

Title: Proximate and Ultimate Aspects of Social Flexibility in the Striped Mouse

Reports by students
Mouse portrait: Male 1695
Gecko portrait: Giant Ground Gecko

Grant from the Swiss National Science Foundation

IMPRESSUM

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PUBLICATION DATES
The FSM-TIMES is published quarterly, in January, April, July and October. The FSM-TIMES is sent as email-attachment in pdf.

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To subscribe to the FSM-TIMES, write an email to: info@stripedmouse.com. In the subject field write "FSM-TIMES subscription". No more text is needed. You will then get the FSM-TIMES four times a year as an email attachment. Subscription to the FSM-TIMES is free of charge. However, we would welcome donations of R 80 (10 Euro, 15 US Dollar) a year to contribute to our research projects at the Succulent Karoo Research Station in South Africa. Larger donations are welcome too. To unsubscribe, write an email to info@stripedmouse.com, and write in the subject field "CANCEL FSM-TIMES".

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WELCOME TO THE FIFTEENTH ISSUE OF THE FSM-TIMES!

Dear Reader,

When I came back to Goegap at the end of March, it was the first time in 8 years that I was not really happy to be back in Goegap. The last three months have been characterized by an absence of scientific progress in Goegap. Instead, many problems arose and little had been achieved.
The main problem was the weather. There was a lot of unexpected rain in December and in February, and the dry season was not so dry. The same had happened in 2005, when the mice had a second breeding season during summer (February – April) when normally they do not breed. As many of our planned studies were studies regarding the dry non-breeding season, these studies were put on hold. At the same time when Maarten told me this, Ivana emailed me that the mice on the farm only 3kms away were getting too light to put transmitters on. So at the one field site the studies were put on hold because there was too much food, but only 3kms away they were put on hold because there was too little food. As a result, nothing happened, but at least all students took the opportunity to go for 2 weeks on nice holidays.

On the positive side, we managed to solve one major problem: Two Swiss Foundations provided money for a new car, and so I could buy the research station a nice bakki, a Mahindra Bolero 2x4. I hope the students will take good care of the new car (as both Ford and Land Rover were rather a pity sight when I arrived). The new car will be at the research station in May and we will report about it in the next FSM-Times. When I was back in Goegap, I soon realized that the situation is not that bad and that both field sites are well managed. That we can use them for more exciting studies for at least another three years became clear as well, as a grant from the Swiss National Science Foundation came through. So Ivana will do her PhD in Goegap and conduct experiments on the farm, while Ed and I (who will be the new research station manager from May on) will continue the long term studies in Goegap. So you can enjoy the FSM-TIMES now and at least for the next three years.

Kind regards,

Carsten Schradin

THE DIFFERENT PLACES AND LOCATIONS

South Africa
As the name says, it is the most southern country in Africa. South Africa lies at the Cape of Good Hope. The population of South Africa (40 million) consists of black South Africans (e.g. the Zulu), which represent 75% of the population. 12% are white, 8% coloured, and some are Indian, Malaysian or descendents of the San (bushman). South Africa is the only industrialized country in Africa with a very good infrastructure.

Succulent Karoo
It describes a special vegetation type. It receives low rainfall in winter and is characterized by dwarf succulent shrubs and an amazing wildflower display in spring. It is a desert to semi-desert environment. Succulent Karoo is found in Namaqualand and southern Namibia. In the FSM-TIMES, the words succulent Karoo and Namaqualand are often used as synonyms.

Namaqualand
It is situated in the northwest of South Africa, between Cape Town and Namibia. Famous for its wildflower display in spring, Namaqualand was one of the world's most important copper mining areas at the beginning of the 20th century. Nowadays the diamond mines are more important. Because of its dry desert like climate, agriculture is mainly absent and population density low. Namaqualand is part of the Northern Cape Province.

Springbok
It is the capital of Namaqualand. Although Springbok has only around 20 000 inhabitants, it has shops for nearly everything, including two well stocked supermarkets. At weekends Springbok is very busy, when all Namaqualanders come here to do their shopping.

Goegap Nature Reserve
Pronounced as "Guchap", this nature reserve lays only 20kms outside of Springbok. In spring it is visited by thousands of tourists that are attracted by its wildflower display. During other times of the year it is very quite and mountain zebra, gemsbok, springbok, aardwolf, mice and mice researchers live in peace.

Field Site
This is the place in nature where the scientist collects his data. So our field site is where we observe the mice

NAMAQUALAND-WEATHER

By Ed Yuen

We had a rather different summer in Goegap this year. This was mainly due to the incredible amount of rain that we had at the beginning of March. For the third time since August 2007, the dry riverbed swelled up with water. This is truly amazing, if one considers the fact that the dry riverbed is only supposed to flow every 20 years. There was so much water this time around that we were literally able to swim in the river! The water however did not last very long and just as quickly as it had appeared, it disappeared: after two days, it had all but dried up. The only exception was a rather large pool left at the farm, which lasted for more than two weeks. The rain had been abundant, so much so that the first

shoots started to appear soon after the water had gone. Within few weeks, Goegap was covered by a carpet of yellow devil thorns (*Trubulus zeyheri*). And, that was not all, as Jopie, the owner of the Springbok Lodge, had told us, we were even lucky enough to witness the blooming of the famous March lily (*Brunsvigia bosmaniae*).

The last three months	January	February	March
Minimum temperatures			
night	10	10	9
day	22	27	21
Maximum temperatures			
night	24	23	22
day	40	40	40
Nights with frost	0	0	0
Rainfall in mm	0	6.2	61.6
Days with rain	0	3	5

The March flower only occurs in years with unexpectedly high rainfall in March.

THE PEOPLE IN GOEGAP

By Maarten Bleeker

Three more months had past and as always the composition of the people in Goegap changed. Some people are actually more part of the furniture like Ivana, Ed and myself. In January my mom with her boyfriend and my sister had a quick look at the mice at the end of my holiday. A short visit was enough to watch the mouse movie, see some mice running in the field and appreciate the land of the mice.

