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DIPLOMARBEIT

Titel der Diplomarbeit

Ecology of the chelid turtles *Platemys platycephala*, *Mesoclemmys gibba* and *Mesoclemmys nasuta* in French Guyana. With notes on short term migrations and dietary spectrum of *Platemys platycephala* in the Nouragues Field Reserve, French Guyana

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Introduction

Freshwater habitats in French Guyana

The Indian name “Guyana” is said to mean “Land of thousand waters”, which is indeed true. Since most of the 86,504 km^2 of Guyana’s area consists of tropical lowland rainforest, a lot of water is retained in the soil and stored in the vegetation. The high annual rainfall of mean 3000 mm in some regions also contributes a significant part to the water-wise richness of the country. Due to the wavy relief of the Guyana-plateau (which covers parts of Venezuela, British Guyana, Surinam, Brazil and French Guyana), small creeks and rivers form in the depressions between the hills, which all drain into the Atlantic ocean in the north.

Guyana has got a shallow, flat coastline, where large tidal mangrove swamps occur, including the Marais des Kaw, which is the largest wetland of France. Parts of this vast estuary of the Approuague river belong to the Reserve Naturelle de Kaw-Roura, which also includes the Montagne de Kaw, a strongly textured area covered by rainforest. The flatness of the coast causes only slow stream velocities of the rivers and flat riverbeds. Also, tidal influences are recognizable far into the country (figure 1). The water of the big rivers is mostly very turbid, because rivers transport much sediment to the sea (figure 2). The annual hydrological regime varies between different times of the year. Water levels rise from December to May, while more than half of the annual discharge appears during the months of April to July. From May to October, the water levels decrease, with lowest water from October to November (Brehm 2003). The hydrological regime correlates to a certain extent to the climatological regime. There are two main seasons: The long rainy season usually last from April to July, followed by a long dry season from July/August to December. From December to February there is a short rainy season, which is followed by a short but severe season of draught in March (Métrallier & Le Gratiet 1996, Nouragues.cnrs.fr 2009).

Physico-chemical water parameters in French Guyana resemble mostly those known from rainforest habitats around the world: Because of the old and therefore long-time corroded soil, which does not contain any nutrients or ions like sodium, potassium, magnesium or silicon, the pH as well as electrical conductivity are low. The colour is often brown like coffee, resulting from leaves that fall into the water body and decay there, releasing tannins and other chelating agents. Depending on sediment load and rainfall, the turbidity can be high. Appendix III shows results of habitat analyses that have been performed in the study areas.

Figure 1: Tidal influences in French Guyana. Modified after Brehm (2003)

Figure 2: The water of the Arataye river is of brown colour because of the sediment load and the tannins that come from the inflowing forest creeks

Besides aerial transportation, the various waterways are the main traffic routes to travel further into the country. Therefore the fish fauna is very well documented (Keith et al. 1996, 2000a, 2000b). Brehm (2003) proposes discrimination between three distinct assemblages of fish fauna in French Guyana: The East, which is influenced by Amazonian species occurring in the Oyapock (e.g. *Pterophyllum scalare*, HECKEL, 1840), the West, which is influenced by the catchment of the Maroni, including species of the Guyana-shield (e.g. *Guianacara owroewefi*, KULLANDER & NIJSSEN, 1989) and the South, which also shows distinct species. The turtles seem not to be influenced by these biogeographical distinctions with one exception: The big headed Amazon River Turtle (*Peltocephalus dumerilianus*, [SCHWEIGGER 1812]) is a widespread species all over the Amazon basin, but only rarely encountered in French Guyana. Until now, this species has only been observed in the far eastern regions with the furthest western record being a specimen caught in the crique (= creek) Fouille near Matoury (Métrallier & Le Gratiet 1996). All other continental (= non marine) species occur all over the country in their specific habitats.

Turtles in French Guyana

Although French Guyana is a relatively small country in South America, there is an impressive diversity of turtles (table 1). 14 regularly recorded species per 86,504 km² equals a turtle density (= turtles per 1,000 km²) of 0.162, which makes it number 31 in the world (Rhodin 2006). Marine turtles are threatened all over the world and therefore receive most of the scientific and public attention in French Guyana. Freshwater turtles of French Guyana are mostly members of scientifically underrepresented families in terms of systematics and ecology and due to their superb hiding ability and hidden lifestyle as well as their small economic value poorly studied.

None of the recent turtle species of French Guyana is endemic to the Département, but *Mesoclemmys nasuta* is endemic to the Guyana Shield. All other turtles inhabit wide parts of the Amazon basin, with the scorpion mud turtle (*Kinosternon scorpioides*) and red footed tortoise (*Chelonoidis carbonaria*) being especially generalistic in their habitat preference and therefore occurrence. The extent of latitudinal distribution of these two species ranges from Venezuela to Argentina (Vetter 2005). The South American wood turtle (*Rhinoclemmys punctularia*), which is the southernmost member of the only Geoemydid genus of turtles occurring in the Neotropis is another generalist that shows a wide distribution all over Amazonia and is commonly found in French Guyana, but poorly studied.

Table 1: Chelonians of French Guyana. The question mark (?) indicates unsure status of populations

Cryptodira

Cheloniidae
*Caretta caretta (*LINNAEUS, 1758*)*
*Chelonia mydas (*LINNAEUS, 1758*)*
*Eretmochelys imbricata (*LINNAEUS, 1766*)*
*Lepidochelys olivacea (*ESCHSCHOLZ, 1829*)*

Dermochelyidae
Dermochelys coriacea (VANDELLI, 1761*)*

Geoemydidae
*Rhinoclemmys punctularia (*DAUDIN, 1801*)*

Kinosternidae
*Kinosternon scorpioides (*LINNAEUS, 1766*)*

Testudinidae
*Chelonoidis carbonaria (*SPIX, 1824*)*
*Chelonoidis denticulata (*LINNAEUS, 1766*)*

Pleurodira

Chelidae
*Chelus fimbriatus (*SCHNEIDER, 1783*)*
*Mesoclemmys gibba (*SCHWEIGGER, 1812*)*
*Mesoclemmys nasuta (*SCHWEIGGER, 1812*)*
? *Phrynops tuberosus (*PETERS, 1870*)*
*Platemys platycephala (*SCHNEIDER, 1792*)*

Podocnemididae
? *Peltocephalus dumerilianus (*SCHWEIGGER, 1812*)*
Podocnemis unifilis TROSCHEL, 1848

Oldest records of the Austral-American Side-necked Turtles (Chelidae) occurred during the Eocene (Pritchard & Trebbau 1984), with their origin still not exactly known. Pritchard & Trebbau (1984) argue that they probably used a trans-Antarctic distribution route (or even an Antarctic origin) that led to their current distribution on the continents of South America and Australia/Indonesia.

There are four, possibly five chelid species occurring in French Guyana: Three of them, *Mesoclemmys gibba, Chelus fimbriatus, and Platemys platycephala* occur in a wide range all over Amazonian South America, while *Mesoclemmys nasuta* is endemic to the Guyana Shield region (Iverson 1992). The possible fifth species is *Phrynops tuberosus*, a member of the taxonomically problematic *Phrynops geoffroanus* complex. According to some authors (Pritchard & Trebbau 1984, Iverson 1992) there are no locality records from French Guyana. Pritchard & Trebbau (1984) state that the locality of Cayenne for the type specimen of *Phrynops geoffroanus* was not justified and speculate that Cayenne may be the port of exportation to Europe. In secondary literature (Fritz & Havas 2007, Vetter 2005), the distribution of *Phrynops tuberosus* is described as follows: North eastern South America (eastern and southern Venezuela, Guyanas, Surinam, north-eastern Brazil). Unfortunately there are no references cited where these data came from. Since there are also no records on *Phrynops tuberosus* from field excursions by hobbyists, there is a great chance that *P.*

tuberosus is not occurring in French Guyana and therefore is excluded from this thesis. *Chelus fimbriatus* is well known for the Marais de Kaw and all bigger river systems, but due to the fact that it has not been recorded for the Nouragues Reserve (the main area of focus of field work for this study), it is excluded too.

The last comprehensive review of the biology of South American chelid turtles, "The turtles of Venezuela" was published by Pritchard & Trebbau in 1984. Although the book's name indicates that only Venezuelan species are being covered, still many species with pan-Amazonian distribution are discussed in this work. Aspects like skeletal features and fossil records hardly changed since then; therefore they are not covered in this work.
Besides the increasing amount of available data on natural history of chelid turtles, which is attempted to compile in this work, the still not fully resolved taxonomy of this group is also updated. While in 1984 many chelid turtles were assigned to the genus *Phrynops*, this name is currently only used for big-sized, small-headed species of the *Phrynops geoffroanus* complex and for P. *hilarii*. Following the systematics proposed by the turtle taxonomy working group (2009), the small and the broad-headed species are summarized under the genus *Mesoclemmys*, which will probably change in the coming years too. In Pritchard & Trebbau (1984) the genus *Platemys* WAGLER, 1830 included four species because the description of *Platemys* (now *Acanthochelys*) *macrocephala* RHODIN, MITTERMEIER & MCMORRIS 1984 was published after the book on turtles of Venezuela. In 2010, the only remaining species in the genus is *P. platycephala* SCHNEIDER, 1792, leaving the genus *Platemys* WAGLER, 1830 monotypic. The other species that were assigned to *Platemys* in the past are now assigned to the genus *Acanthochelys*, GRAY 1873.

Expectations

In this study I review the current available literature on ecology of chelid turtles in French Guyana, compare the compiled data to those acquired via questioning of keepers of captive specimens and add my own observations from the field and from several years of captive keeping and breeding. Additionally, interviews with the local villagers of Kaw were carried out to determine possible threats and to explore common knowledge among the local people. A comparison of data from the field and from captivity may lead to new insights into the biology of the elusive chelid turtles of French Guyana.

Materials & Methods

Literature acquisition

To acquire information on chelid turtles, the following methods of searching were used. Keywords were the scientific names of the target species using old and recent taxonomy: “Mesoclemmys”, “Phrynops”, “Batrachemys”, “Platemys”, “gibba”, “gibbus”, “nasuta”, “nasutus”, “platycephala”. Internet search for open access papers and reports was done via google and google scholar, search in peer reviewed literature included popular databases like ISI Web of Knowledge, PubMed, Blackwell Elsevier, etc.. Access to these journals was partially granted through the MetaLib^{TM} service of the library of the University of Vienna. The herpetological library of the Museum of Natural History, Vienna and my personal collection of literature provided additional information. Further literature was obtained from the Chelonian Research Institute in Oviedo, FL, USA. Locality data were also obtained through literature. These compilated localities were complemented by personal records and through personal communications.

Museum specimens

Voucher specimens of chelid turtles from the Guyanas were measured in the museums in Vienna (NMW) and London (NHM) and in the Chelonian Research Institute (CRI) in Oviedo, FL, USA. If possible, locality, CL, CW, PL and PW were recorded (for a table of abbreviations see Appendix I). The CRI offered a type catalogue including CL and visiting time there was very limited, therefore other measurements were not taken.

Survey of data from captive keeping

To receive more data on reproduction and lifestyle of chelid turtles, I contacted private and professional keepers of these animals and added my own observations. Although not every aspect of captive keeping can be thoroughly compared to natural conditions, some observations are still useful for science. Especially stereotypic behaviour like courtship and feeding mechanisms are hardly influenced and are seldom observed in nature. Contacts were mostly made during meetings of herpetological societies (WCH6 in Manaus, annual meetings of the German Chelonia Group, Internationale Schildkröten Vereinigung and Österreichische

Gesellschaft für Herpetologie) and over the internet at the webforums of www.chelidae.com. All names of keepers are known to me, but not all of the keepers wanted their names to be published.

Field work

Field work in the Nouragues reserve, French Guyana was done in August 2008, February 2009 and February 2010. Totally, 50 days were spent in the field and were used to search for turtles, surveying habitats and analyzing habitat parameters.
To effectively catch as many turtles as possible, the following methods adapted to the lifestyle of different species were used to cover different habitats of the chelid turtles:

Aquatic trapping:
For this study five funnel traps as used by Magnusson et al. (1997) and Caputo & Vogt (2008) were set up to catch individuals. The traps were self made of mesh wire with 10 mm aperture. The length of the traps was approximately 150 cm, diameter was approximately 70 cm. The entrance holes had an approximate diameter of 30 cm. On the upper side there was a closable opening for easy access. The traps were either non-baited or equipped with half opened fish cans (preferable mackerel in oil).
Because there are no turtle related studies published before in the area and to cover different aquatic habitats suiting the target species, trap locations were changed from time to time in 2009. If the area around the traps would fall dry, possibly attracted turtles were not able to access the traps. In that case the traps were transferred to another, possibly more attractive location. Every trap was set up in a way that a part of the trap would always stick out of the water, so caught turtles would not drown. This also made it easier to find them.
The traps were set up near a track along the Aratye River that was established by other scientists for a study on mammals in the rainforest. Sites with different hydrological connectivity to the river were chosen to cover a broad spectrum of microhabitats since it is not completely clear which habitats the chelids, especially *Mesoclemmys gibba* and *Mesoclemmys nasuta* prefer. Habitats included were: Oxbows, backwaters, palm swamps and forest streams.

Check walks:

During a check-walk of the traps, several chosen areas were also searched to collect turtles. The aim was not only to find turtles, but also to find other, off track ponds, oxbows and creeks that offer good places for trap positioning. These check-walks mostly lasted between 90 and 250 minutes and were done at different times of the day to cover diurnally as well as nocturnally active turtles. They were also done regardless of the weather, because rainfall seems to be a stimulus for mating and feeding activities in many turtle species (personal obs.). Based on observations from 2009, the traps were set up along the bigger forest creek near Camp Pararé in 2010 and were checked every other day.

Aquatic habitats:

Turtles are often hiding in locations under water that cannot be seen from above the surface. Snorkelling in suitable waterbodies enables researchers to learn more about hiding places and rarely observed behaviour. Where possible, a diving mask with a snorkel was used to explore aquatic habitats.

To compare habitats and to explore habitat requirements for chelid turtles, areas where turtles where found or were supposed to occur were analysed. Therefore six types of waterbodies were defined:

Arataye River (AR): Arataye river near the Pararé camp (N = 1).

Forest creek (FC): Small creeks in primary rainforest which permanently carry water (N = 4).

Flooded Forest (FF): Ephemeral ponds in primary rainforest which show up after heavy rainfall and flooding events (N = 1).

Kaw Pond (KP): Ephemeral and permanent anuran breeding ponds along the road to Kaw and around Kaw village (N = 4).

Kaw River (KR): Kaw river at the board dock of Kaw village (N = 1).

Palm swamp (PS): Swampy areas in primary rainforest that can dry up, but always have moist soil. Palm trees are the predominant plants (N = 2).

These habitat types were defined through data of both quantitative (water parameters and general morphology) and qualitative nature (presence/absence of associated animal groups and soil types). For length measurements, commercially available scales were used. Macrophyte and canopy cover were visually estimated. Stream velocity was calculated by letting a tennis ball travel a distance of 3 m in lotic water bodies and noting the time it took to

complete the distance. Temperature, pH and conductivity were measured with a pH-meter by Hanna Instruments, type HI0981. Measurements were taken 4-6 cm below the surface. Nitrite (NO_2), Nitrate (NO_3), Phosphate (PO_4), total hardness (GH), carbonic hardness (KH), carbon dioxide (CO_2) and iron (Fe) contents of the waterbody were measured with the Testlab water testing kit by JBL.

Qualitative data were gathered by visual surveys of the area close to the location where water parameters were determined. Associated animal groups were chosen by means of possible food items. If animal groups or substrate types different to the ones in the checklist were occurring, they were noted separately.

Results

Hump-backed sideneck turtle

Mesoclemmys gibba (SCHWEIGGER, 1812)

Original description: Schweigger, A. F. 1812. Prodromus monographiae Cheloniorum. Koenigsberger Archiv für Naturwissenschaft und Mathematik 1: 299.

Terra typica: "Patria ignota - Vidi specimen in museo Parisiensi."

Restricted to surroundings of Cayenne, French Guyana by Bour and Pauler (1987)

Local names: Platémyde bossue (French), To'tue se'pent (Créole), Mara-youbeta (Carib Indians, Galibi region), Watra-sekrepatoe, kromniki, arakaka (Surinaams); Cágado de poças da floresta (Brazilian Portuguese) (Mittermeier et al. 1980; Vogt 2008)

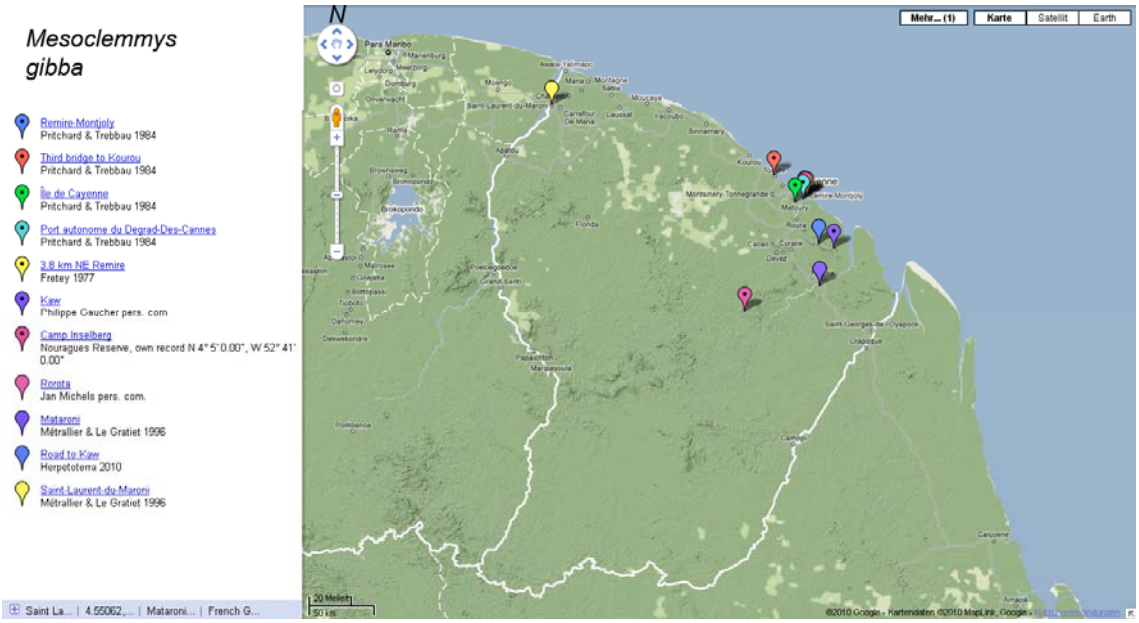

Figure 3: ***Mesoclemmys gibba*****, distribution map in French Guyana**

Description

Mesoclemmys gibba is a small to medium sized turtle that usually reaches sizes of approximately 18 to 19 cm, but males of more than 20 cm SCL (Michels, pers. Comm.) and females of more than 23 cm SCL are also known (Pritchard & Trebbau 1984). The carapace is oval-shaped and uniformly dark. The bridge and the undersides of the marginals are of cream white colouration. The plastron is of dark colour, but sometimes the borders are also cream white. The outer parts of the limbs as well as the dorsal part of the head are dark grey. Juveniles have a vermiculated head pattern, but the markings fade with age. Generally the

juveniles are brighter and lighter coloured than the adults. The head is generally narrow (per definition by McCord et al. 2001, head width is typically 15-20% of the carapax length), but especially females sometimes show slightly enlarged heads. The ventral parts of the head are cream white coloured, while the upper jaw sometimes shows some vermiculated patterns. Other prominent features of the head are the two chin barbels, skin appendages that have a high density of nerve cells. They are supposed to enable the turtle to orientate under dark or turbid conditions while foraging (Winokur 1982). The species possesses musk glands at the rear parts of the bridge which are used for self defence if the turtle is attacked or picked up. The stench reminds one of old cheese, a reason why it is not consumed in large numbers by local people all over the Amazon (pers. Obs., Rueda-Almonacid et al. 2007). Bour (2005) gives a detailed description of the holotype of *M. gibba* and of nominal species currently synonymized with *M. gibba*, explaining the taxonomical history of the name currently used. To date, no subspecies are recognized, but some authors (Bour & Pauler 1987, McCord 2001) mention a gradual variation between eastern and western populations. In Table 2 of Appendix II, morphometrical and locality data of *M. gibba* from the Guyana shield are presented. Mean SCL of Guyana populations is 155.4 ± 19.0 mm regardless of sex (N = 56) but without incorporating juveniles. If sex is regarded, mean SCL for males is 143.3 ± 17.48 mm (N = 24) and mean SCL for females is 161.3 ± 16.75 mm (N = 23). Sexual dimorphism is not very pronounced in this species, but males generally stay smaller, which also holds true for the presented data in this work (tested with ANOVA, F = 12.99; P = 0.00078). Males also have longer tails, and the cloacal opening lies closer to the tip. Females in turn are usually heavier because of a bulkier shape.

The diploid number of chromosomes in *M. gibba* was reported as 2n = 50; 2n = 60 and 2n = 58 (McBee et al. 1985). Pieau & Dorizzi (2004) report GSD patterns during incubation, indicating that *M. gibba* possesses heteromorphic sex chromosomes.

Figure 4: ***Mesoclemmys gibba*****, ventral view. Left = female, right = male**

Figure 5: ***M. gibba*****, ventral view. Left = 1 year old juvenile, right = few weeks old juvenile**

Figure 6: ***M. gibba*****, frontal view**

Distribution

The hump-backed sideneck or gibba turtle is wide-spread in the tropical lowland rainforests of South America. According to Iverson (1992) its pan-Amazonian distribution includes the countries of Ecuador, Colombia, Venezuela, Peru, Brazil, Venezuela, Guyana, Surinam, French Guyana and Trinidad. Vogt (2008) also mentions an area of occurrence in Paraguay, but according to Thomas Vinke this is very doubtful (pers. comm.). Rueda-Almonacid et al. (2008) add northern Bolivia to the range of distribution, but do not cite any locality records. In French Guyana it is found all across the country in swampy areas in or near primary rainforests and gallery forests (figure 3). Recorded localities are Rémire, "the road from Cayenne to Kourou", "Degrad des Cannes-Pascaud", "Near Ille de Cayenne" and "North East of Rémire" (all from Pritchard & Trebbau 1984). Michels found one male in the forest of Rorota on the peninsula of Cayenne (pers. comm.).There are also records from the Nouragues Reserve near the camps at the Inselberg and Arataii sites (pers. obs., Ringler pers. comm.). The herpetologically famous road to the village of Kaw is also recorded as locality of *M. gibba* (Gaucher pers. comm., Herpetoterra 2010). Unlike stated in Métrailler & Le Gratiet (1996), missing localities from the center and south of French Guyana do not indicate that the species is not occurring there, it rather reflects the remoteness and therefore lack of herpetological knowledge of these areas. According to interviews done during the 2010 field trip, the turtle is known by the local people of the Kaw village, but because of the small commercial and nutritional value it is mostly ignored. All currently known records in French Guyana are indicated in the given distribution map.

Figure 7: Habitat of *Mesoclemmys gibba* in the Nouragues Reserve

Habitat and activity

Mesoclemmys gibba prefers marshy areas, ponds and streams in or near primary rainforests or gallery forests, mostly under closed canopy situations (Fretey 1977, Dixon & Soini 1977, Rueda-Almonacid et al. 2008, figure 7). Vogt (2008) adds that this species is commonly found in permanent black- or whitewater ponds where Buriti palms (*Mauritia flexuosa* Arecales: Arecaceae) are growing. He also mentions that he has never found it in temporary rain filled pools. Contrary to that, I found a dead female in a temporary forest pool that is used by amphibians as an explosive breeding site where I also found *Platemys platycephala*. Ringler and Gaucher (pers. comm.) observed the species in temporary amphibian breeding pools near the camp Arataii in the Nouragues Reserve. Barrio-Amorós and Narbaiza (2008) describe small creeks and lakes in the rainforest as habitat.

In a study on *Pseudis bolbodactyla* (Anura: Pseudidae) conducted by Brandão et al. (2003) at a field study site in the state of Goias, Brazil, one of four artificial ponds was inhabited by *M. gibba*. The estimated area was 180 m², while the maximum depth was 3 m and about 40% of the surface was covered with plants of the families Cyperaceae, Poaceae and Xyridaceae. Aquatic macrophytes were also abundant. Because the pond was created through damming a forest creek, fish were present. Along with *P. bolbodactyla* there were 17 other species of anurans recorded at the pond. The frog's stomachs were found to be filled with animals of the taxa Insecta and Arachnida, which means that these animals were also present at the study site. These findings correspond well with own results from visual surveys of a possible habitat in the Kaw reserve in 2010 (Appendix III). Those surveys along the road to Kaw (where these turtles are sometimes encountered by local inhabitants) showed that both temporary and permanent forest pools are present and may serve as microhabitats for the turtles.

Further information on the habitat of *M. gibba* is given by Mittermeier et al. (1978), who also describe small forest streams and ponds under closed canopy as habitat. From captive observations they also conclude that gibba turtles aestivate during the dry season when ponds are disappearing. Another observation of Mittermeier et al. (1978) is that many waterbodies where *M. gibba* is occurring have a thick layer of mud at the bottom. This was also mentioned by Jan Michels who found a female *M. gibba* near Rémire in an approximately 120 cm deep pond, which was filled with so much mud, that only 10 cm were free water (pers. comm.). Such a layer of mud may prevent the turtles from dehydration during seasons of drought and provide protection against predators.

At the Tiputini Biodiversity Station in Ecuador, *M. gibba* was recorded in close distance (10 m) to the Tiputini river in an ephemeral swamp created through a rain-related flooding event

in the area, living in sympatry with another chelid, *Mesoclemmys raniceps* GRAY, 1856 (Cisneros-Heredia 2006). The schematic map of the area surrounding the Tiputini River Biodiversity station (Figure 1) illustrates the different habitats used by chelid turtles.

Métrailler and Le Gratiet (1996) provide data on physico-chemical parameters of a pond where *M. gibba* was found in French Guyana. These data are incorporated in Appendix III for comparison with own data from 2010. They also mention that animals of this species bury themselves in mud near water holes during the dry season and thus suppose aestivation.

Most authors describe the hump-backed sideneck turtle as a primarily nocturnal species that forages during the night and is especially active during periods of rainfall (Mittermeier et al. 1978, Rueda-Almonacid 2008, Métrailler & Le Gratiet 1996). Animals found outside of waterbodies like creeks or ponds often migrate through or rest in puddles that are formed during heavy rainfall or flooding (Ringler pers. comm., Hoogmoed pers. comm., Métrailler & Le Gratiet 1996).

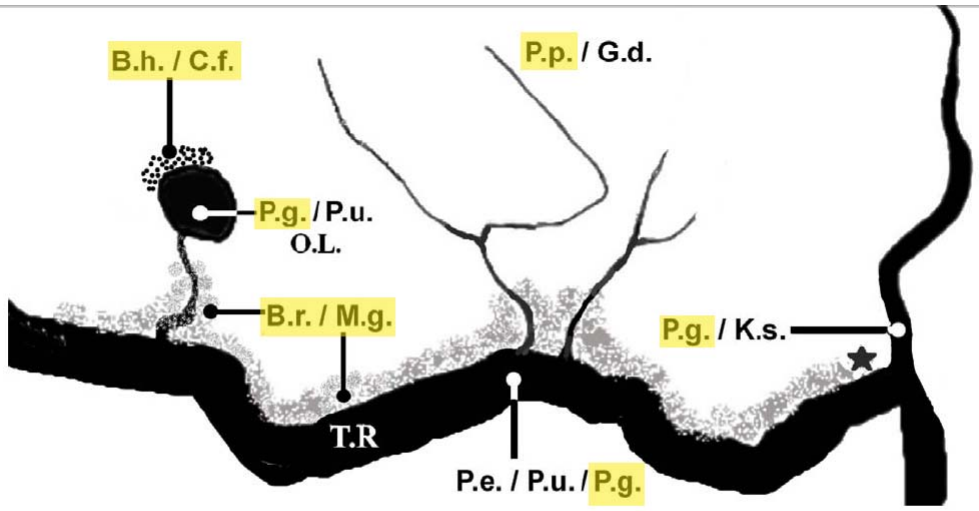

Figure 7. Schematic map of a section of the Tiputini River (T.R.) at the Tiputini Biodiversity Station (station laboratory = star), province of Orellana, Ecuador; indicating habitat preferences by ten chelonian species. O.L. = oxbow lake; dotted area next to oxbow lake = non-seasonally flooded shallow swamp; gray shadow areas = seasonally flooded forest. B.h. = Batrachemys heliostemma; B.r. = Batrachemys raniceps, C.f. = Chelus fimbratus, G.d. = Geochelone denticulata, K.s. = Kinosternon scorpioides, M.g. = Mesoclemmys gibba, P.g. = P.p, = Platemys platycephala, P.e. = Podocnemis expansa, P.u. = Podocnemis unifilis. P.g. = *Phrynops geoffroanus*

Figure 8: Schematic map of the Tiputini River Biodiversity Station, modified after Cisneros-Heredia (2006). Chelid turtle species are highlighted in yellow, the abbreviation P. g. was corrected to "*Phrynops geoffroanus*"

Food items

Possible prey items in temporary ponds surveyed along the road to Kaw and in the Kaw Reserve included insect and amphibian larvae as well as fish of the family Rivulidae. If the species also directly inhabits the swamps of Kaw, a countless number of other fish species, crustaceans (mostly palaemonid shrimps) and molluscs would also be available.

Brandão et al (2003) found animals of the taxa Insecta and Arachnida in stomachs of dissected *Pseudis bolbodactyla* (Anura, Pseudidae) originating from a pond where *M. gibba* was also found. According to Vogt (2008), Mittermeier et al. (1978) and Métrailler and Le Gratiet (1996) these could also be part of the diet of *Mesoclemmys gibba*. Amphibians and their larvae are also possible prey items, because they use similar habitats as *M. gibba*. Vogt (2008) and Mittermeier et al. (1978) also mention that a certain amount of plant material (especially palm seeds and fruits of *Mauritia flexuosa*, Arecales, Arecaceae) is consumed. Métrailler and Le Gratiet (1996) found aquatic algae, florescences of aquatic macrophytes and seeds as well as insect and crustacean parts in faeces of freshly caught *M. gibba*. Observations from captive keeping indicate that fish and carrion could also be prey items in the natural habitat (Onkonburi & Formanowicz 1997, Métrailler and Le Gratiet 1996, Rueda-Almonacid et al. 2008). Barrio-Amorós and Narbaiza (2008) caught an adult female with a fish-baited hook and reported that juveniles will eat grasses (*Pennisetum purpureum* Poales: Poaceae and *Saccharum sinensis* Poales: Panicoideae) in captivity.