Shortly afterwards two new field assistants arrived: Claudia Sobe, University of Berlin, Germany and Elena Zwirner, University of Trieste, Italy. Both were eager to learn a lot and they loved the mice. Together they grew very close and have a lot fun. Also all the rest of the people are affected by their happiness and we have a lot of fun. The only thing is that Claudia helps Ivy and Ed on the farm and Elena is working on the main field site, which results in a very noisy reunion ritual in the evening, including sniffing, grooming and body contact, when they all return at home. Almost like the mice do.

Mid January David Lehman returned to Goegap, he was a field assistant in September and liked it so much that he wanted to come back as a master student. He is doing a project about vigilance during the night.

Gaby Schmohl was here for over 7 months and left us in the end of February to defend her title in the Swiss squash championship and write her thesis. She really liked the mice and worked, worked some more and worked a lot. After the relatively long but good time she was happy to leave and return to her family, friends and especially her boyfriend.

Adri Coetzee, working in the office of Goegap NR, also joined our project. She is studying to become a ranger and has to do a little research project and chose to help us to study the striped mouse. She comes during the week in the early mornings and afternoons to do observations, trapping and radio tracking. However, when she is done with the mice she returns to the office to get everything done over there. She is doing great and I hope she will become a good ranger soon.

For me this was a period of visits and holidays. In February my dad arrived in Cape Town and together with him I had my last two weeks holiday. At the end I had to show him the mice and had to say goodbye. It will not be long before I see him again, because at the end of April my time has passed and I have to go home again. Together with all these people we had fun, we worked and still enjoyed our stay in Goegap.

From left to right: Carsten, Ed, Ivana, David, Elena, Claudia and Maarten.

ARRIVAL IN THE LAND OF MICE

By Claudia Sobe

After three weeks of holiday with my brother and his wife, enjoying the warm water of the Indian Ocean and the gorgeous Cape, it was time to make our way to Goegap. The drive was very long and after Cape Town the vegetation changed rapidly from the green Fynbos into a desert-like landscape. After eight hours following the always straight and never-ending road, we finally reached the gate of Goegap Nature Reserve. My excitement grew as I saw the impressive stone formations and the huge gemsboks, with their long horns. And, finally, there it was: the research station; a small house with a sunflowers garden, a veranda and a lot of bones and skulls of African wildlife.

When we arrived, nobody was there, just a lovely welcome letter with the words "feel like home". A quick goodbye to my brother and the others (knowing that we would see each other in three months and that time flies), and I was ready to explore the research station on my own. That's when I saw for the first time *Rhabdomys pumilio* - the pet version. I never could have imagined them so fat!! But I didn't have much time to think about it, because only a couple of minutes later the others were back from the weekly shopping trip, and I was suddenly busy to meet my new roommates: Gaby, Ed, Ivy and Maarten.

That evening (as every evening) it was movie time and, as I was the new arrival, I had to choose out of half a video store a good movie. It might sound easy, but it was not, because they saw almost every single movie a couple of times!

The first night I fell asleep with the certainty of a free day the next day. I woke up when the others came back from the field and enjoyed a nice breakfast before getting ready for a small hike, with the hope to reach the top of the hill in front of the research station to make a phone call home. Maarten told me it was going to take 15 minutes, but it actually took me almost one hour and 15 minutes!

After sharing my first impression with my family at home and enjoying the amazing view and the nice aloe trees, I went back down. That evening I went with Maarten in the field and with surprise I discovered that some mice are very smart – and fast: they can open and escape traps in just 2 seconds. Crazy mice! .Probably those at home can't even reach the water bottle at the top of the cage.

During the next days I had to learn a lot, especially how to grab mice without getting bitten. I tried to do exactly what Maarten did, but it looks much easier then it is. But after several "real bites" you get the right feeling to handle them.

At the beginning also the orientation in the field site is quite difficult. There are hundreds of bushes and they all look alike, and you have to find the right one... I think this is the perfect moment for a special thank to my GPS, without which I would still be looking for my first trapping spots!

During radio tracking, especially in the first weeks when you're pretty slow, you get to see a lot. As, for example, blue agama males, making their pushups on a rock to impress females, or an African wild cat jumping out of a bush two meters in front of you, and almost give you a heart attack.

But not only in Goegap can you learn a lot. We are always into science and learning here! In fact, ,a night out in Springbok for dancing, I learned that "Springbok" is not only a beautiful animal, and not only a nice town here in Namaqualand, but is also a "lekker" drink – as the people would say it here – made of Amarula and mint liquor.

I'm sure that I will see (and of course learn) a lot in the next months! ...I will let you know what a Gemsbok really is!

Claudia (left) and Elena in Goegap

FIRST WEEKS IN GOEGAP

By Elena Zwirner

As always before leaving, I had to deal with all the scaring recommendations from my family and, moreover, I had a kind of bad experience with airports and flights during Christmas holidays, so my departure has been lived wishing to be already at my destination.
In the reality of facts, it has not been so dramatic, but long: half a day waiting at Frankfurt airport; a couple of movies and a lighting storm flying over Africa; a little disorientation once in Cape Town due to my "Italian disorganization": find a backpackers where to stay, look and book a bus to Springbok for the next morning, a restless sleep until dinner time… And I was ready to wait two o'clock in the morning for a crazy driver to pick me up! Of course I didn't know he was crazy from the beginning, but – believe me – I was trying hard to fall asleep on that MINI mini-bus just to escape his neurotic driving style! …But maybe I'm just used to different standards, because all the other passengers looked to be fine with it: they were laughing and talking to each other in this strange language I couldn't understand and of which I still can not get when a word ends and the next begins.
Anyhow, I'm still alive! And not only did I survived the travel, but also 36 looooong hours of waiting in Springbok, drinking milkshakes and wasting time, hoping that the appointment at the internet café I arranged so late I couldn't get an answer for, was going to be fine.