Reproduction

Stereotypic mating behaviour is described for at least four species of South American chelid turtles: *Phrynops hilarii* (Fritz & Mann 1993), *Hydromedusa maximiliani* (Novelli and DeSousa 2007), *Platemys platycephala* (Medem, 1983a and Harding, 1983 in Pritchard & Trebbau, 1984) and *Mesoclemmys vanderhaegei* (Brito et al. 2009). In *Mesoclemmys gibba*, stereotypic behaviour that leads to successful copulation is not described under natural conditions, but known from captive specimens. This is discussed in the chapter “experiences in captivity”. The eggs of *M. gibba* are usually elongate and hard-shelled. The large size of the eggs allows only small clutch sizes of usually two to four eggs (Métrailler and Le Gratiet 1996, Mittermeier et al. 1978). According to Bour and Pauler (1987), eggs have medium lengths of 45 ± 1 mm, and egg widths are 32 ± 1.5 mm. Egg mass is 25.2 ± 1.8 g (summarized from Medem 1973). Dixon and Soini (1977) reported egg sizes of 44 x 32 mm and 43.5 x

31.5 mm for a female that was caught at the Rio Momón (Peru) and kept under captive conditions. Compared to the mean body size of about 18 cm and thus a weight of approximately 500 g, total clutch weights of more than 100 g are a considerable energetic effort for an animal (Pritchard & Trebbau 1984), a sign of a K-strategy for reproduction (MacArthur & Wilson 1967), which is also found in other small chelids like *Platemys platycephala*. *Acanthochelys pallidipectoris, A. radiolata* and *A. spixii* (Rueda-Almonacid et al. 2007, Römpp 2008, Cabrera 1998).

Eggs are buried in shallow cavities, hidden under leaf litter or termite nests (Mittermeier et al. 1978, Métrailler & Le Gratiet 1996, Barrio-Amorós and Narbaiza 2008), mostly close to waterbodies in shaded areas.

Incubation takes up to 200 days (Mittermeier et al. 1978), depending on temperatures and moisture of the substrate. In French Guyana, eggs are deposited during the dry season (July to August) and hatch during the rainy season after five to six months (Métrailler and Le Gratiet 1996). To date, no data on temperatures in the incubation chamber under natural conditions have been published. Ewert et al. (2004) state that in *M. gibba* the development of the eggs has a GSD pattern.

Medem (1973) measured freshly hatched hump-backed sideneck turtles from the Rio Vaupes region (Colombia), which had mean SCL of 48 ± 0 mm and a mean weight of 13.75 ± 1.69 g. One hatchling from semi-natural keeping conditions in Surinam had 43 mm SCL and a weight of 10 g. After nearly six months of captive rearing after hatching, the Rio Vaupes hatchlings had mean SCL of 58.7 ± 1.2 mm and mean weight of 22.33 ± 0.81 g which means a growth rate of 22.3% (SCL), respectively 62.4% (weight) (Medem 1973).

Experiences in captivity

In captivity, *Mesoclemmys gibba* is a shy and gentle turtle. The animals in my collection (two females, two males, two captive bred juveniles) are primarily nocturnal, but will eat also during the daytime. Accepted food is: dead fish, insects (Blattodea, Ensifera, Caelifera, Tenebrionidae), molluscs (Gastropoda, Bivalvia), worms (Oligochaeta), crustaceans and commercial pellets. Vegetarian food is commonly ignored, but in times of infrequent feeding and high water temperatures, water plants (*Lemna* sp., Alismatales: Araceae, *Salvinia* sp., Salviniales: Salviniaceae) are also consumed. Bananas and figs were also accepted at rare occasions by juveniles and adults. Generally, the spectrum of accepted feeding items in captivity indicates a carnivorous diet in *M. gibba*.

Basking has almost never been observed in adults, but they will leave the water during the night every once in a while. Stressed specimens seem to use the land area to avoid dominant specimens. The two young hump-backed sideneck turtles can sometimes be seen basking during sunny days.

Because of their gentle behaviour, sexes can be kept together permanently (Niessen 2007, Grossmann 1989), but general practice in modern turtle keeping is to separate the sexes. Co-habitation with other species is not suggested because the shy gibba turtles are usually not fast enough to catch a sufficient amount of food. It is beneficial to have one or more dark places to hide in the keeping unit. The turtles seek out shaded areas during the day and come out only for feeding or breathing.

Mating seems to take place during the night, and a stereotypic mating behaviour has not been described (Niessen 2007, pers. obs.). But if a male is introduced to a female, it will sniff its anal and marginal regions when approaching it. Also, direct facing of the female was observed. The male then began to nod its head quickly, moving it up and down only slightly. These motions are commonly referred to as head bobbing and are part of mating system in other chelids too (Murphy & Lamoreaux 1978, Rhodin et al. 2009).

A small number of publications with data on reproduction in captivity are available in hobbyist literature. Métrailler (2001) and Goode (1988) provide detailed measurements of freshly laid eggs. According to Métrailler, eggs have mean dimensions of 40 mm x 28 mm (N = 77). Unfortunately, standard deviation and data on egg mass are not given. Goode (1988) presents a table including eggs per clutch, mean egg size per clutch, incubation time and in some cases egg mass of 55 eggs from 14 clutches. Reported minimum egg dimensions were 34 mm for length and 13.5 mm for width, reported maxima were 48 mm (length) and 32 mm (width). Clutch size was mostly three or four eggs, but in one occasion seven rather small eggs were laid (mean dimensions 35.1 x 24.4 mm, mean egg mass = 13.5 g). A summary of own data, mailed comments from fellow breeder R. Blainvillain and data from an article by Grossmann (1989) shows mean egg dimensions of 44.0 ± 2.7 mm x 29.6 ± 1.3 mm and 24.9 ± 4.4 g with N = 28, but unfortunately the sizes of females and their origin is not known for the eggs of Grossmann and Blainvillain.

Most eggs hatch after 140 to 180 days (pers. obs., Grossmann 1989). Métrailler (2001) reports the emergence of the hatchlings at incubation temperatures of 28-29 °C after a mean incubation period of 152.9 days (N = 31, min = 116 d, max = 200 d). In two cases, temperatures were 27 °C and 25 °C during the day and the night, respectively. The hatchlings emerged after 252 and 270 days. Niessen (2007) reports an incubation period of 197 days

after incubation at temperatures of 28-29 °C and a relative humidity of 80-90%, but only for two eggs. Mean incubation time reported by Goode (1988) at temperatures between 26 and 31 °C was 178.1 ± 25.09 days (N = 20), with a minimum of 140 days and a maximum of 248 days.

In some cases (Medem 1973, Grossmann 1989, Dixon & Soini 1977), eggs were manually opened by the keeper because many embryos died in late stages of their development, often with a fully absorbed yolk sac. Personal observations have shown that hatching is induced by increasing humidity in the substrate when the embryos are fully developed, which is also described by Goode (1988). The hatchlings lie on their backs and break the eggshell with their feet rather than using their egg tooth (pers. obs.). When applying this method, the animals have never had any yolk sacs left when leaving the egg. Lehmann (1987) hypothesizes about egg shell erosion through dissociated carbonic acid: H_2CO_3 is built up in wet substrate, because the H_2O from the environment reacts with CO_2 from the embryo. Lehmann's hypothesis is based on an observation in American alligators (Ferguson 1981). The acid may help the turtles to hatch by corroding the egg shell, but this still does not explain the (for turtles) rather untypical position of hatching neonates.

Hatchlings are rather large and have a SCL of approximately 40-50 mm (pers. obs., Grossmann 1989). As with all turtles, growth rates of hatchlings are dependent on temperature and food items or feeding intervals. Therefore data from different sources are difficult to compare due to different feeding schemes and used foods. Grossmann (1989) reports mean hatchling sizes of 51 ± 2 mm SCL and weights of 18.6 ± 0.2 g (N = 8). After 6 months, the hatchling of Niessen (2007) was 71 mm (SCL) long. Five-year old adults bred by Métrailler had SCLs of 155 and 160 mm (females) and 140 mm (male); unfortunately, there is no weight reported (Métrailler 2001). Goode (1988) provides tables for males and females which show growth over several years. Two captive bred females grew from hatchling to 190 mm and 191 mm SCL, respectively, in nearly eight years, laying eggs for the first time after six years and 116 days (at 187 mm SCL) and five years and 85 days (at 184 mm SCL), respectively. Males grew from hatchling to a maximum of 187 mm SCL in little more than six years, starting to attempt copulation in their fourth year at approximately 150 mm SCL.

Mittermeier et al. (1978) report that specimens kept in captivity are often prone to fungal infections. Goode (1988) also acknowledges that *M. gibba* are prone to infections and necrosis. While marking individuals by scarring plastral scutes in 450 specimens of 48 taxa over the years from 1977 to 1985, five of six reported cases of complications involved *M. gibba*. This has also been observed by myself, especially in juveniles and when water

temperatures have been low. In 2009, one freshly hatched juvenile died from such an infection, because treatment was started too late. Usually treatment with antifungal drugs and catappa leaves (*Terminalia catappa*, Myrtales, Combretaceae) combined with high temperatures help to fight the infection. Besides that, juveniles are easy to care for and will grow quickly.

Common toad-headed turtle

Mesoclemmys nasuta (SCHWEIGGER, 1812)

Original description: Schweigger, A.F. 1812. Prodromus monographiae Cheloniorum. Koenigsberg. Arch. Naturw. Math. 1:299.

Terra typica: Patria ignota

Local names: Platémyde de Schweigger (French), Ayoulouta (Oyampi Indians), Kromnikki, Arakaka, Watra-sekrepatoe (Surinaams); Cágado da cabeça de sapo comum, Lalá (Brazilian Portuguese) (Mittermeier et al. 1980; Vogt 2008)

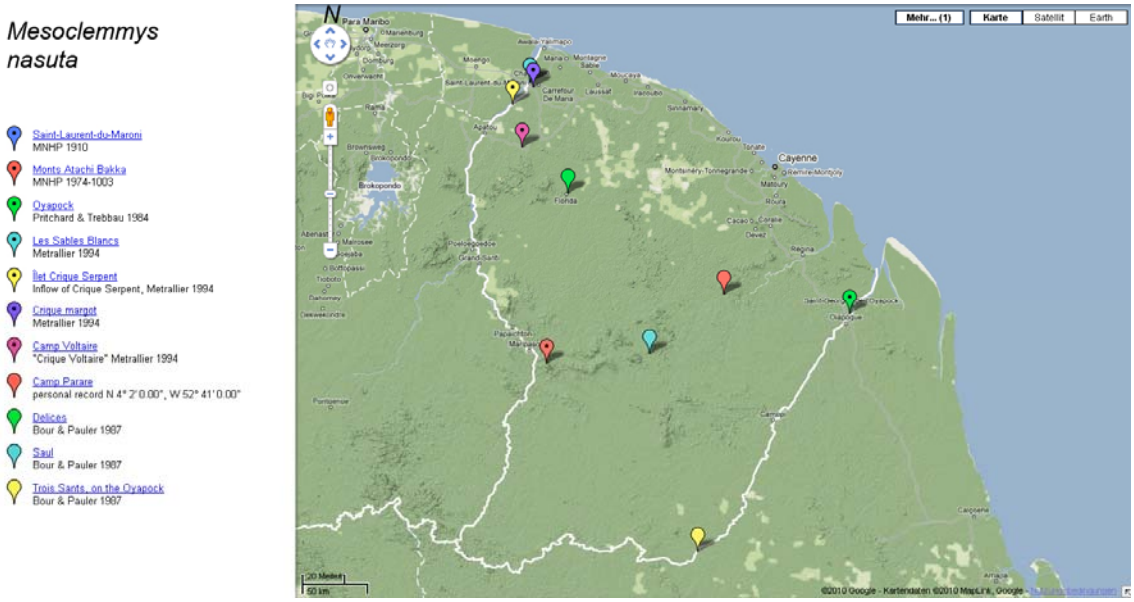

Figure 9: ***Mesoclemmys nasuta*****, distribution map in French Guyana.**

Description

The most prominent feature of *Mesoclemmys nasuta* is its large head, which is always wider than 20% of the straight carapace length (SCL) (measured from tympanum to tympanum, McCord 2001). The reported maximum carapace length is 371 mm, known from a specimen in the turtle collection of the CRI, Oviedo, USA. Most adults have a maximum SCL of about 300 mm (females) and about 320 mm (males) (Bour & Pauler 1987), which indicates that there is no sexual size dimorphism. Measurements of examined specimens from museum and live collections are presented in Appendix II, table 3. The mean SCL of the studied specimens is 250 ± 47 mm (N = 41), regardless of sex, but without inclusion of juveniles. The mean SCL of males is 264 ± 54 mm (N = 14), while the mean female SCL is 253 ± 43 mm (N = 9).

Using ANOVA, no significant size dimorphism between males and females could be detected ($F = 0.28692$, $P = 0.598$).

The shape of the carapace is rather ellipsoid, while the plastron is wider on the cranial side than on the caudal side. The typical colouration of adults is composed of an entirely chestnut to dark brown carapace, while the plastron usually has a light rim with dark pigmentation in the centre. The limbs and the tail are mostly gray to black, but under the carapace the skin is cream-coloured. On the dorsal side, the head is uniformly grey. The jaws and the ventral sides of the neck and head are cream-coloured as well. *M. nasuta* has paired chin barbels that are clearly visible, but not as pronounced as in the genus *Phrynops* WAGLER, 1830. Like in most species of South American chelid turtles, *M. nasuta* possesses musk glands on the bridge.

Males have longer and thicker tails than females, and the cloaca is located closer to the tip of the tail. In old males the plastron can be concave. Old specimens of both sexes sometimes show a medial groove on the carapace. Juveniles show wide heads as well, but are darker coloured than adults. Bour (2007) provides a detailed description including the turbulent taxonomic history of the holotype (MNHN 4140), which is a juvenile specimen.

Figure 10a: Forest creek near Camp Pararé during a period without significant rainfall.

Figure 10b: The same site after a few days of heavy rainfall, picture taken from the opposed side of the creek

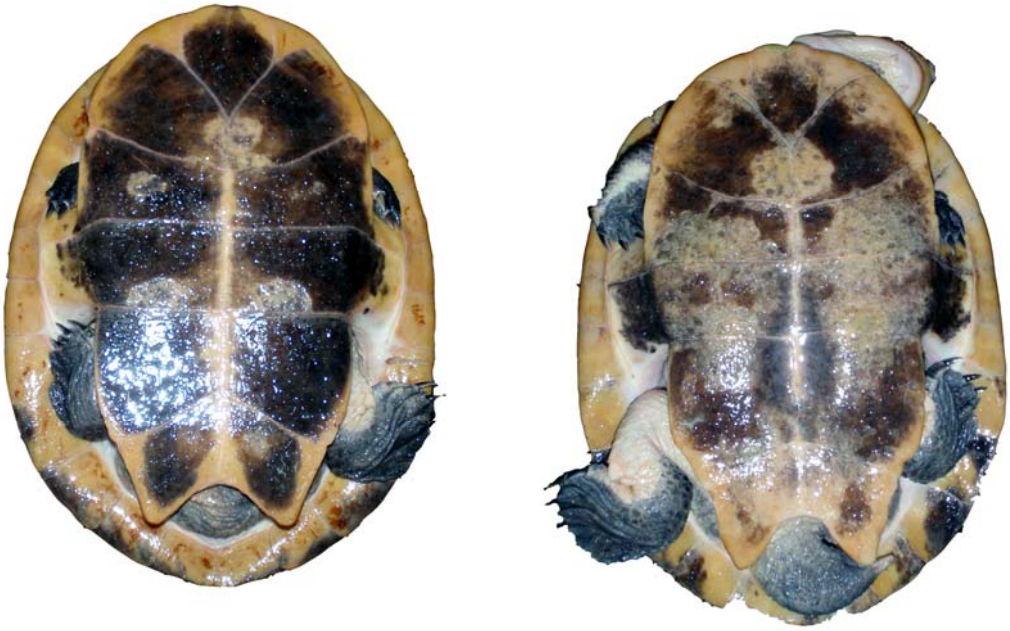

Figure 11: ***Mesoclemmys nasuta*****, ventral view. Left = female, Right = male**

Figure 12: ***M. nasuta*****, dorso-lateral view**

Distribution

Unfortunately, Schweigger's description of the species (Schweigger 1812) is very vague and the type locality is stated as "Patria ignota" because he designated a specimen of unknown origin as the holotype in the MNHN in Paris. This led to a good amount of uncertainty about the distribution of the species, although Duméril & Bibron (1835) restricted the terra typica to "Amérique méridionale" until Bour & Pauler (1987) revised the taxonomic status of the broad-headed members of the genus *Phrynops*. The central Amazonian populations, previously known as the subspecies *Phrynops nasutus wermuthi* MERTENS, 1969, were elevated to a full species (now called *Mesoclemmys raniceps* GRAY, 1855), separating the north-eastern populations of the former taxon *Phrynops nasutus* (now *Mesoclemmys nasuta*) and making it endemic to the Guyana shield (with distribution records in Suriname, French Guyana and northern Brazil). Because the two taxa *M. raniceps* and *M. nasuta* resemble each other strongly, they are often confused. Therefore a number of records with doubtful localities of *M. nasuta* exist, such as Paraguay, Bolivia and Southern Brazil (Iverson 1992, Embert 2007). Since little is known about the biogeography and taxonomy of broad-headed chelid turtles, future (genetical and morphological) studies (Michels, pers. comm., McCord, pers. comm.) will have to tell whether these records represent unknown species or extend the range of the already known ones.