I was so happy to shake Maarten's and Claudia's hands! I finally felt that I arrived! And so, after a little chat in front of another milkshake (which are now the aim of the week) and the shopping, we were on the road to Goegap and to the research station.
HOME SWEET HOME!
It looked like a little hideout place in the countryside, with its white fence, yellow sunflowers, the water pod for birdies, the veranda and the silence! Only the sound of the wind and the song of the hundreds of different birds broke the silence. Moreover, it was just the three of us, so silence and quite were everywhere in the house.
The surrounding landscape was hilly, red and hot. It still is, but I expected something different. Maybe less rocky, or less reddish, for sure I didn't expect that these little hills where so hard to hike! After the first Sunday on the hill in front of the research station for phone calls, I stopped calling home!
With phone calls, slowly the silence also disappeared: after a couple of days in the intimacy of three people. Suddenly David arrived, and in another maybe ten days also the others came back from their holiday.
Maarten, Claudia, David, Ed, Gaby, Ivy and myself; seven people in a house can be a lot, and I did feel the impact, especially in the kitchen, with all the traffic and hits to get from the fridge to the sink!
But everything went for the best: everybody is nice and pleasant. There are those who are more silent, those who will moan all day but in the evening entertains us with laughter (and karate) and those who make me laugh all the time!

How to become a field assistant?
Only people with a biological background can become field assistants. These are students of biology, veterinary medicine or related areas. The work of field assistants includes: radio-tracking, trapping and marking of small mammals, behavioural observations, work at the research station, including maintenance, and much more.
People interested in working as a field assistant for 2-3 months write an email to *info@stripedmouse.com*. Please write a short motivation and attach a CV. You will then obtain more information.

Usually in the evening we are divided between the kitchen, where "Everybody loves Raymond" -time takes place, and the veranda, where we have semi-serious conversations and lots of jokes, waiting for a shooting star. Ah, yes! …Here the sky is AMAZING (as Claudia knows as well)!
About mice: my first encounter has been with pet mice and (as everybody) I thought that they were huge, unexpectedly big! Then you see them in the field and you realize that pet mice just need to go on a diet. Striped mice are cute, especially

the “wild type” (as I call the unpainted ones)! But then, with no exceptions, the moment of the first bite arrives and you wonder how they can bite so hard being so small. Cute little bastards!
For about a week I spent the trapping time trying not to get bitten the second time, with the nightmare of having to take out of the bag a screaming and jumping mouse. But slowly and probably thank to tens of other bites, I left my fear behind, and now I enjoy the trapping moment and I play circus with the most athletic ones!
As for the observations, I thought I was getting better as well: I could remember some individuals’ number and colors and I didn’t scare them off when handling my binoculars.
Shortly: my very first day in Goegap we had a visitor, a mole snake. A harmless, fat black snake. A couple of weeks later, doing home-ranges, I met a black spitting cobra in the field: thinner, faster and of a shiny darker black. I was alone, no camera, no hood seen... Everybody thought I was making it up (except from Claudia). Until the predicted “great day” (of rain and storm) came, and this time it was the skeptical Maarten to jump in to it, and see its hood. We all enjoyed it! Especially David, who got spitted at twice!

BACK HOME IN SWITZERLAND OR ONCE MORE FROM SUMMER TO WINTER

By Gaby Schmohl

Saying “Goodbye” to Gaby at the bus in Springbok.

After 7 months in the semi desert of Goegap I could pack my big backpack to fly home. One last nest observation, hold one last mouse, elephant shrew or bushkaroo rat in my hands, enjoy one last sunset over the hills of the nature reserve…that’s it. A long, long time I was waiting for this moment, but on my last day, I had the blues. In spite of numerous painful bites at the beginning of my stay, I loved these little cute mice and had a lot of fun with them during observations and trapping. To see how the juveniles suckle or 2 juveniles groom each other that looks like they’re kissing, these are just two examples out of several highlights (see pictures).
Before my departure I spent two days in Cape Town. What a difference! On one side the total silence in Goegap and on the other side such a hectic rush in the city. Luckily, I survived this shock without any problems and my boyfriend and family could welcome me hale and hearty in Zurich. One single step out of the airport building and it was clear: the summer is gone, I’m back in winter. A cold wind was blowing and I think it was hardly over 0°C. Just a few days ago, I wore shorts and t-shirt and enjoyed the sun shining on my face… Thanks to heating installations in buildings I didn’t have to freeze anymore inside my apartment. In Goegap we didn’t live in luxury, but now, once arrived back in the civilisation, I got used to such “luxurious” things quite fast. Soon normal course of my life started. That means going to university working on my master thesis and pick up the (squash-) training, which I really missed down in South Africa. All this stuff sounds really boring. Everyday life in Goegap was much more interesting with all the wild animals and funny nest observations.
I had to answer a lot of question and should be able to tell everything happened the past months in one sentence. Several times people wanted to know when I fly back to South Africa. Others wanted to know: “What do you miss most?” This cannot be a serious question, can it? Who can work 7 months with mice and not miss them at the end? I can’t. I would like to swap the bustle of the city with the silence of the nature….

GETTING BITTEN BY MICE

By Adri Coetzee

Hi, I am Adri and all the way from the office of Goegap Nature Reserve. I am here to do my research project. The first week was so much fun and lots to learn. Everyone at the research station were so helpful when I needed to know something. At the end of the day it all came back to Maarten. He had to teach me all I needed to know about the mice. May I add: he did a pretty good job at it. Elena and I had to get the right grip for handling the mice. I was lucky to get it right the first week. After that came the weighing, inspecting and painting them. Two weeks went by and then…… my first bite! I was stunned that a mouse so small could bite like that….. Yes I was bleeding. After that I did not want to see a mouse, but Maarten made me. I got myself a glove to cover the mice especially the big scrotal males. Maarten always is making fun of me and my glove. Three weeks went by and then I was trapping all alone, the rest was on holiday. I was excited and gained a lot of confidence. I painted a lot and some escaped but that is part of the job, I will trap them again tonight or tomorrow! I have trapped a lot of elephant shrews and bush karoo rats. Elena`s coffee and cookies kept me awake in between rounds in the mornings. Once a week I felt like a packhorse, because I had to move traps, needless to say: usually it is a lot of them! It has been two months now and my fascination with the mice still continues…..

Adri with an elephant shrew

HOMEPAGE: STRIPEDMOUSE.COM

By Carsten Schradin

	January	February	March	**Total last quarter**
Visits of stripedmouse.com	2977	2609	3232	**8818**
Downloads FSM-TIMES, SGM-Spiegel	1441	399	101	**1941**

TITLE: PROXIMATE AND ULTIMATE ASPECTS OF SOCIAL FLEXIBILITY IN THE STRIPED MOUSE (*RHABDOMYS PUMILIO*)

By Carsten Schradin

This is a shortened version of the introduction of my habilitation thesis which I submitted in February at the faculty of sciences at the University of Zurich. If accepted, the habilitation gives me the opportunity to apply for full professorships in German speaking countries (Austria, Germany and Switzerland).

Behavioral Ecology and Ecophysiology
Studies in behavioral ecology analyze how animals survive and reproduce in their natural environment. The core question here is how do individuals behave adaptively in their environment, increasing their

inclusive fitness? Often the environment is a changing one, either in a predictable (e.g. seasonal) or in an unpredictable way (e.g. droughts, storms; Wingfield, 2003). Accordingly, the behavior and physiology of individuals might change too, often leading to different reproductive and social tactics (defined after Gross, 1996), either followed by different individuals within a given population or by the same individual across different time periods. The field of behavioral ecology has been established during the last few decades, on a broad base of theory (Hamilton, 1964; Hamilton, 1971; Maynard Smith, 1977; Trivers, 1971; Trivers, 1972; Wilson, 1975) which has been tested in the field (for reviews see Clutton-Brock, 2005; Emlen, 1995; Krebs and Davies, 1993). Long-term field studies are of crucial importance, as the behavioral response of animals to a changing environment can only be studied over time scales encompassing environmental change plus the time required to detect responses to environmental changes. In a world that is characterized by anthropogenic induced climate change (Friedlingstein, 2008; Lovett et al., 2005), such studies might yield important results not only for understanding the evolution of behavior, but also the extent to which different animal species might be able to cope with this change. One main challenge in the field of behavioral ecology is the integration of the proximate mechanisms of behavior (Krebs and Davies, 1993; Tinbergen, 1963). To study evolved physiological mechanisms of behavior, it is best to analyze them in the natural environment, and the study period must be long enough to make it possible to monitor physiological changes that can enable individuals to respond adaptively to changing environmental conditions.

My work focuses on the questions why animals live in groups and why males participate in infant care. The integration of both ultimate and proximate causes of social behavior of free-living animals has been my most important aim. During the last seven years, I conducted a long-term study on the life history of the African striped mouse (*Rhabdomys pumilio*) from the Succulent Karoo in South Africa (Schradin, 2005a; Schradin, 2005b; Schradin, 2006; Schradin et al., 2007; Schradin and Pillay, 2005; Schradin et al., 2006), comparing the social system between populations situated in different biomes, conducting field experiments (Schradin, 2007b) and taking physiological measurements from free living individuals. Therefore, the striped mouse is a species allowing us to better understand the behavioral ecology and behavioral endocrinology of different aspects of group living such as paternal care, communal breeding, and whether offspring remain philopatric or disperse.

Advantages of the striped mouse as a study species

Rodents have been underrepresented in studies of behavioral ecology. While rodents make up more than 40% of mammalian species (Wilson and Reeder, 2005), many are nocturnal, and their shy habits as well as small body size make them difficult to study in the field. My collective work represents one of the most detailed

field studies in muroid (mouse like) rodents. For a better understanding of the evolution of social behavior in mammals in general, it is crucial to increase our knowledge about the largest mammalian taxon, which means the social behavior of rodents in their natural habitat. The striped mouse is an excellent model for several reasons:

1. Field studies with direct behavioral observations are possible because the striped mouse is diurnal and easily habituated to the presence of human observers (Schradin, 2005a; Schradin, 2006; Schradin, 2007b) which is very rare for muroid mammals.
2. As I know the nesting sites of habituated mice, which readily enter traps, traps can be set before mice get active, and watched from a distance of 5-10m. Thus, a mouse entering a trap can be removed immediately and a blood sample taken within less than 3 min, avoiding a stress response.
3. As a rodent, it has a short life expectancy, making it possible to study individual life histories within 1-2 years, and over different ecological conditions. I have monitored a population at my field site since 2001, where the histories of more than 3 000 individuals have been followed from birth to death.
4. Its social system differs between populations and individuals can follow different social and reproductive tactics within a single population. As a non obligate group living species that shows complex social groups only under special conditions but is solitary under others (Schradin, 2005b), it is the ideal system to study reasons for group living without the confounding effects of phylogeny or specialized sociality.
5. It offers paternal care as one variable of sociality, with some males being group living and paternal, and others being solitary and non-paternal. While the reasons and mechanisms of paternal care have thus far been mainly studied in monogamous mammals (Brown, 1993; Kleiman and Malcolm, 1981; Schradin, 2002; Wynne-Edwards, 2001), paternal care can evolve independent of monogamy even in polygynous species (Dunbar, 1995; Komers and Brotherton, 1997; Brotherton and Komers, 2003). Therefore, the paternal and polygynous striped mouse is of special interest.
6. Easy and cheap laboratory studies are possible, and captive colonies exist at my research station in South Africa and at the Zoological Institute, University of Zurich.