In French Guyana most recorded localities are in the North-West and in the central western part of the country (Bour & Pauler 1987, Métrailler 1995), but during the present study this species was also found in the Nouragues Reserve (see figure 9). Its presence there was also reported by local scientists (P. Gaucher, pers. com.). In areas where *M. nasuta* occurs, it is rare to find, which indicates low population densities (Métrailler & LeGratiet 1996, Gaucher, pers. comm., pers. obs.).

Habitat and activity

Reports and publications about the ecology of *Mesoclemmys nasuta* are scarce and observations in the natural environment are rarely made by scientists. The animals seem to be very shy and have an elusive lifestyle that includes resting under logs and in crevices under water during the day and being active only by night or dawn. From 122 observations of turtles during a study by LeGratiet (1989), only 5 involved *Mesoclemmys nasuta*. All of them were in or in near distance to creeks in forest environments. Vogt (2008) also describes the

preferred habitat as slow moving areas of rivers, lakes, ponds and canals. During field work in February 2009, I caught one subadult specimen in a funnel trap, which was deposited at the meeting point of two small streams with a width of approximately 3-5 metres, located in the primary rainforest of the Nouragues Reserve in French Guyana (see figure 13). The water was clear, but of brown colour and without submersed macrophytes. Several branches of trees were dangling into the water, and submerged tree trunks provided hiding places. In 2010, one male specimen was collected during a flooding event in the forest near Camp Pararé and near the place where the 2009 specimen had been found. It was encountered in a flooded palm swamp at approximately 8 a.m., migrating through shallow water with a depth of approximately 30 cm. The forest had been flooded within only two to three days and the point where the turtle was found was usually dry (see figure 10a and 10b).

Sometimes specimens are found along roads or in roadside ditches (Métrailler 1994). In their book about the turtles of French Guyana, Métrailler & LeGratiet (1996) describe the water parameters in the habitat of *M. nasuta* at a site at the Crique Voltaire, where *M. nasuta* was encountered. The water temperature was 25 °C. The other parameters were pH = 5.9 and GH = 0°. At this site two specimens were found: One young *M. nasuta* was caught in a muddy pool near the creek. The pool covered an area of approximately 35 m by 7 m and was 1.5 to 2 m deep. The second specimen (a large female) was caught directly in the creek, which was 2 to 3 m deep at this site. Personal measurements revealed that forest streams which provide a habitat for *M. nasuta* have mean water temperatures of 25.2 °C, mean pH = 6.5, and mena GH = 1.25° (N = 4). During dry periods without significant rainfall, these streams have a mean depth of 35 cm and a mean flow velocity of 0.15 m/s. After heavy rainfalls, they increase their volumes by several hundred percent, which is shown in the figure 8. The substrate of these creeks' streambeds consists mostly of sand, gravel and fallen leaves in zones of slow water velocity. Fallen logs and branches are common and sometimes block the whole creek. Mean estimated canopy cover of these streams is 80%, with smaller streams being completely shaded for the whole day. For a complete overview, see Appendix III.

To date, there are no detailed studies available on the movements and habitat usage of *M. nasuta*. A study using radio telemetry (and a mark-recapture method) on the Red toad-headed turtle *Rhinemys rufipes* (Magnusson et al. 1997) showed that this species inhabits forest creeks in the primary rainforest and has home ranges of about 1-2 linear kilometres of stream. A publication on Dahl's toad-headed turtle (*Mesoclemmys dahli*) in Colombia is currently in preparation (Forero-Medina et al. in prep.).

The *M. nasuta* specimen collected in 2009 (MN1, collected on February 14th, 2009) was equipped with a radio transmitter, but because of the late collection date it could only be tracked once in 2009. The turtle moved only a few metres from the collection site to a sunken tree where it hid in a crevice. In 2010 it could be tracked again (February, 5th 2010). It had moved a little downstream (approximately 40 m of stream length) and was hiding in a hole under the riverbank. Unfortunately, on the second day of field work the turtle was lost, leaving behind the transmitter in a palm swamp a few metres away from the 2009 collection site, which was about 130 m of stream length away from the first point of encounter of 2010. That means that over the course of one year the turtle did not move too far away from the first point of encounter, which could indicate that this area could represent some kind of core area of the specimen's home range. The adult male from 2010 was collected on the last day of field work in Pararé. For this reason, we did not equip it with a radio tag.

Métrailler and LeGratiet (1996) hypothesize that juveniles live in small streams or creeks, subadults are found in pools along rivers and adults inhabit the rivers themselves. Whether this is true or not has not been proven yet, but personal findings of two animals of different life stages (subadult and adult) in the same habitat could indicate that the presumed age-dependent habitat usage theory is not valid in this formulation. Deduced from other turtle species (e. g. *Graptemys* sp., *Apalone sp*., see Ernst & Barbour 2009 and Dalrymple 1977 for detailed descriptions of habitat usage for these genera), it is possible that females, males and juveniles occupy different niche situations, or different trophic niches are used by specimens of the same species in the same biotope but thorough studies are needed to confirm these assumptions.

Figure 13: Habitat of *M. nasuta*.in the Nouragues Reserve

Food items

There are only anecdotal reports on the food spectrum of *Mesoclemmys nasuta*. Métrailler (1994) analysed faeces and found parts of crabs and beetles. In another article (Métrailler 1995), an animal is reported to regurgitate seeds of *Philodendron solimoesense* (Alismatales: Araceae), a plant that is common in the area. From this observation Métrailler & LeGratiet (1996) deduce omnivory for this species, but an anatomical study by Herrel et al. (2002), personal observations on captive specimens and the fact that even typical carnivores like *Chelydra serpentina* or *Staurotypus triporcatus* will sometimes eat vegetable food point to a more carnivorous or at least durophagous diet of *M. nasuta*. In the faeces of two freshly imported animals, seeds of plants were found (pers. obs.).

The streams in the area where I found *Mesoclemmys nasuta* were inhabited by the following possible prey items: fish of the families Characidae, Cichlidae and Siluriformes; snails of the families Ampullarioidea and Thiaridae, shrimps of the genus *Macrobrachium* (Palaemonoidea: Palaeomoninae), and crabs of the family Pseudothelphusidae. Stomach flushing of the two collected specimens showed that the turtles had empty stomachs at the time of their capture. Probably both animals were caught while foraging.

Reproduction

Pritchard & Trebbau (1984) cite an earlier work of Medem (1960) who reports a clutch size of six to eight eggs for specimens from Colombia, but this most likely refers to *Mesoclemmys raniceps*, which was not considered a separate species at the time of publication. Since *M. raniceps* and *M. nasuta* are ecologically and genetically quite similar (Iverson et al. 2007), a clutch size of eight eggs might be possible in *M. nasuta*, too, depending on size and condition of the female. Vogt (2008) states that six to eight round eggs are laid in nests, constructed in low level flat areas near lakes or rivers. Métrailler & LeGratiet (1996) speculate that in French Guyana eggs are deposited during the dry season, which starts in July or August. The fact that eggs of *M. raniceps* need dry substrate during incubation and that increasing humidity and moistening the substrate will induce hatching after about 120 days (pers. obs.) supports Métrailler's theory. In French Guyana the dry period lasts approximately until early December, which is four months after August and thus fits the assumption of Métrailler & LeGratiet, assuming that the incubation period of *M. nasuta* eggs is similar to eggs of *M. raniceps*. According to Bour & Pauler (1987), egg dimensions from nature are unknown.

Experiences in captive keeping

Toad-headed turtles of the genus *Mesoclemmys* are quite uncommon in the pet trade, and despite their relatively limited range, most of the offered animals are *Mesoclemmys nasuta*. This results from the fact that Suriname sometimes allows the exportation of turtle species like *M. nasuta*, *M. gibba*, *Platemys platycephala* and *Rhinoclemmys punctularia* (Ouboter 2001). Despite this, reports and literature about husbandry are not available. Personal communications from other keepers and personal experience with keeping the closely related species *M. raniceps* indicate that *M. nasuta* has a high potential of intraspecific aggression while it is gentle and shy if housed together with other turtle species. Fights look rather brutal, because the dominant turtle will use its strong jaws to bite other animals, preferably in the head or in the limbs. This can lead to heavy abrasions and even shell damage.

In captivity, *M. nasuta* will rest most of the day under logs or in caves and is active at dusk or dawn or by night. Long-term captive and captive bred animals will eat and beg for food during any time of the day. Commonly accepted foods are dead fish, insects (Blattodea, Ensifera, Caelifera, Tenebrionidae), molluscs (Gastropoda, Bivalvia), worms (Oligochaeta), crustaceans and commercial pellets. There is clearly a strong preference for hard-shelled food like clams, shrimps and snails. One big female *M. raniceps* of my personal collection was once offered a wooden stick that was fully overgrown with Zebra mussels (*Dreissena polymorpha* PALLAS 1771*)*. Within several hours, all clams were bitten off the stick and cracked by the female. Herbal food is commonly ignored, but turtle pudding (a gelatinous mass containing chopped food items, see Artner 1998) with a high percentage of herbal food items is eaten. The turtles will also accidently ingest floating water plants if they feed from the surface. While walking on land *M. nasuta* looks rather clumsy, but in the water they act a lot more agile. In shallow water they walk along the bottom, but they are also able to adapt to a high water level like in the Exotarium of the zoo in Frankfurt. This is also one of few zoos that have bred this species (R. Wicker, pers. comm.).

Like in *M. gibba*, basking is only rarely observed in adults. There are also no husbandry records of basking juveniles, but juvenile *M. raniceps* will do so in captivity.

Up to date, no stereotypic mating behaviour has been described for *M. nasuta* in captivity, and there are no data on reproduction available in hobbyist literature. Personal observations on the eggs of captive kept *M. raniceps* show an ellipsoid shape with a mean TL of 38.5 ± 6.7 mm, a mean TW of 28.25 ± 2.2 mm, and a mean weight of 20.33 ± 5.6 g (N = 13) (Böhm 2009), which could be quite similar in *M. nasuta*. In *M. raniceps*, double clutching is possible in captivity (pers. obs.), while it is not reported for *M. nasuta*.

Twist-necked turtle

Platemys platycephala (Schneider, 1792)

Original description: Schneider, J. G. 1792. Beschreibung und Abbildung einer neuen Art von Wasserschildkröte nebst Bestimmungen einiger bisher wenig bekannten fremden Arten. Schrift. Ges. Natur Freunde Berlin 10

Terra typica: "Ost-Indien" (corrected to “Cayenne, French Guiana" by Ernst (1983)

Local names: Platémyde a tête plate; Platémyde a tête jaune (French), To’tue se’pent (Créole), Mara-youbeta (Carib Indians, Galibi region), ayoulouta âkâtawa (Wayapi Indians), Watra-sekrepatoe, kromniki, arakaka (Surinaams); Jabuti machado, lala, perema, machadinha (Brazilian Portuguese) (Mittermeier et al. 1980, Vogt 2008, pers. obs.)

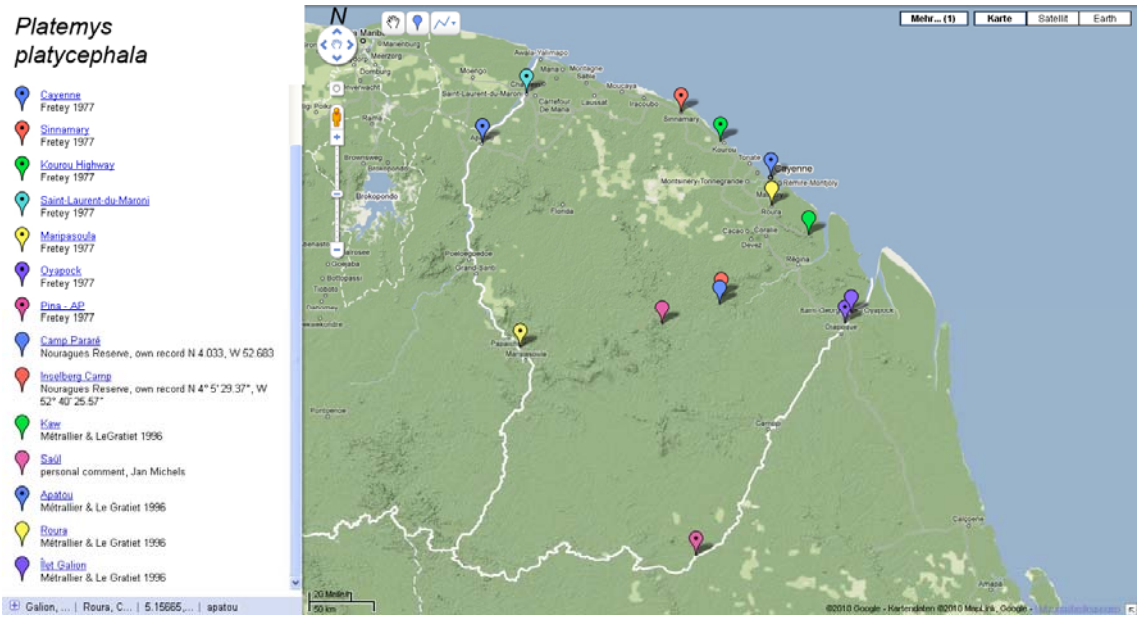

Figure 14: *Platemys platycephala*, distribution map of French Guyana.

Description

With maximum SCL of 17.5 cm (Vogt 2008), *Platemys platycephala* is one of the smaller members of the chelid family. Mean SCL of 69 adult animals of both sexes (Appendix II, Table 4) is 145.4 ± 10.2 mm. ANOVA showed that males are significantly larger than females ($F = 4.0298$; $P = 0.049$), with mean SCL of 148.5 ± 9.1 mm ($N = 27$) for males and 143.2 ± 11.0 mm for females ($N = 33$). Ernst & Lovich (1986) published a series of measurements on 121 specimens of *Platemys platycephala*. Maximum CL was 168.1 mm, no

significant size difference between sexes was found. Statistical analyses showed that CL, CW and CH showed a linear correlation with PL as the turtles grow. Besides that, sexual dimorphism is visible in the anal region. Males have longer and thicker tails, the cloaca lies further distal than in females.