Synthesis

My main aim was to study the evolution and endocrine ecology of sociality in a small mammal, the African striped mouse. First I established the striped mouse as a suitable model to study the evolution and physiology of paternal care and group living in a mammal. I demonstrated that paternal care occurs in the striped mouse not only in captivity but also in the field. Many other muroid rodents show paternal care in captivity but not in the field (Dewsbury, 1985). My habilitation represents one of the

most detailed long-term field studies done on a muroid rodent. This has been achieved by combining direct behavioral observations, radio tracking and capture-mark-recapture methods, including the very first study that observed a muroid rodent for its entire activity period in its natural habitat (Schradin, 2006). I collected blood samples from hundreds of free living striped mice whose life histories were known from birth until the time of sampling. I demonstrated that the striped mouse is suitable to study the reasons for group living, because both solitary and group living individuals occur in the same species and even within the same population (Schradin et al., 2006). The comparison between sociable and solitary populations controls for phylogenetic factors (Schradin, 2005b; Schradin, 2007a; Schradin et al., 2006) and the comparison within a single population can even control for ecological (though obviously not social) factors. Social flexibility is on example of phenotypic plasticity, but so far we are missing a clear definition of social flexibility that highlights its differences from alternative reproductive strategies.

Phenotypic plasticity describes the extent to which an organism can change its development, morphology, physiology and / or behavior in response to environmental cues (Lott 1991; Moore 1991). One well-studied case of phenotypic plasticity is the variability of male reproductive strategies within a species. A 'strategy' is genetically determined and describes the decision rules of an individual, which operate through physiological mechanisms whereas a 'tactic' is the behavioral component of a strategy (Krebs and Davies 1993; Gross 1996; Fig. 1). Reproductive strategies can be genetically fixed (alternative strategies) or one genetically determined strategy exists with different tactics that either have the same (mixed strategy) or different fitness (conditional strategy; Gross 1996; Oliveira et al., 2008; Fig. 1). Individuals following a tactic within a conditional strategy that leads to a lower fitness than another tactic are also said "to do the best of a bad job" (Gross, 1996). Different male tactics may include being the 'breeding male' of a group, a 'helper', a 'sneaker', a 'satelite' or a 'roaming' male (Burda et al 2000; Clutton-Brock 2005, Lucas et al. 1996; Reyer 1980; Taborsky 1994; Young et al. 2007). Thus, in many species there is significant variation in male tactics and often males can change from one tactic to another (Reyer 1980; Clutton-Brock 2005; Gross 1996).

My studies suggest that the male striped mouse breeders have a higher resource holding potential than natal philopatrics (these males could breed with females of neighboring groups; Young et al., 2007) and a higher fitness. Thus, within the Succulent Karoo population, male striped mice show a conditional strategy (Fig. 1, right) with the three tactics 1. philopatric male, 2. roamer and 3. breeding male. Female striped mice have a conditional strategy with the two tactics 1. philopatric non-breeding female and 2. breeding female. Therefore, in striped mice both sexes can show different tactics,

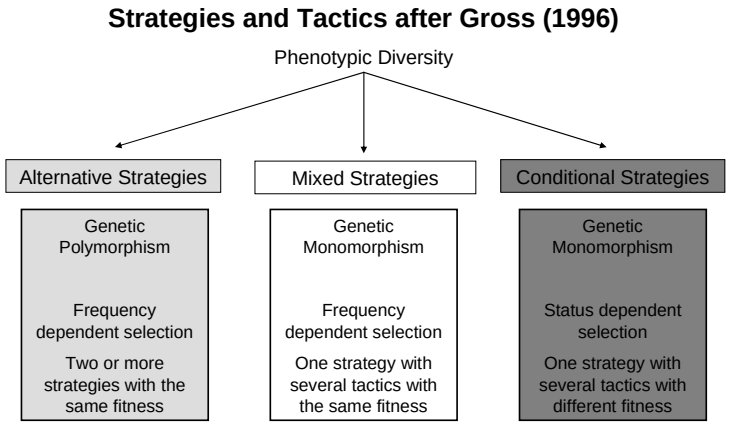

Fig. 1
The three different forms of strategies (genetically determined) and the difference between strategy (decision rules) and tactics (behavioral components) after Gross, 1996.

which is in contrast to most studies in fish and reptiles on alternative reproductive strategies. In fish and reptiles, males might often show different tactics, while the females have only one tactic (Brantley et al., 1993; Knapp and Neff, 2007; Moore et al., 1998; Oliveira et al., 2005; Schütz et al., 2006; Wikelski et al., 2004).

While the terms of strategy and tactic are now generally used following the definition of Gross (1996; see for example Oliveira et al., 2008 and the chapters within), another popular term for a similar phenomenon has so far been used in a way that is much less clear. *Social flexibility* is used often by students of animal behavior, but what it means can differ dramatically between those studies (Table 1). Unfortunately, the term social flexibility is most commonly used in a very imprecise way to describe that individuals can change their behavior in a possibly adaptive way or that individuals of the same species can differ in their social behavior. The term social flexibility should be avoided if the same phenomenon can also be described with the well defined terms strategy or tactic. Therefore, the term social flexibility is only of help if it describes some- thing else (than strategy or tactic) which aids in studying and understanding a phenomenon that goes further than differences in social tactics. While we are still far from an understanding of

social flexibility, I am trying here to define social flexibility as a phenomenon that includes differences in social tactics between conspecifics, but that goes beyond it by including a view on the entire

population, and not only on the single individual.