The carapace is ovally shaped and bears a characteristic grove, formed by the vertebral bones and shields. Carapacial colouration is rather cryptic in the rainforest, consisting of broad areas of dark to light brown. These brown areas form a thick stripe across the back in most cases, but there are also animals with uniform carapacial colouration. Viewed from above, the turtles look like a decomposing leaf in the forest. This phenomenon is described by Fretey (1977), who compares the carapacial shape and colouration of *P. platycephala* to plants of the families Leguminosae, Mimosidae and to *Inga sp*. (Fabales: Fabaceae) as well as *Croton sp*. (Malphigiales: Euphorbiaceae). All of these are also occurring in French Guyana.

The plastron is flat and ovally shaped too. Its colour is dark brown to black with a light brown to bright yellow rim on the outside. The bridge is light brown to yellow with a dark blotch and is connected by flexible skin which is expanded in gravid females. The varying degree of dark colouration on the bridge is used for subspecies determination (see chapter distribution). The legs are uniformly dark brown to black and are only poorly webbed. The head is coloured in the same way as the legs, but shows a light to bright yellow stripe extending from the nose through the eyes which fades along the strongly tubercled neck. The paired barbels are small, but visible. Juveniles are coloured in the same way as adults, but show more contrasting colour.

Figure 15: *Platemys platycephala*, ventral view. Left = male, right = female

Figure 16: *P. platycephala*, frontal view

Figure 17: *P. platycephala hatchling*, dorsal view

Karyotypic studies revealed that besides specimens with 2n = 68 (Gorman, 1973, which seems to be errorneous) or 2n = 64 (Barros et al. 1976, McBee et al. 1985) also animals with 96 chromosomes exist, which indicates that these specimens are triploid (Bull & Legler, 1980). Not only the possible triploidy makes *P. platycephala* peculiar in terms of karyology. 2n = 64 is also the highest known diploid number in pleurodiran turtles and among all other chelonians, only trionychid soft shelled turtles have higher diploid numbers (McBee et al. 1985).

McBee et al. (1985) cite Barros et al. (1976) and Bull & Legler (1980) and state that *P. platycephala* does not have sex chromosomes, but Pieau & Dorizzi (2004) report GSD patterns during incubation.

Distribution

Platemys platycephala is widely distributed all over the amazonian area in Bolivia, Brazil, Colombia, Ecuador, French Guyana, Guyana, Peru, Suriname and Venezuela. There are currently two subspecies recognized: *Platemys platycephala melanonota*, ERNST 1984 from the far western parts of Amazonia in Peru and Ecuador and *P. p. platycephala* from the eastern Amazon area. There is a large zone of intergradation in Bolivia, Brazil, Colombia and Peru. Among other hardly recognizeable , the most distinct feature between these two local forms is the amount of black colouration on the bridge. While in the nominate subspecies the bridge is mostly yellow to crème-coloured with a dark blotch, the bridge of *P. p. melanonota* is nearly entirely black. The two subspecies and the gradient of morphological difference are probably a result of the vastness of the amazonian rainforest, which enables forest dwelling species to migrate without any real borders, especially if they are able to swim. Similar tendencies are also known from another amazonian turtle species, *Chelonoidis denticulata* LINNAEUS, 1766 (Vargas-Ramirez et al. 2010).

In French Guyana, *P. p. platycephala* is known from scattered locations but it is most likely to occur all over the country in suitable habitats. Most of the records available were published by Fretey (1977), which are indicated in figure 14 along with personal records and records from Métrallier and LeGratiet (1996).

Habitat and activity

The twist-necked turtle prefers swampy areas in primary and secondary rainforests. Most of the time it rests under roots and leaf litter, where it is camoflagued to predators. It seems like a closed canopy habitat is preferred over open formations. Due to its cryptic coloration and leaf-mimicking appearance this species is mostly found when it enters waterbodies such as temporary forest pools, or inundated areas during the rainy season because it is more conspicuous then. During times of draught, the turtles are able to aestivate (pers. obs.). Dixon and Soini (1977) found *P. platycephala* mostly in swamps and streams in primary forest, which is described in a similar manner by Fretey (1977).

Findings of my telemetry survey in 2009 and 2010 indicate that the twist-necked turtle leads a more terrestrial lifestyle than commonly thought. Over a period of 14 days, only few times turtles were encountered in lentic waterbodies and even more seldom they were found to rest in or along forest streams. The turtles were never found moving or sitting uncovered, except for the times of their first capture. All of the observed turtles moved across hills that were dividing the palm swamps adjacent to the Arataye river, migrating from sometimes inundated areas (floodplain forests and palm swamps) to higher levels with non-flooded (terra firme) forest habitats.

Vogt (2008), Rueda-Almonacid et al. (2007) and Pritchard & Trebbau (1984) describe *P. platycephala* as a primarily nocturnal species. This could not be fully verified in my study, because observed specimens moved between two search-bouts over night as well as during two bouts on the same day. Métrallier and Le Gratiet (1996) also describe it as active during night and day.

One temporary pool (= FF in Appendix III) in the forest where a male specimen was found during a night-walk had an area of 4.7 x 3.3 m and a perimeter of 14.4 m with a mean depth of 14 cm. It appeared after heavy rainfall. Therefore no aquatic macrophytes were present. The bottom of the pond was fully covered with leaves, just like the surrounding forest floor. The estimated canopy cover was 95%. Water temperature was 25 °C, pH was 6.4 and electrical conductivity was 115 μScm^{-1}. Amphibian and insect larvae were present, although the waterbody was established only a short time before. When it did not rain significantly for a period of little more than a week, the pond disappeared. After heavy rainfalls, the pond appeared again and got connected with other small ponds to form a bigger pond which was used by explosive breeding frogs (*Chiasmocleis sp.*, Microhylidae) for courtship displays.

Métrallier and Le Gratiet (1996) report that *P. platycephala* is hard to observe, but can be found during the rainy season when it enters temporary forest ponds. They also mention that the species is nearly impossible to find during the dry season because of their ability to aestivate in times without rainfall. Habitat parameters after two days of heavy rainfall in a forest habitat with several puddles on the forest floor are also given: Air temperature 29 °C , water temperature 24 °C, pH = 6.4, Nitrate = 0 mgl^{-1}, Nitrite = 0 mgl^{-1} and KH = 0 °dH.

Food items

To date, no direct observations on feeding under natural conditions are reported. One specimen was collected by me when it was feeding on freshly laid anuran eggs in a water-filled depression. Some of the gelatinous mass that surrounds the eggs was still sticking to its jaws. Unpublished findings of stomach flushings by Vogt (2008) were primarily tadpoles and anuran eggs as well as some aquatic insects and small fish. Based on the small angle of mouth-opening and the weak jaw musculature, shelled molluscs and shelled crustaceans which are occurring in the same microhabitat are not likely to belong to the natural food spectrum of *P. platycephala*. Smaller shrimps (Family Palaemonidae), living in creeks and lagoons of the rainforest could belong to the food spectrum though. These assumptions were tested by Fretey (1977) by placing forest dwelling crabs in an enclosure for *P. platycephala* in captivity. The turtles did not attack the crustaceans, but what caused the result remained unknown.

Reproduction

Reported matings under natural conditions start with behaviour described by Medem (1983a) and described by Harding (1983) under captive conditions. The male sniffs the bridge of the female and nods its head quickly. Then it mounts the female and switches between head bobbing and swinging the head sideways. Mating *P. platycephala* were observed by both Dixon & Soini (1977) and W. Hödl (pers. comm.) in a temporary pond. Hödl observed the mating at the start of the rainy season during an event of amphibian explosive breeding. Métrallier & Le Gratiet (1996) also report that breeding activities start in the early rainy season in French Guyana under semi-captive conditions. Usually, one egg of enormous size is laid per clutch, which can reach lengths of approx. 1/3 of the gravid female’s body length and

multiple clutches per reproductive season are possible (Rueda-Almonacid et al. 2007, Métrailler & LeGratiet 1996). The eggs are deposited in leaf litter on the forest floor, which is common in smaller forest dwelling chelonians like *Geoemyda spengleri* (Gmelin 1789) and *Cuora galbinifrons* (Bourret 1939). This seems reasonable because the soil in amazonian rainforests is hard and the limbs of *P. platycephala* are rather weak. Also, Lehmann (1987) hypothesizes that the decomposing bacteria among the leaves in combination with the surrounding acidic conditions help to corrode the hard egg shell, making it easier for the embryo to breathe and finally hatch.

Up to date, there are no data available on incubation under natural conditions. Métrailler & LeGratiet (1996) cite a personal communication by Jerome Maran in which the length of incubation is given as 130 to 170 days. Unfortunately it is unclear if under captive or natural conditions. Remarks in Vogt (2008) and Rueda-Almonacid et al. (2007) about a mean incubation length of 5 months are also without a declaration whether observations have been made in captivity or nature.

Figure 18: Habitat of *P. platycephala* in the Nouragues reserve, pictures of all cardinal directions. Top = North, middle from left to right = West, *P. platycephala* hiding, East, bottom = South

Experiences in captive keeping

Platemys platycephala is a well known species in the pet turtle trade. It is popular because of its small size and gentle behaviour. In many cases, animals of different sexes can be kept together without signs of aggression. Usage of the land and water parts of the keeping facilities is variable from specimen to specimen. Keepers report that while some animals stay strictly aquatic, other will rest buried in the substrate of the land area for most of the day. Therefore, setups used for keeping *P. platycephala* range from mainly terrestrial types with a bowl of water for drinking and soaking to fully aquatic tanks with a small dry area. Most individuals won't bask in direct sunlight, but occasionally it is observed.

If seasonal variation of climate including a dry period is simulated, the turtles will bury themselves for some time to rest, but will still accept food.

Food items reported to be accepted are fish, pelleted cat food, gastropods, insects (Blattodea, Ensifera, Caelifera, Tenebrionidae), pinky mice and worms (Oligochaeta) (Bakowskie, pers. com., Thieme & Thieme 1996, Métrallier 2001, Buchert 2010). The species takes up food in or outside of the water, but the act of swallowing is performed only in water.

There is a small number of reports on breeding from hobbyist literature (e.g. Thieme & Thieme 1996, Métrallier 2001), but breeding in significant numbers or with good hatching rate has not been published yet. In one case, several hatchlings were produced, but some of them had scute abnormalities on their carapace (Blanvillain 2005).

Generally one egg per clutch is produced, but some females will lay two clutches per season. Thieme and Thieme (1996) report a clutch of two eggs (of which one was found to be infertile) and in another case the hatching of twins from a single, but not significantly enlarged egg. The twins were nearly the same size as regular hatchlings (49 and 44 mm SCL compared to mean = 46.0 ± 2 mm), also the weight was similar (11 and 9 g compared to 11.0 ± 3 g). They also mention that some males show no signs of mating activity for some reason, which is also sometimes mentioned by other keepers (pers. com.). Whether this comes from permanent cohabitation with females (which is rather unnatural according to personal observations from the field) or might be a result of triploidy, or stems from another reason is still unresolved. Métrailler (2001) discusses different methods for incubation, but also reports only five hatchlings from 38 incubated eggs of *P. platycephala*. The best working incubation technique included an incubator after the scheme by Budde (1980), but instead of burying the eggs in substrate, they were placed on plastic egg-crating. Temperatures were 28 °C by day and 26 °C by night. Reported incubation time was 110 days at constant 29 °C and between

148 and 198 days at the varying temperatures reported above. Bakowskie (pers. comm.) reports incubation length of approximately 150 days at temperatures between 28.0 and 29.0 °C and up to 191 days of incubation at temperatures between 26 and 27 °C.

Previously unpublished mean egg dimensions reported by two breeders from Germany are 51.9 ± 3.6 mm x 27.9 ± 4.1 mm and m = 22.5 ± 4.1 g (N = 10) for *P. platycephala platycephala*. In Métrailler (2001) egg dimensions given are 45 – 51 mm x 25 - 26 mm (N = 35).

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Appendix I: Glossary

CH	Carapace height
CL	Carapace length
CW	Carapace width
PL	Plastron length
SCL	Straight Carapace length
TL	Total length
TW	Total width
CRI	Chelonian Research Institute, Oviedo, FL
CNRS	Centre Nationale de Reecherche Scientifique
DIREN	Direction Regionale de'l Environment
INPA	Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil
MNHP	Muséum national d'Histoire naturelle, Paris, France
NHM	Natural History Museum, London, Great Britain
NMW	Naturhistorisches Museum, Wien, Austria
WCH6	World Congress of Herpetology
ca.	circa
Coll.	Collection
et al.	et alteri
in prep.	In preparation
pers. obs.	Personal observation
pers. com.	Personal communication
GH	Total hardness of water [°dH]
GSD	Genetic sex determination
KH	Carbonate hardness of water [°dH]
LW	Electrical conductivity [μScm^{-1}]
pH	potentia Hydrogenii
TSD	Temperature dependant sex determination
Fretey	Fretey (1977)
MLG	Métrailler & LeGratiet (1996)
PT	Pritchard & Trebbau (1984)

Appendix II: Studied specimens

Table 2: Studied specimens of *Mesoclemmys gibba*. Abbreviations: ID = Identification at Source; Source = Institution or citation; CL = Carapax length; MLG = Métrailler & LeGratiet (1996), Coll. S. Boehm = personal collection of Stephan Böhm; rest see Appendix I

ID	Source	Locality	CL (mm)	Sex
juv.	MLG	French Guyana	38	juvenile
juv.	MLG	French Guyana	38	juvenile
juv.	MLG	French Guyana	41	juvenile
1939.1.1.107	NHM	Brit. Guyana	50	juvenile
1946.1.22.86 (*Hydraspis bicolor* holotype)	NHM	Suriname (Demerara falls)	55	juvenile
juv.	MLG	French Guyana	70	juvenile
juv.	MLG	French Guyana	79	juvenile
juv.	MLG	French Guyana	89	juvenile
juv.	MLG	French Guyana	100	juvenile
1925	CRI	Suriname	102	unknown
male	MLG	French Guyana	105	male
juv.	MLG	French Guyana	105	juvenile
juv.	MLG	French Guyana	106	juvenile
male	MLG	French Guyana	110	male
0434	CRI	Guyana	115	unknown
male	MLG	French Guyana	119	male
female	MLG	French Guyana	119	female
1945	CRI	Suriname	122	unknown
male	MLG	French Guyana	122	male
male	Coll. S. Boehm	Suriname	123	male
juv.	MLG	French Guyana	123	juvenile
male	MLG	French Guyana	136	male
male	MLG	French Guyana	138	male
male	MLG	French Guyana	140	male
male	MLG	French Guyana	140	male
female	MLG	French Guyana	140	female
male	MLG	French Guyana	141	male
male	MLG	French Guyana	141	male
female	MLG	French Guyana	143	female
female	MLG	French Guyana	144	female
2045	CRI	Suriname	145	unknown
male	MLG	French Guyana	145	male
female	MLG	French Guyana	145	female
Male	MLG	French Guyana	146	male
Male	MLG	French Guyana	148	male
Male	MLG	French Guyana	148	male
Male	MLG	French Guyana	150	male
female	MLG	French Guyana	151	female
female	MLG	French Guyana	152	female
female	MLG	French Guyana	153	female
Male	MLG	French Guyana	154	male
Male	MLG	French Guyana	154	male