The striped mouse is a good example of the way in which social behavior varies with the environment, especially food abundance, population density and duration of the breeding season (Schradin, 2005; Schradin, 2007; Schradin et al., 2006). Here I describe why I think the striped mouse offers a new and maybe higher level of phenotypic plasticity in social behavior than only differences in social strategies or tactics. I call this phenotypic plasticity *social flexibility* because it can lead to plasticity of entire social systems within or between populations, based on individual differences in social tactics. *Social flexibility* describes how the social system of a species can change due to the individuals reacting highly flexibly to different environmental conditions. In this case, the social tactics of not only single individuals, but of most or even all individuals of an entire populations can differ from the social tactics of individuals of another population or the same population at another time. Therefore, studying individual tactics can help us to understand the (predominant) social system of a population. I define *social flexibility* as the phenomenon that all individuals (males and females, juveniles and adults) of a species or population can change their social tactic conditionally (Gross 1996) depending on environmental factors, including the social and demographic environment. Thus, the frequency of the different reproductive and social tactics within a population, changes with changing environmental conditions. As a result, the entire social system (combination of social organization, mating system and social structure; Kappeler; 2006) of a population can change, or differ when compared to other populations of the same species. Three conditions have to be met for the definition of social flexibility and they are listed below with the striped mouse as an example:

1. In both sexes (not only one!) individuals can follow different reproductive tactics (males: solitary roamers, group living paternal males and group living allo-parental philopatric helpers; females: solitary and communally breeding females as well as allo-parental philopatric helpers).
2. Significant population differences in social organization exist: Individuals in the arid Succulent Karoo typically live in extended family groups (up to 30 adult mice), while individuals from mesic grasslands are solitary.
3. The individuals of a single population can switch their social tactic such that the entire social system of the population can differ between years. The social system of my study population in the Succulent Karoo is characterized by large social groups in years of high population density, with nearly 100% of individuals living in social groups. However, all individuals (100%) live solitarily in years of low population density (Schradin et al., 2006) while in years of intermediate population density, a mixture of different reproductive tactics.

Tab. 1
A search in ISI Web of Science for the topic "social flexibility" revealed 94 publications in the field of Zoology for the period 1900 to present. Investigation of these papers demonstrated that most were about "behavioral flexibility", i.e. for non-social behaviors (with the exception of vocalization). Only 27 papers were about flexibility in social behavior, mainly in social insects and callitrichid primates. However, no clear difference was made between "social flexibility" and the occurrence of alternative social tactics. For example in social insects, the term social flexibility was used to compare between females nesting alone or cooperatively (Tibbetts, 2007), in callitrichids for social groups that were either monogamous or polygynous (Digby and Ferrari, 1994).

Number of publications in ISI Web of Science as a result of the topic search "social flexibility"			
Other	Comparison between species	Behavioral flexibility	Social flexibility
5	5	57 Foraging: 11 Cognition: 20 Predator avoidance: 3 Reproduction: 5 Vocalization: 6 Other: 12	27 Social insects: 5 Flexibility in social behavior: 9 Social relationships: 6 Tactics: 4 Other: 3

Conclusions

Social flexibility offers a very good opportunity to study ecological factors of group living and to determine endocrine differences between solitary and group living striped mice (research questions: aim 3). So far, this aim has been mainly achieved for the aspect of paternal care (aim 1). Paternal care occurs because males defend harems of several communally breeding females and are thus associated with their pups without having the cost of missing pairings with other females. This is in contrast to males of the solitary population that have access to about the same number of females, but only by roaming from one single receptive female to another, such that they are not associated to pups. The father's presence has a positive effect on pup development, possibly increasing the direct fitness of paternal males. Paternal care in the striped mouse is correlated with increased prolactin levels (aim 3) which might play an important role in the regulation of paternal care. Increased prolactin levels might be important in breeding males to facilitate the onset of paternal care in the presence of seasonally increased testosterone levels (aim 4) that might inhibit paternal care. However, a demonstration of a causal relationship between prolactin and paternal care in mammals is absent at present. Instead, increased prolactin levels in paternal care might represent a broader difference between group living and solitary living male tactics than a direct cause of paternal care. The ecological reasons for group living (aim 2) include a high population density, leading to habitat saturation that leads to aggressive competition for access to resources, especially food and nesting sites independent of breeding. Thus, under high population density striped mice are forced to remain philopatric to their natal groups. The main benefit of

group living might relate to thermoregulatory benefits of huddling in groups, with mice sleeping in groups saving 25-50% of energy compared to single sleeping mice. Social flexibility can explain why the striped mouse can inhabit different habitats, such as mesic grasslands and arid areas that differ from each other in environmental conditions, e.g. the Kalahari, Namib Desert and Succulent Karoo. Social flexibility is a solution for surviving in unpredictable changing environments such as the Succulent Karoo and other deserts that experience dramatic changes in food availability due to droughts, which can affect one generation of striped mice, while the next might live under much better conditions. Apart from humans, the striped mouse is the most common mammal in southern Africa, and its social flexibility is one main key to this success.

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NEWS AND INFORMATION ABOUT PLANTS AND ANIMALS

MOUSE PORTRAIT: MALE 1695

By Carsten Schradin

Mother: F932 or F1212	**Father:** M835
Date of birth: 1st October 2005	**Date of death:** December 2006
Age: 13 months	**Cause of death:** unknown
Partners: Roamer, which visited the groups 7, 12, 15, 21 and 23	
Children: unknown	**Grand-children:** unknown

F: Female = Weibchen, M: Male = Männchen

1.4 hectare, that was the second largest home range of a striped mouse we measured in 2006. It was the home range of male 1695, who was roaming over it. M1695 was a nice guy and big male, but not extraordinarily big. That might be the reason why he did not become the breeding male of any group. Others were just even bigger and could chase him away. That might be the reason why he left his natal group G7 in July 2006 and started sleeping by himself, 150m away and separated by the territory of group G12 from his original family. But he did not seem to mind and he roamed nearly over the entire field site. In the early morning one often saw him at the nest of one or two groups. Was the breeding male of this group still at the nest, then M1695 was soon chased away. But often only the females were present, and the ladies did not seem to dislike him. They never chased him, but sometimes even sat in body contact with him. If there was even more, remains unknown until we did some paternity analyses. So far we do not know whether roamers are successful in mating with females, as mating typically occur secretly inside shrubs.

At least for M1695 I expect that he was successful in some cases. But roamer is not roamer, and other roamers had many more difficulties. Some were not only chased away by the breeding male, but also by the breeding females. Female striped mice do not get involved with just any guy, but they are choosey. Which criteria female striped mice use to choose a mating partner would open an entire new field of research.

M1695 (right) together with F2152 from G23. M1695 was a roaming male that was treated nicely by the females.