Table 2 continued				
Male	Coll. S. Boehm	Suriname	154	male
female	MLG	French Guyana	155	female
female	MLG	French Guyana	159	female
2825	CRI	French Guyana	160	unknown
3309	CRI	Suriname	160	male
Male	MLG	French Guyana	160	male
female	MLG	French Guyana	160	female
female	MLG	French Guyana	160	female
2933	CRI	Suriname	162	unknown
female	MLG	French Guyana	162	female
3306	CRI	Suriname	163	unknown
3267	CRI	Suriname	165	unknown
7269	CRI	Guyana	167	male
Male	MLG	French Guyana	168	male
6149	CRI	Guyana	169	unknown
7189	CRI	Guyana	169	female
Male	MLG	French Guyana	170	male
female	MLG	French Guyana	170	female
female	Coll. S. Boehm	Suriname	173	female
female	MLG	French Guyana	174	female
M. gibba 1	Pers. obs.	*Camp Inselberg, French Guyana*	175	female
female	Coll. S. Boehm	Suriname	175	female
2931	CRI	Suriname	178	unknown
2932	CRI	Suriname	179	unknown
female	MLG	French Guyana	180	female
female	MLG	French Guyana	180	female
6579	CRI	Guyana	181	female
6598	CRI	Suriname	190	female

Table 3: Studied specimens of *Mesoclemmys nasuta*. Abbreviations: ID = Identification at Source; Source = Institution or citation; rest see Appendix I

ID	Source	Locality	CL (mm)	Sex
MNHP 4140	Fretey	"Guyanes"	59	juvenile
"live"	PT	Suriname	60	juvenile
MNHP 1974-1003	Fretey	Monts Atachi-Bacca, French Guyana	64	juvenile
spec 1	MLG	French Guyana	92	juvenile
"live"	PT	Suriname	111	juvenile
M. nasuta 1	Pers. obs.	Camp Pararé, French Guyana	128	male
1832	CRI	Suriname	154	unknown
spec 7	Métrailler (1995)	Crique Voltaire, French Guyana	155	female
0153	CRI	Suriname	159	unknown
"live"	PT	Suriname	168	unknown
HRM 455b	Fretey	Suriname	205	unknown
spec.5	Métrailler (1994)	French Guyana	220	male
4589	CRI	Suriname	223	unknown
RMNH 17599	Fretey	Suriname	224	unknown
= spec1 after 6 years	Métrailler (1994)	French Guyana	225	female
HRM 455a	Fretey	Suriname	225	unknown
7700	CRI	Suriname	236	unknown
RMNH 17597	Fretey	Suriname	239	unknown
spec 6	Métrailler (1995)	Crique Serpent, French Guyana	240	male
RMNH 17598	Fretey	Suriname	247	unknown
4585	CRI	Suriname	250	unknown
Antons nasuta	Coll. Stanic	Suriname	250	male
Spec. 3	Métrailler (1994)	Crique Voltaire French Guyana	250	female
nasuta Weibchen	Coll. Stanic	Suriname	251	female
nasuta Männchen	Coll. Stanic	Suriname	251	male
7553	CRI	Guyana	254	female
spec 2	Métrailler (1994)	Crique Margot, French Guyana	260	male
1830	CRI	Suriname	265	male
4588	CRI	Suriname	265	unknown
spec 4	Métrailler (1994)	French Guyana	265	male
7552	CRI	Guyana	266	male
7749	CRI	Suriname	266	unknown
4584	CRI	Suriname	272	unknown
4587	CRI	Suriname	272	unknown
7532	CRI	Guyana	274	female
7023	CRI	Suriname	275	female
4586	CRI	Suriname	278	unknown
1831	CRI	Suriname	280	male
M. nasuta 2	Pers. obs.	Camp Pararé, French Guyana	283	male
7523	CRI	Guyana	285	female
4583	CRI	Suriname	287	unknown
MNHP 1910-1	Fretey	Saint Laurent du Maroni, French Guyana	298	unknown
1873.195 / 73.3.31.1	NHM	Suriname	300	male
7531	CRI	Guyana	304	female
"live"	PT	Suriname	317	male
7554	CRI	Guyana	371	male

Table 4: Studied specimens of *Platemys platycephala*. Abbreviations: ID = Identification at Source; Source = Institution or citation; CL = Carapax length; MLG = Métrailler & LeGratiet (1996), Fretey = Fretey (1977); rest see Appendix I

ID	Source	Locality	CL (mm)	Sex
MNHNP 2098	Fretey		62	juvenile
1866.9.20.15	NHM	Suriname	64	juvenile
23503:3	NMW	Suriname	65	juvenile
MNHNP 6603	Fretey		69	juvenile
MNHNP 2099	Fretey		70	juvenile
FT 163	Fretey		97	juvenile
FT 150	Fretey		105	juvenile
23503:2	NMW	Suriname	113	female
FT 162	Fretey		119	juvenile
155	CRI	Suriname	122	Female
33223:5	NMW	French Guyana	125	female
23502:5	NMW	Paramaribo, Suriname	125	male
4978	CRI	Suriname	129	Female
6592	CRI	Guyana	129	Female
7584	CRI	Suriname	129	unknown
33223:3	NMW	French Guyana	129	male
	MLG	French Guyana	130	Male
	MLG	French Guyana	130	female
33223:6	NMW	French Guyana	130	male
23502:6	NMW	Paramaribo, Suriname	130	male
33223:1	NMW	French Guyana	131	female
3668	CRI	Suriname	132	Female
3320	CRI	Suriname	133	Female
	MLG	French Guyana	133	female
LG 4292	Fretey		134	female
444	CRI	Suriname	135	unknown
3334	CRI	Suriname	135	Male
3356	CRI	Suriname	135	Female
34573	NMW	French Guyana	135	male
P1		Camp Pararé, French Guyana	137	Female
P5		Camp Inselberg, French Guyana	137	Male
3315	CRI	Suriname	137	Female
3629	CRI	Suriname	138	Female
FT 173	Fretey		138	female
3964	CRI	Suriname	139	Male
7585	CRI	Suriname	139	unknown
11154	CRI	Suriname	140	Female
11168	CRI	Suriname	140	Female
1829	CRI	Suriname	140	Male
6596	CRI	Guyana	140	Female
	MLG	French Guyana	140	Male
	MLG	French Guyana	140	female
3357	CRI	Suriname	142	Male
3963	CRI	Suriname	142	Male
4845	CRI	Suriname	142	Female
6160	CRI	Guyana	142	Male
	MLG	French Guyana	142	Male

Table 4 continued				
7583	CRI	Suriname	143	unknown
FT 219	Fretey		143	female
33223:4	NMW	French Guyana	143	male
4916	CRI	Suriname	144	Female
7586	CRI	Suriname	144	unknown
	MLG	French Guyana	145	Male
33223:2	NMW	French Guyana	145	male
6161	CRI	Guyana	147	Male
4847	CRI	Suriname	148	Female
7708	CRI	Suriname	148	Male
	MLG	French Guyana	148	female
P2		Camp Pararé, French Guyana	149	Male
P3		Camp Pararé, French Guyana	149	Male
11153	CRI	Suriname	149	female
1827	CRI	Suriname	150	Female
11103	CRI	Guyana	150	Male
	MLG	French Guyana	150	Male
	MLG	French Guyana	150	Male
	MLG	French Guyana	150	Male
	MLG	French Guyana	150	female
7587	CRI	Suriname	151	unknown
LG 4303	Fretey		152	female
1826	CRI	Suriname	153	Female
3312	CRI	Suriname	153	Male
P4		Camp Pararé, French Guyana	154	Male
1944	CRI	Suriname	154	Female
1872.10.16.80	NHM	Demerara falls, Suriname	155	Female
6162	CRI	Guyana	155	Male
7582	CRI	Suriname	155	unknown
	MLG	French Guyana	155	Male
	MLG	French Guyana	157	Male
AC 1901-89	Fretey		157	Male
FT 145	Fretey		159	Male
MNHNP 8760	Fretey		160	Female
FT 207	Fretey		161	male
1825	CRI	Suriname	162	Female
1943	CRI	Suriname	162	Female
MNHNP 8753	Fretey		164	male
6159	CRI	Guyana	166	Male
FT 203	Fretey		167	female

Appendix III: Results of habitat analyses

Table 4: All own data are means of the given numbers of sample sites. Abbreviations: AR1 = Arataye River, FC = Forest creeks, FF = Flooded forest, KP = temporary ponds in Kaw, KR = Kaw River, PS = Palm swamp, MLG1 = Habitat of *M. gibba*, MLG2 = Habitat of *M. nasuta*, MLG3 = Habitat of *P. platycephala*. All MLG data taken from Métrailler & LeGratiet (1996).

lot = lotic waterbody; len = lentic waterbody; / = impossible to measure; n.m. = not measured;

For soil types and associated animal groups: 0 = absent; 1 = present

	AR (N=1)	FC (N=4)	FF (N=1)	KP (N=4)	KR (N=1)	PS (N=2)	MLG1	MLG2	MLG3
Habitat type	lot	lot	len	len	lot	len	len	lot	len
Abiotic factors: measurements									
Length (m)	/	n.m.	4,7	85	/	n.m.			
Width (m)	30	3,4	3,3	43,25	15	2,55			
Perimeter (m)	/	/	14,4	n.m.	/	n.m.			
mean depth (cm)	/	35	14	33	4	21			
aquatic macrophyte cover (%)	0	1,25	0	70	0	0			
Canopy cover (%)	5	80	95	30	0	90			
current velocity (m/s)	n.m.	0,1	0,0	0,0	0,1	n.m.			
Abiotic factors: Soil types									
Boulder	1	0	0	0	0	0			
Gravel	0	1	0	0	0	0			
Sand	1	1	1	0	0	1			
Mud	0	0	1	1	1	1			
Leaves	0	1	1	1	0	1			
Else	0	0	0	0	0	0			
Abiotic factors: Water chemistry parameters									
Temp. (°C)	27	25,2	25	28,73	29	26,6	26,5	25	24
pH	6,5	6,48	6,4	6,025	5	6,3	6,5	5,9	6,4
LW (µS/cm)	15	42	115	38,5	34	30,5			
NO_2 (mg/l)	0	0,01	0,01	0,015	0	n.m.	0	0	0
NO_3 (mg/l)	1	0,75	0,5	0,35	1	n.m.	5	0	0
PO_4 (mg/l)	0	0,02	0,05	0,1	0	n.m.			
GH (°DH)	1	1,25	1	1	1	n.m.	0	0	
KH (°DH)	2	1,75	2	1,25	2	n.m.	0	0	0
CO_2 (mg/l)	32	23	32	28		n.m.	16	2	13
Fe (mg/l)	0,6	0,45	0,1	1,1	2	n.m.			
Biotic factors: Associated animal groups									
Ampullaridae	0	1	0	0	1	0			
Thiaridae	0	1	0	0	0	0			
Characide	1	1	0	0	1	1			
Siluriformes	1	1	0	0	1	0			
Cichlidae	1	1	0	0	1	0			
Rivulidae	0	0	0	1	0	0			
Amphbians/larvae	1	0	1	1	1	0			
Insects/larvae	1	1	1	1	1	1			
Shrimps	1	1	0	0	1	0			
Crabs	1	0	0	0	0	0			
Else	1	0	1	0	1	0		1	

Appendix IV: Table of illustrations

Appendix V: Abstract/Zusammenfassung

Abstract

Although French Guyana is a relatively small country, comparable in size to Austria, its turtle diversity is impressive: 14 species of the order Testudines occur over an area of 86.504 km². Of these 14 species, many belong to scientifically underrepresented families such as the chelid turtles *Mesoclemmys gibba*, *Mesoclemmys nasuta* and *Platemys platycephala*. These three species are regularly recorded in the Reserve Naturelle de Nouragues, a forest reserve in French Guyana. In this thesis, a comprehensive review of aspects of the ecology of these three chelid species is given. Every species is described in detail by comparing museum specimens. Distribution records in French Guyana are compiled for composition of distribution maps. Data on habitat and activity, feeding and reproduction from their native range with special focus on French Guyana, acquired from available scientific literature are reviewed and compared. Because of lack of data of certain aspects of life history like incubation period, mating and feeding, also hobbyist literature with data from captive husbandry is incorporated in separate chapters.

Records of *Mesoclemmys gibba* are dispersed mainly along the coast of French Guyana, but because of its pan-amazonian distribution it is likely that the species also occurs in the southern parts of the country. It is a shy species that doesn't seem to be constricted to any specific habitat as long as there is some fresh water and typical food items such as amphibian larvae, insects and worms. Algae and plant seeds are also reported to be ingested by free-ranging specimens. *M. gibba* seems to be very adaptable to varying habitat conditions and is also reported to aestivate if necessary. Mating behaviour is not described under natural conditions and data on natural reproduction are scarce. Typically, two to four eggs are laid in shallow cavities and covered with leaves. In French Guyana, eggs are deposited during the dry season and hatchlings emerge five to six months later at the start of the rainy season. Several reports of keeping and breeding *M. gibba* under captive conditions are available which describe it as a gentle species which adapts easily.

Mesoclemmys nasuta is an endemic species of the Guyana Shield and is considered a separate species of the closely related species *M. raniceps* since 1987. Therefore older literature has to be read carefully to avoid mixing up data from guyanian populations with populations from outside of French Guyana. The species is found in small forest streams and ponds all over the country, but because of its hidden lifestyle, observations are rare. *M. nasuta* seems to be closely bound to water bodies of a certain size, because there are no records of specimens

migrating over land or reports on aestivating specimens. Fecal analyses of freshly caught specimens showed that crabs, beetles and parts of fruits, plants and seeds are used as food sources. Data on mating and reproduction are absent from the field and from captivity.

Like *M. gibba*, *Platemys platycephala* is a species with a wide-ranging distribution all over amazonian South America. It is known from several locations spread over French Guyana, but seems to prefer forests with closed canopy and temporary ponds. Observations on specimens in the field are often made when they are foraging for food, which is mostly done in small waterbodies. For resting, specimens will chose fallen trees or bury themselves under leaves at the roots of trees. Rainfall seems to play an important role in the life of *P. platycephala* and the species is suspected to aestivate during the dry season. No direct observations on feeding are currently reported, but stomach flushings and observations on captive specimens indicate that they feed on tadpoles, amphibian eggs, small insects and worms. Mating behaviour is described under natural and captive conditions. Females will lay only one single egg per clutch, but multiple clutches per season are possible. Incubation time in the field is unknown, but in captivity hatchlings emerge after approximately 180 days.

Zusammenfassung

Obwohl Französisch Guyana ein relative kleines, in Größe mit Österreich vergleichbares, Land ist, zeigt es eine beeindruckende Diversität an Schildkröten: 14 Arten der Ordnung Testudines kommen auf einer Fläche von 86.504 km² vor. Von diesen 14 Arten gehören viele zu wissenschaftlich unterrepräsentierten Familien wie auch die cheliden Schildkröten *Mesoclemmys gibba*, *Mesoclemmys nastua* und *Platemys platycephala*. Diese drei Arten werden regelmäßig in der Reserve Naturelle de Nouragues, einem Schutzgebiet in Französisch Guyana, angetroffen. In dieser Arbeit wird eine zusammenfassende Übersicht von Aspekten der Ökologie dieser drei cheliden Arten gegeben. Jede Art wird detailliert anhand von Vergleichen mit Museumsexemplaren beschrieben. Aufzeichnungen über die Verbreitung in Französisch Guyana wurden in Verbreitungskarten dargestellt. Daten über Habitat und Aktivität, Ernährung und Fortpflanzung aus dem natürlichen Verbreitungsgebiet mit besonderem Fokus auf Französisch Guyana, aquiriert aus der zugänglichen wissenschaftlichen Literatur werden besprochen und verglichen. Wegen des Mangels an Daten zu bestimmten Aspekten der Life-History wie Inkubationsdauer, Paarung und Ernährung wurde auch Liebhaberliteratur mit Daten aus der Haltung einbezogen, allerdings in separaten Kapiteln.