GECKOPORTRAIT: GIANT GROUND GECKO (*CHONDRODACTYLUS ANGULIFER*)

By Ramona Pötzinger

There are two subspecies but one of them is restricted to the Namib Desert. The other one (*C. a. angulifer*) occurs in South Namibia and the karoo areas of the Cape.

Identification: They have stout limbs, ventral scales that increase in size on the sides, and a dorsal pattern consisting of 4-5 pale, dark-edged chevrons that extend as bars onto the tail and are more conspicuous in females but fainter in males. The body is stout and cylindrical and has a big head with a short snout and prominent bulging eyes with vertical pupils. The tail is segmented, swollen and shorter than the body.

Biology and breeding: This species is like most geckos nocturnal and spends the day in a burrow that they dig afresh each night, or an old scorpion burrow. It feeds on termites, moths, spiders and also other small geckos. The females lay 1-2 large eggs in a chamber that she digs in sand. If threatened it arches the tail scorpion-like and hisses, but although considered poisonous in some regions, they are quite harmless.

CONFERENCES, PRESENTATIONS AND PUBLICATIONS

CONFERENCES

Carsten Schradin went to the meeting of the Ethologische Gesellschaft in Regensburg from the 20th to the 22nd of February. He presented there a poster the abstract of which was:

Endocrine ecology of social flexibility in the African striped mouse

Social flexibility occurs when different individuals of the same species follow different reproductive tactics. When individuals can switch from one tactic to another, the proximate mechanisms of social flexibility might include differences in hormone levels, as hormone secretion can change easily and influence behaviour. I studied ecological reasons and endocrine correlates of social flexibility in a field study in the African striped mouse in South Africa. Males of the striped mouse can follow one of three different tactics: 1. Paternal group-living breeders, 2. alloparental philopatric group-living males or 3. roaming non-paternal solitary males. Which tactic is chosen depends on population density, with most males being roamers when population density is very low. If population density is very high, old males defend harems of 2-4 cooperatively breeding females against other males, while young adult males are forced to remain philopatric due to habitat saturation. I took blood samples from males under medium population density, when all three tactics occurred at the same time. Prolactin, a hormone known to be associated to both maternal and paternal care, was significantly higher in paternal group-living males than both in philopatrics and in roamers. Roamers had the highest testosterone levels, potentially promoting risky behaviour such as invading territories of group-living males to get access to their females. Philopatric males had the lowest testosterone levels indication physiological sexual suppression. Philopatric males had nearly ten times higher corticosterone levels than both breeders and roamers, indicating that philopatry due to habitat saturation is stressful. In sum, population density as an environmental factor influences which social tactic is chosen by male striped mice. Different tactics were associated to differences in hormone levels, supporting the hypothesis that prolactin is associated to paternal care and that remaining philopatric instead of starting independent breeding is stressful.

SCIENTIFIC PUBLICATIONS

Three scientific publications have been published at the beginning of this year, the abstracts of which are provided here. The PDFs are available at our homepage www.stripedmouse.com.

Schradin, C. 2008. Differences in prolactin levels between three alternative male reproductive tactics in striped mice (*Rhabdomys pumilio*). Proceeding Royal Society Series B 275:1047-1052.

In male fish, birds and mammals increased prolactin secretion is thought to play a role in species showing parental behaviours. This hypothesis was investigated in the striped mouse (*Rhabdomys pumilio*). I compared serum prolactin levels in 71 free living male striped mice following three different reproductive tactics: 1. Paternal group-living breeders, 2. alloparental philopatric group-living males and 3. roaming non-paternal solitary males. Prolactin levels of breeding males were significantly higher than in roamers. Allo-parental philopatric males had low prolactin levels, which concurs with studies of cooperatively breeding mammals, but contrasts with studies in cooperatively breeding birds. Both breeding males and females showed a decrease in prolactin levels after the breeding season, but not alloparental philopatric males. Prolactin levels were neither correlated with corticosterone levels nor with age. These results are in agreement with the hypothesis that prolactin is one proximate mechanism of male reproductive tactics, possibly regulating differences in male parental care.

Schradin, C. 2008. Seasonal changes in testosterone and corticosterone levels in four social categories of a desert dwelling sociable rodent. Hormone and Behavior 53: 573-579.

Animals have to adjust their physiology to seasonal changes, in response to variation in food availability, social tactics and reproduction. I compared basal corticosterone and testosterone levels in free ranging striped mouse from a desert habitat, comparing between the sexes, breeding and philopatric non-breeding individuals, and between the breeding and the non-breeding season. I expected differences between breeders and non-breeders and between seasons with high and low food availability. Basal serum corticosterone was measured from 132 different individuals and serum testosterone from 176 different individuals of free living striped mice. Corticosterone and testosterone levels were independent of age, body weight and not influenced by carrying a transmitter. The levels of corticosterone and testosterone declined by approximately 50% from the breeding to the non-breeding season in breeding females as well as non-breeding males and females. In contrast, breeding males showed much lower corticosterone levels during the breeding season than all other classes, and were the only class that showed an increase of corticosterone from the breeding to the non-breeding season. As a result, breeding males had similar corticosterone levels as other social classes during the non-breeding season. During the breeding season, breeding males had much higher testosterone levels than other classes, which

decreased significantly from the breeding to the non-breeding season. My results support the prediction that corticosterone decreases during periods of low food abundance. Variation in the pattern of hormonal secretion in striped mice might assist them to cope with seasonal changes in energy demand in a desert habitat.

Keller, C., and C.Schradin. 2008. Plant and small mammal richness correlate positively in a biodiversity hotspot. Biodiversity and Conservation.