Aufzeichnungen über Funde von *Mesoclemmys gibba* sind hauptsächlich über die küstennahen Gebiete von Französisch Guyana verteilt, aufgrund ihrer pan-amazonischen Verbreitung ist es aber wahrscheinlich, dass die Art auch in den südlichen Teilen des Landes vorkommt. Es handelt sich um eine scheue Spezies, die in ihren Anforderungen an das Habitat nicht besonders beschränkt ist, solange es ein wenig Wasser und typische Futterelemente wie Amphibienlarven, Insekten und Würmer gibt. Algen und Pflanzensamen wurden auch als von wild lebenden Tieren aufgenommene Nahrung berichtet. *Mesoclemmys gibba* scheint sehr anpassungsfähig an variierende Habitatbedingungen zu sein und es wird auch über Ästivation unter für die Schildkröten ungünstigen Bedingungen berichtet. Unter natürlichen Bedingungen ist kein Paarungsverhalten beschrieben und es gibt nur wenige Daten über Reproduktion in der Natur. Typischerweise werden zwei bis vier Eier in flache Gruben abgelegt und mit Blättern bedeckt. In Französisch Guyana werden die Eier während der Trockenzeit gelegt und Schlüpflinge erscheinen fünf bis sechs Monate später zu Beginn der Regenzeit. Mehrere Berichte über die Haltung und Zucht von *M. nasuta* in menschlicher Obhut sind vorhanden, die sie als ruhige Art beschreiben, welche sich leicht an die Terrarienhaltung anpasst.

Mesoclemmys nasuta ist eine endemische Art für den Guyanaschild und wird seit 1987 als eigenständig von der nah verwandten Art *M. raniceps* angesehen. Daher muss beim Lesen der älteren Literatur Vorsicht geboten sein, um nicht Daten von Guyana-Populationen mit denen von außerhalb Französisch Guyanas zu vermischen. Die Art kann in kleinen Waldbächen und Tümpeln im gesamten Land angetroffen werden, aber wegen ihrer versteckten Lebensweise sind Beobachtungen selten. *M. nasuta* scheint eng and Wasserkörper einer gewissen Größe gebunden zu sein, denn es gibt keine Berichte von über Land wandernden oder ästivierenden Tieren. Kotanalysen von frisch gefangenen Tieren zeigten, dass Krabben, Käfer und Teile von Früchten, Pflanzen und Samen als Nahrungsquelle genutzt werden. Daten über Paarung und Fortpflanzung in der Natur sowie in der Haltung sind nicht vorhanden.

Wie auch *M. gibba* ist auch *Platemys platycephala* eine Art mit einer weitreichenden Verbreitung über das gesamte amazonische Südamerika. Sie ist von mehreren über Französisch Guyana verteilten Lokalitäten bekannt, scheint aber Wälder mit geschlossenem Kronendach und temporäre Tümpel zu bevorzugen. Beobachtungen an wildlebenden Exemplaren werden oftmals gemacht, während sie nach Nahrung suchen, was hauptsächlich in kleinen Wasserkörpern passiert. Zum Ruhen suchen sich die Tiere umgefallene Baumstämme aus oder graben sich in Blätter an der Wurzel eines Baumes ein. Niederschlag scheint eine bedeutende Rolle im Leben von *P. platycephala* zu spielen und es wird vermutet, dass die Art während der Trockenzeit ästiviert. Keine direkten Beobachtungen der Nahrungsaufnahme sind derzeit in der Literatur vorhanden, aber Magenspülungen und Beobachtungen an Exemplaren in menschlicher Obhut weisen darauf hin, dass sie sich von Kaulquappen, Amphibieneiern, kleinen Insekten und Würmern ernähren. Ein Paarungsverhalten ist in der Natur und in menschlicher Obhut beschrieben. Weibchen legen nur ein einzelnes Ei pro Gelege ab, aber mehrere Gelege pro Saison sind möglich. Die Inkubationszeit in der Natur ist unbekannt, aber in der Haltung erscheinen Schlüpflinge nach ungefähr 180 Tagen.

Appendix VI: Curriculum vitae

PERSÖNLICHE DATEN

- Name: Stephan Böhm
- Geburtsdatum: 20. Dezember 1984
- Geburtsort: Wiener Neustadt, Österreich
- Staatsbürgerschaft: Österreich
- Adresse: Johannagasse 18/16, 1050 Wien, Österreich
- Mobiltelefon: +43-660 466 09 97
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AUSBILDUNG

- Feb. 1995 - Jun. 2002: Bundesrealgymnasium Gröhrmühlgasse Wr. N.:
  Abschluss mit Matura (Ausgezeichneter Erfolg)
- Sept.. 2003 - April 2004: Präsenzdienst Bechtolsheimkaserne Wr. Neustadt:
- Okt. 2004 - Jan. 2011: Universität Wien:
  Diplomstudium Ökologie
  Zweig Limnologie/Herpetologie

BERUFSERFAHRUNG

- Sept. 2002 -Juni 2010: BK Blue Devils, Wr. Neustadt:
  Basketballtrainer versch. Altersstufen (U10 – U18)
- März 2005 - Juni 2006: Schülerhilfe Christiane Humer, Wien:
  Nachhilfelehrer Mathematik & Englisch
- August 2006: Holub, Steiner und Partner, Herbholzheim (GER):
  Fundraising für BN Bayern im Raum Augsburg
- Dez. 2006 – Nov. 2008: Story & Co., Wien:
  Webredakteur www.thomasbrezina.com
- Seit Juni 2009: Megazoo, Brunn/Geb.:
  Fachverkäufer Aquaristik

Wichtigste *PUBLIKATIONEN*

Böhm, Stephan. 2005. **Zoos und zoologische Einrichtungen in Kalifornien (USA). Ein Reisebericht**. Sacalia 8 (2): 25-32

Budischek, Andreas; Blanck, Torsten; Böhm, Stephan. 2007. **Im Jahr 2550 – Auf der Suche nach Thailands Schildkröten**. Sacalia 16 (4): 14-43.

Böhm, Stephan. 2008. **Considerations regarding a near-natural husbandry of the Tuberose side-necked turtle, *Phrynops tuberosus* (Peters, 1870)**. Radiata. 17 (5): 45-54

Böhm, Stephan. 2009. **Die Amazonas-Krötenkopfschildkröte, *Mesoclemmys raniceps* (GRAY 1855)**. Sacalia. 23 (6): pp. 9-29.

Böhm, Stephan. 2010**. Beobachtungen an den Wasserschildkröten der Alexander Springs in Florida, USA**. Sacalia. 27 (7): pp. 5-25

Böhm, Stephan. 2010. **Auf der Suche nach Schildkröten in der Réserve Naturelle Nouragues (Französisch Guyana)**. Marginata

Wichtigste *VORTRÄGE*

Die Wasserschildkröten Amazoniens (Uni Wien, Vorlesung „Fauna & Ökologie Amazoniens“ 2006)

Die Halswenderschildkröten Amazoniens (Jahrestagung DGHT AG Schildkröten, Hofheim 2007)

Die Amazonas-Krötenkopfschildkröte *Mesoclemmys* (*Batrachemys*) *raniceps* (Jahrestagung ÖGH, Wien 2008)

Erste Erfahrungen und Unterschiede in der Haltung südamerikanischer Halswenderschildkröten (Jahrestagung ISV, Salzburg 2008)

Neues aus Französisch Guyana (Jahrestagung ISV, Wien 2009)

Ökologie, Haltung und Nachzucht der Schwarzknopf-Höckerschildkröte *Graptemys nigrinoda nigrinoda*, (Jahrestagung ÖGH,
Wien 2010)

Habitat usage and short-term movements in the Twist-necked Turtle (*Platemys platycephala* Schneider 1792) during the late rainy season inThe Nouragues Reserve, French Guyana (TSA Konferenz, Orlando 2010)

SONSTIGE ERFAHRUNGEN

- Sommer 2004: Tiergarten Schönbrunn, Wien:
  Praktikum Tierpflege in der Einhuferabteilung

- Sommer 2005: Tiergarten Schönbrunn, Wien:
  Praktikum Tierpflege im Aquarienhaus

- Sommer 2006: Abwasserverband Wr. Neustadt Süd:
  Praktikum in der Kläranlage

- Sommer 2008: World Congress of Herpetology, Manaus (BR):
  Teilnehmer

SPRACHKENNTNISSE

Deutsch (Muttersprache)
Englisch (Verhandlungssicher)
Französisch (Grundkenntnisse in Wort und Schrift)

EDV-KENNTNISSE

MS-Office: Word, Excel, Power Point, Access, Publisher;
Adobe: Photoshop, Contribute,
Sonstige: R, Sigma Plot, HTML, Windows 7, Mac

WEITERE INTERESSEN

Mitglied in folgenden Vivaristischen Vereinigungen:
Österreichische Gesellschaft für Herpetologie (ÖGH)
Internationale Schildkrötenvereinigung (ISV)
DGHT AG Schildkröten
Turtle Survival Alliance (TSA)
1. Wiener Neustädter Aquarien- und Terrarienverein

Aktive sportliche Tätigkeiten:
Basketball, Wandern, Schnorcheln, Fußball

Notes on short term migrations and dietary spectrum of the Twist-necked Turtle, *Platemys platycephala* (Testudines: Chelidae) in the Nouragues Reserve, French Guyana

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Abstract

The Twist-necked Turtle (*Platemys platycephala*, SCHNEIDER 1792) is the only member of the genus *Platemys*. Despite a pan-Amazonian distribution in South America, ecology and population status of this small, forest dwelling species are unknown in many countries of its range. Currently it is not listed in the IUCN red list of threatened species and there are no published data on reproduction, feeding and habitat in the wild. In this paper, observations on habitat selection, short term migrations and feeding in the Nouragues field reserve, French Guyana are reported for the first time. Study specimens used the same areas in the late rainy season of 2009 and 2010, migrating total distances of 503 to 686 m over a period of approximately 3 weeks. Calculated areas of activity ranged between 0.73 and 1.59 ha. Mainly used habitats were palm swamps, temporary flooded forest and primary non-flooded forest. The analysis of 4 stomach and 2 fecal samples showed that different classes of insects, worms and crustaceans as well as amphibian eggs were used as food items.

Key words: Reptilia; Testudines; Chelidae; *Platemys platycephala*; ecology; migrations; movement; habitat selection; feeding; French Guyana;

Platemys platycephala (SCHNEIDER, 1792) is a small chelid turtle with an elliptical carapax (up to 17.5 cm, Vogt 2008) which is rather flat and of brown colour, perfectly mimicking rotting leaves on the forest floor. Due to the remarkable karyotypic trait of some specimens showing triploidy (McBee et al. 1985), the genus *Platemys* is considered monotypic (Rhodin 1985). The Twist-necked Turtle occurs all over the

Amazonian rainforest including Bolivia, Brazil, Colombia, Ecuador, French Guyana, Guyana, Peru, Suriname and Venezuela. Currently, two weakly defined subspecies with a broad area of intergradation are recognized: *P. p. platycephala* (Schneider, 1792) from the eastern parts of its range and *P. p. melanonota* Ernst, 1984 from the far western parts of Amazonia in Peru and Ecuador. Despite its vast distribution it is a rarely encountered animal in the field. Therefore, although it is readily available in the commercial pet trade or often to be seen in zoological institutions, field studies on life history and especially published articles on diet or migrations are scarce (SOUZA 2004). There are only few detailed records from the field about food items of chelid turtles (FACHIN-TERAN et al. 1995, CAPUTO & VOGT 2008, Alcalde et al. 2010). Most observations come from captive specimens, for example by MITTERMEIER ET AL. (1978) and MÉTRALLIER (2001), but no detailed dietary studies are published for *P. platycephala* under natural conditions. There are also no published quantitative field studies on habitat selection. The clear lack of basic ecological information in most chelid turtles was discussed by Souza (2004), where the status of knowledge about activity patterns and reproduction in *P. platycephala* are classified as "little known" and knowledge about alimentation is classified as "unknown". Further examples show that the former genus *Phrynops* WAGLER, 1830 (in which many of the chelid turtles of South America were placed in the 20th century) was believed to be strictly carnivorous, but research on *Rhinemys rufipes* (named *Phrynops rufipes* in the 20th century) showed that these turtles consume a considerable amount of palm seeds and fruits (MAGNUSSON et al. 1997, CAPUTO & VOGT 2008). Some authors also mention that *Mesoclemmys gibba*, which is thought to be a carnivore, occasionally consumes plant matter (PRITCHARD & TREBBAU 1984, RUEDA-ALMONACID et al. 2007). Vogt (2008) even states that the fruits of the Buriti Palm are the turtle's favourite kind of food.

Platemys platycephala is said to be strictly carnivore, feeding primarily on tadpoles and anuran eggs as well as some aquatic insects and small fish (Vogt 2008). This is reported by other authors too (Métrallier & LeGratiet 1996, Rueda-Almonacid et al 2007), but none of these references rely on quantitative studies.

Radio telemetry has been used as an instrument for studies on migrations and habitat selection of turtle species which may belong to different families, but with comparable lifestyles like *Emys orbicularis*, *Glyptemys muhlenbergii* and *Rhinemys rufipes* (Poschadel 2003, Magnusson et al. 1997 and Pittman and Dorcas 2009). For elusive species that can not be caught easily in sufficient numbers, radio-telemetry can also be

used to increase recapture rates and therefore increase numbers of tissue, fecal or stomach content samples. Vogt (2008) mentions that radio-telemetry based studies have been conducted on *P. platycephala*, but to date these studies are neither published in scientific nor popular literature.

The occurrence of *P. platycephala* is recorded in the Nouragues reserve, French Guyana for a long time and specimens are sometimes encountered by researchers. Still, no field work on this species has been carried out in the reserve yet. In this paper I present observations on short- and long term migrations and dietary spectrum of *P. platycephala* in the Nouragues reserve for the first time.

Materials & Methods

The Nouragues Reserve lies in the eastern center of French Guyana and is nearly fully covered with primary rainforest. There are no villages in the Reserve and entrance is prohibited except for scientists and staff. The pristine habitats and two field stations (Camp Pararé and Camp Inselberg) provide perfect conditions for studies in an environment nearly free of anthropogenic influences. Camp Pararé, in which most of the field work for this study was done is situated directly along the Arataye river, granting access to river-influenced terrestrial habitats such as temporary flooded forests and palm swamps. The geographic coordinates of the Camp are N 4° 02' W 52° 41'.

Two field excursions to the camps in the Nouragues reserve were made in 2009 and 2010. In 2009, field work was done from Feb. 2nd to Feb 20th as a side-project of a field course held by the University of Vienna and from Feb. 4th until Feb. 21st 2010 in the vicinity of Camp Pararé.

To obtain specimens for the study, visual surveys and baited hoop-traps were used. The traps were self constructed of iron mesh (10mm aperture) with dimensions of 1.5 m length and approximately 70 cm in diameter. The visual surveys were performed along a track that was established by mammalian biologists along the Arataye which crossed different habitats like temporary flooded forest, terra-firme forest and palm swamps. The traps were set up at sites comprised of different habitats close to the track. In 2009, 8 checks of the traps were performed from Feb. 12th to Feb. 19th. In 2010, eleven check walks from Feb. 5th to Feb. 12th were performed additionally to the telemetry work.