Hotspots of biodiversity are important areas in facilitating an understanding of species richness and its maintenance. Herbivores can increase plant diversity by reducing dominant plant species thus providing space for subdominant species. As small mammals are abundant in the Succulent Karoo and therefore might affect plant diversity by means of herbivory. We tested if this mechanism might exist in the Succulent Karoo in southern Africa, a biodiversity hotspot due to its extraordinary plant diversity. At 10 ecologically different study sites we measured plant and small mammal diversity and determined 11 abiotic factors including soil composition, altitude and rainfall. We found positive correlations between plant diversity and the number of small mammal species. A General Linear Model revealed that the number of small mammal species was more important than abiotic factors in explaining variation in plant diversity. To test whether small mammals might directly influence plant diversity, we studied the influence of the bush-Karoo rat Otomys unisulcatus, a central place forager, on the plant community. The immediate surroundings of occupied O. unisulcatus nests showed significantly higher plant diversity than control areas. We conclude that small mammals can have a positive effect on plant diversity in the Succulent Karoo. While experimental data are needed to support these correlative results, the results of our study indicate that areas of high small mammal diversity should be highlighted in conservation programs of the Succulent Karoo.

POPULAR SCIENCE PUBLICATIONS

In February, two popular science publications appeared, both about animal fathers in European Wildlife. One was authored by Carsten Schradin and appeared in the “Jäger” (the hunter). The magazine “Ein Herz für Tiere”, Europe’s largest animal magazine, reported about Carsten Schradin’s popular science publication from last year (“Wildbiologie”).

FUNDING OF RESEARCH: CALL FOR DONATIONS

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GRANT FROM THE SWISS NATIONAL SCIENCE FOUNDATION

The Swiss National Science Foundation supports the grant application “Social flexibility in a mammal: environmental and endocrine causes and consequences” from Carsten Schradin with a total amount of CHF 279 000 (175 000 Euro) for the next three years. Ivana Schoepf will conduct a PhD within this research program and her salary, travel costs etc. will be paid from this grant for three years. Though the Swiss National Foundation offers very generous support, the research expenses of the original proposal were cut by CHF 72 000 (45 000 Euro). So we still have to search for further funding for research. Especially, these leaves no financial options for extra little research projects, such as David’s master thesis on nest sharing, for which we will still largely depend on support from the readers of the SGM-Spiegel and FSM-Times.

Social flexibility in a mammal: environmental and endocrine causes and consequences

In mammals, social organization ranges from solitary species to complex social groups with cooperative breeding. However, it is still poorly understood which environmental factors cause different forms of animal societies. Furthermore, the physiological mechanisms of group living are not well studied in mammals. To understand the reasons of group living versus solitary living, different species with different social systems have often been compared. However, it is best to study a single species that can both be solitary or form complex social groups, to avoid confounding phylogenetic factors. Such a socially flexible species is the striped mouse (*Rhabdomys pumilio*) from southern Africa, which occurs solitary and also forms complex extended family groups of one breeding male, up to four breeding females and their adult philopatric offspring of both sexes. In previous correlative field studies I showed that high population density and end of reproductive competition after the breeding season favor group living. Population density might influence the availability of territories. Only during the breeding season will intra-group conflict over reproduction act against group living. To test for a causal relationship, we will experimentally remove single groups to free territories. Thus, the neighboring experimental groups will experience a local reduction in population density, while control groups of the same population will remain their neighboring groups, experiencing no or a much smaller reduction in local population density. We will compare the percentage of solitary mice between experimental and control groups. In several previous bird studies it has been demonstrated that providing free territories by removing individuals leads to offspring dispersing instead of remaining philopatric, but to my knowledge this will be the first field study of that kind for a mammal species. To investigate the influence of reproductive competition, we will compare groups whose neighbors have been removed to free territories both during the breeding season (reproductive competition present) and the non-breeding season (reproductive competition absent). Offspring are only expected to disperse during the breeding season into vacant territories but to remain philopatric during the non-breeding season. Over three field seasons, altogether 12 replicates will be done. Furthermore, to study physiological causes and consequences of group living we will collect blood samples to measure the hormones corticosterone, testosterone, estrogen and prolactin and test five predictions in how far group-living mice will differ from solitary mice in hormone levels. By following life histories of individuals that switch from group- to solitary-living, we can determine whether hormonal changes occur before or after individuals got solitary. Brain samples will be collected to compare mRNA expression of neuropeptides known to play an important role in the regulation of social behavior: oxytocin and arginine vasopressin. While several studies have investigated hormonal correlates of helping behavior of philopatric offspring, this will be one of few studies that compare philopatric with dispersing offspring. In captivity, I will experimentally manipulate the social environment and neuropeptide levels using nasal sprays to test for a causal relationship between social flexibility and neuro-endocrinology. This study will yield important information on how environmental factors lead to differences in the endocrine system and finally to either a group living or solitary social system.

THE MOUSE'S TAIL

HOUSE ON THE HAUNTED HILL

By Ivana Schoepf

In and around the research station there are sometimes some weird things happening. From the "strange noises" coming from the loft upstairs the research room, to the peculiar growth of fungi that looked like human's hair in the showers, the amount of spooky stories just keeps growing and growing. However we always thought that away from the research station, and especially at the farm, we were quite safe. That was until we discovered the house on the haunted hill! At the end of our field site at the farm there is a small hill and who would have thought that a terrible secret was hiding behind that innocent looking place. Just in the shadow on the other side of the hill lays a shack of twisted metals. Inside it, an iron bed, that has certainly seen better days, adds to the sense of uneasiness that one feels while standing there. The vision of the bed laying there abandoned, would be enough to give many sleepless nights. However, what really adds to the spooky atmosphere of the place is the nearby garden with its ground carpeted by animals' skulls and bones. This would probably be the perfect setting for a horror movie: the Goegap Chainsaw Massacre, anyone?! And the fact that once in a while one smells the odour of cooked food coming from that direction does not help our belief that perhaps some kind of monster truly inhabits that part of the hill. Well, we were thinking that the mice population was low this year because of the high predation from the wild cat and the jackal buzzard, but perhaps, at least at the farm, there might be another cause for their disappearance…

GOLDEN MOUSE PRIZE-WINNERS

2007: GOEGAP NATURE RESERVE

2006: DR. GUSTL ANZENBERGER

2005: JENS SCHRADIN