For sensing secretive animals like *Platemys* strong radio transmitters of the type TW-3 by Biotrack Ltd. with individual frequencies in the range from 150,033 to 150,152 MHz with an estimated range of 2-4 kilometres for ground to ground sensing in open

conditions were used. They were outfitted with a ½ AA Battery to ensure a working signal of the transmitter for more than one year. Thus, turtles equipped with transmitters in 2009 could be tracked again in 2010. Following the suggestions by KENWARD (2000) and the Biotrack website (BIOTRACK 2000), the tags were designed to be attached to animals of at least 250 g of body mass. This excludes juveniles and subadults of *Platemys platycephala*. Due to the high humidity of the area and the at least temporary aquatic lifestyle of the turtles, the SIKA Receiver by Biotrack Ltd., a nearly water proof tracking device was chosen. For comfortable use in the rainforest a Biotrack YAGI-Antenna with flexible side arms was used.

Radio tags were glued to the carapace of the turtles by using a two-component adhesive (Repair Express Powerknete) by Pattex. In 2009, radio telemetry was mainly used to raise the number of stomach samples for dietary studies, therefore the turtles weren't followed every day to avoid continuous disturbance by picking them up and flushing their stomachs. From Feb. 5th until Feb. 9th 2010, the turtles were tracked once a day to have time for preparations of turtle traps and searching for possible turtle habitat. From Feb. 10th, 2010 on, the turtles were tracked twice a day (morning after sunset and late afternoon before nightfall) to monitor their migrations during the day and over the night. Each location of a turtle was recorded by setting waypoints with a GPS-device of the type Etrex Vista HCx by GARMIN. Tracking bouts usually took 3 to 4 hours, which meant a total time in the field of 6 to 8 hours per day excluding night excursions and trap check walks, which were done additionally.

To determine if a turtle moved or not between two trackings, a red and white striped plastic ribbon was tied to a vine or branch right above the resting turtle. Thus, imprecision of the GPS device was conquered. Generally, GPS reception was inacurrate due to the closed canopy situation and produced locality errors of 0 to 30 metres from the actual locality, which is a widely known phenomenon in situations with canopy cover of more than 70 % (Frair et al. 2010).

GPS data were analysed in silico, using Garmin Mapsource software and ESRI ArcView 4.2. Statistical tests were performed in MS Excel 2003, maps and pictures were edited in Adobe Photoshop CS2. Detailed topographical maps including rivers and creeks of scales below 1:100.000 were not readily available, therefore a height model (resolution of 1 m altitude) that was produced by the CNRS (Centre national de la recherché scientifique) Guyane showing the vicinity of the camp Pararé was used as basis for map production. Additionally, colleagues at the University of Vienna provided

data on trails and small creeks of the near vicinity of the camp Pararé which were gathered during a geographical survey and were used for work on the poison dart frog *Allobates femoralis* (Ringler et al. 2009). Since the turtles were using habitats that were located in distances to the camp where both the height model and the data by Ringler et al. (2009) were not sufficient, an exact correction of possibly errorneous GPS data was not possible. Therefore no data were corrected, except for when turtles were not moving to avoid possibly occurring shifts in distances covered by the turtles. Because of the small dataset, no conventional methods like calculating Minimum Convex Polygons were used. Instead, "areas of activity" are used as a term for the area that has been used by the animals instead of home range. These areas of activity were defined by connecting the outermost tracking points for each specimen and measuring the perimeter and area of the resulting polygon. Because of the small dataset in 2009 they were only calculated for the 2010 field season.

Stomach contents for dietary analysis can be received by sacrificing a certain number of animals to dissect them or by flushing their stomachs. The latter method was chosen because the population size in French Guyana, especially in the Nouragues reserve is not known and because of ethical thoughts. Right after catching, the turtles' stomachs were flushed to gain the contents for later analysis with the method described by LEGLER (1977), which was modified to the specific needs of the small turtles. The following instruments were used: A chemical scoop to open the mouth and a pressure-sprayer for plants connected a 3/5 mm (inside/outside) diameter tube to transport water into the turtles' stomachs. A turtle's stomach was considered empty if clear water was coming out of the turtles' mouth for more than 15 seconds.

After first capture, the turtles were kept captive a maximum of 2 days to receive fecal and stomach samples and to attach radio transmitters. Further stomach flushings were done in the field and at the end of the study when radio transmitters were removed. Fecals were not sampled during the telemetry study to avoid disturbance. Feces and stomach contents were deep-frozen and brought to Austria to analyze them later in the laboratory to the lowest possible taxon. Tracked animals were stomach-flushed in intervals of approximately one week to give them time to recover from procedure related stress and to digest.

For detailed description of the habitats used by the turtles, physico-chemical parameters of waterbodies and terrestrial habitats were measured with a pH/Temperatur/Conductivity multimeter by Hanna Instruments (HI-98129) and titration

tests by JBL for carbonic hardness. Water depth was measured with an industrial scale and stream velocity was calculated by letting a tennis ball float in the waterbody, measuring the time it took to pass a preset distance. Canopy cover was estimated by comparing shaded areas to areas with patches of light on the forest floor or water body.

To determine which habitats were used by the turtles, the following types were defined (in order of distance from the Arataye river): Arataye river, forest creeks, palm swamps, temporary flooded forest and primary non-flooded rainforest. All of these habitat types were close to the Arataye river with a maximum aerial distance of approximately 270 m from the furthest point where one of the study specimens was found to the Arataye. For an overview of the study area, see figure 5.

The Arataye River is a tributary to the Approuague river, one of the major rivers in French Guyana. It receives water from the countless forest creeks of the eastern centre of French Guyana and discharges into the Atlantic Ocean. The water level is highly dependant on rainfall and therefore season of the year. It varies between below one and several metres, but the river never runs dry. There is no closed canopy above the main channel, but the shores are densely vegetated. The following parameters were measured directly at the camp site during the late rainy season: Width = 30 m, temperature = 27 °C, pH = 6.5, electrical conductivity = 15 μScm^{-1}, carbonic hardness = 2 °DH.

Forest creeks are meandering through lower areas of the forest and are fed by runoff water from the hills in the Reserve and drain into the Arataye. Means of physico-chemical parameters in the late rainy season (n = 4) are temperature = 25.2 ± 0.5 °C, pH = 6.5 ± 0.2, electrical conductivity = 42 ± 14.8 μScm^{-1}, carbonic hardness = 1.75 ± 0.5 °DH, current velocity = 0.15 ± 0.05 m/s. Mean depth is 35.0 ± 21.5 cm, mean width is 3.4 ± 1.1 m.

The soil of palm swamps is saturated with water most of the time and canopy cover is not always 100 %. The forest floor is covered by leaves and palm branches. During flooding events and heavy rainfall the whole swamp floor is covered with water, which is retained longer than in temporary flooded forests. Sometimes small rivulets remain permanent without rain and gain in size during rainfall. Palm swamps are often found in lower elevations of 10 to 20 m a. s. l. near the Arataye or between hills.

Temporary flooded forests show basically the same structures like non-flooded forests, but due to their flat relief pools develop on the forest floor and depressions are filled with water during heavy rainfall. Measured physico-chemical parameters of one forest pool of 4,7 m x 3,3 m and 14,4 m perimeter were temperature = 25,0 °C, pH = 6,4,

electrical conductivity = 115 µS/cm, carbonic hardness = 2 °DH. During flooding events, the whole forest floor is covered by water. Primary non-flooded forests covered the higher situated areas of hills at 20 m a.s.l. or more and often showed inclining forest floor. Canopy cover of the forest floor is mostly close to 100%, so there is no dense vegetation in the understorey. The forest floor is covered with leaves.

Results

In 2009, one female (P1) and one male (P2) *Platemys platycephala* were caught by hand and equipped with radio transmitters and stomach flushed five times. In 2010, radio tags were still working on P1 and P2, which enabled tracking of the same individuals in the second season. During the 2010 field season, two more males (P3 and P4) could be hand-caught and equipped with radio transmitters. All four turtles were adults and showed typical coloration of the nominate subspecies *Platemys platycephala platycephala* (SCHNEIDER, 1792).

Basic morphological data and GPS coordinates of the first point of encounter are given in table 1. The female (P1) didn't show signs of growth from 2009 to 2010, but the male specimen's (P2) carapace length (CL) increased 3 mm, plastron length (PL) increased 5 mm and plastron width (PW) increased 1 mm. In 2009 weight was not measured, therefore it can't be said if and how weights changed over the year.

Total covered distances in the 2010 field season did not vary much and ranged from 503 m (P1) to 686 m (P2), but mean covered distances were quite variable in the study animals (see table 2). Especially specimens P3 and P4 showed great variety in moved distances, with the standard deviation being nearly the double mean (P3: mean = 31 ± 74 m and P4: mean = 34 ± 61 m) (table 2). This is a result of long periods of resting in combination with long migrations. For example, specimen P3 was not moving for 13 consecutive trackings over a period of seven days from Feb. 11th to Feb. 17th 2010, but moved over distances of over 100 m three times, accumulating a total migrated distance of 648 m. Specimen P1, which migrated mean = 23 ± 24 m has been found to be stationary only in 5 cases, accumulating 503 m over the study period. Comparisons of migrated distances of all for study specimens are given in table 2.

To see whether *P. platycephala* are more active during the day or during the night, therefore covering greater distances, one-factorial ANOVA was performed on the datasets divided by movements over night and during the day. While individual comparisons showed no statistical significance (P1: $P < 0.0979$, $F = 3.030$; P2: $P <$

0.1456, F = 2.326; P3: P < 0.3063, F = 1.122; P4: P < 0.1201, F = 2.800), combined data divided by day and night were significantly different, indicating that these four specimens were more active during the night hours (P < 0.0028, F = 9.541, see table 3).
In 2010 areas of activity were 0.73 ha (P3, see figure 3), 1.00 ha (P2, see figure 2), 1.20 ha (P4, see figure 4) and 1.59 ha (P1, see figure 1). These areas did not overlap between specimens, but the areas used in 2009 by P1 and P2 overlapped with those from 2010, the ones from 2010 being way larger because of the larger dataset.
The three habitat types that were mainly used within areas of activity were primary non-flooded rainforests, temporary flooded forests and palm swamps. Forest creeks were only rarely used and no specimen of *P. platycephala* has been found directly along the shores or in the Arataye river. First encounters with turtles were always made in aquatic habitats like palm swamps and temporary pools in the forest, where the leaf mimic of the carapace is not as inconspicuous as on the forest floor. During the study, specimens were concealed most of the time and were almost impossible to find without Radio telemetry equipment. They chose resting places in mostly non-flooded and temporary flooded forests. The Turtles were resting under logs or near roots, buried under the leaf litter. In aquatic habitats like forest creeks or palm swamps, the turtles were found buried in mud or under leaves, even when the water level was too high to breathe by just stretching out the neck. After first encounters, the turtles were never found uncovered again, indicating that they rarely move in the open.
During the study, 10 stomach samples were taken, 4 of them were positive (i.e. containing items from the stomach). 2 fecal samples could be obtained as well, which were composed of unidentified plant material, berries, decapods, oligochaetes and orthopterans. Among unidentified plant material, stomachs contained oligochaetes, nematocerans, diplopods, cicadas and two kinds of amphibian eggs (table 4). Based on recorded amphibian species that are occurring in the reserve and on observations of breeding amphibians during the study, the eggs most likely belonged to a member of the *Bufo margaritifer* complex and to a microhylid frog, probably *Chiasmocleis shudikarensis* or *C. hudsoni*.
In one case feeding was observed, when specimen P1 was found for the first time. It was sitting at the edge of a water-filled depression and just had eaten freshly laid amphibian eggs, the gelatinous mass that surrounds the eggs still sticking to its jaws.

Discussion

Despite a study length of approximately 2 months and the fact that all scientists staying at the Camp Pararé (up to 20 people) were advised to catch a Side-necked turtle if they find one, only four specimens were found during a period of the year, where turtles are supposed to be active because of regular rainfall. This indicates that although *P. platycephala* is a widespread species in South America, local abundance seems to be quite low in the vicinity of Camp Pararé. Compared to other forest-dwelling chelonian species of similar size, for example Chinese box turtles (*Cuora flavomarginata*) and hinge-backed tortoises (*Kinixys sp.*), *P. platycephala*'s sizes of areas of activity lie within the reported ranges (Lue and Chen 1999, Lawson 2006). Unlike in other studies, the female covered the biggest area with her movements. This may be a result of small sample size, because the three males tended to cover greater distances when they were moving, contrary to the female which moved more continuously, but in smaller steps. Thus, over a longer period of monitoring, the males might have bigger areas of activity.

Contrary to general belief, *P. platycephala* turned out to behave quite terrestrial. Only when encountering them for the first time or on rare occasions during the study, specimens were found along stream banks or in temporary ponds, which indicates that the species only enters waterbodies (and thereby giving up its camouflage) for foraging and mating. When they are inactive, twist necked turtles are nearly invisible among the leaf litter, which explains why most reported observations are made in aquatic habitats like ponds, water-filled car tracks or puddles in the rainforest.

Even though variable habitats like palm swamps and temporary flooded forests change a lot during the course of the year, *P. platycephala* occupied the same areas in 2009 and 2010. This indicates that maybe the actual home range of these individuals might not differ significantly from the calculated area of activity, assumed that the same habitats are also used during the dry season.

None of the observed animals had overlapping areas of activity during the study period, therefore intraspecific interactions during this time were highly unlikely to happen in scope of the low density of individuals. Specimen P4 came close to the area of activity of specimen P3 in one case, showing that basically the distances between the individuals are close enough for them to meet, but at this time, P3 was found in a different area.

No detailed quantifications have been performed in this study, but dietary analyses showed that *P. platycephala* is not exclusively feeding on amphibian larvae and eggs.

However, when they were present, they made up most of the stomach contents. Other food items indicate that the turtles are not only foraging in water, but at least catch prey on land and then return to the water for swallowing. The feeding mechanism in *P. platycephala* has not been studied in detail yet and up to date reports on land-feeding chelid turtles were not available.

The berries and plant material found in the fecal and stomach samples looked like they were rather ingested incidentally or contaminated the samples during the stomach flushing procedure on the forest floor than taken up deliberately, because they only made up a small proportion of the samples. If a fruit or a leaf would have been intentionally swallowed, the amount of biomass found within the sample would have been bigger.

Summing up the results of this short preliminary study, the twist-necked turtle lives quite terrestrial and solitary throughout most of the end of the rainy season in French Guyana, seeking out waterbodies only for feeding and rarely for resting. If there were no significant rainfalls, the study specimens were inactive, indicating that during the dry season they might aestivate. The food spectrum includes small, easy-to-catch prey with an opportunistic preference for amphibian eggs.

This leads to further research questions: Do twist-necked turtles use the same areas throughout the whole year or will they move to other habitat types during the dry season or at the start of the rainy season? If so, do they aggregate during times like explosive amphibian breeding events, like single observations by Dixon & Soini (1977) imply? A longer observation period could also be used to see if *P. platycephala* randomly migrate through the forest or if they return to certain areas that get flooded or to ponds that always emerge at the same place after strong rainfalls, to feed and copulate there. A small indication of this behaviour was given by specimen P3 of the study, which repeatedly entered a small artificial pool that carried water and contained larvae of the monkey frog *Phyllomedusa tomopterna* most of the time.

Since *P. platycephala* is not listed in the IUCN red list of threatened species, it is not sure if the continuous harvest, mostly for the pet trade, affects populations all over the amazon basin. Therefore further studies of fundamental aspects of this species' ecology and assessments of population status in countries that regularly export *P. platycephala* (Peru, Guyana, Surinam) are needed.

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APPENDIX 1: Figures

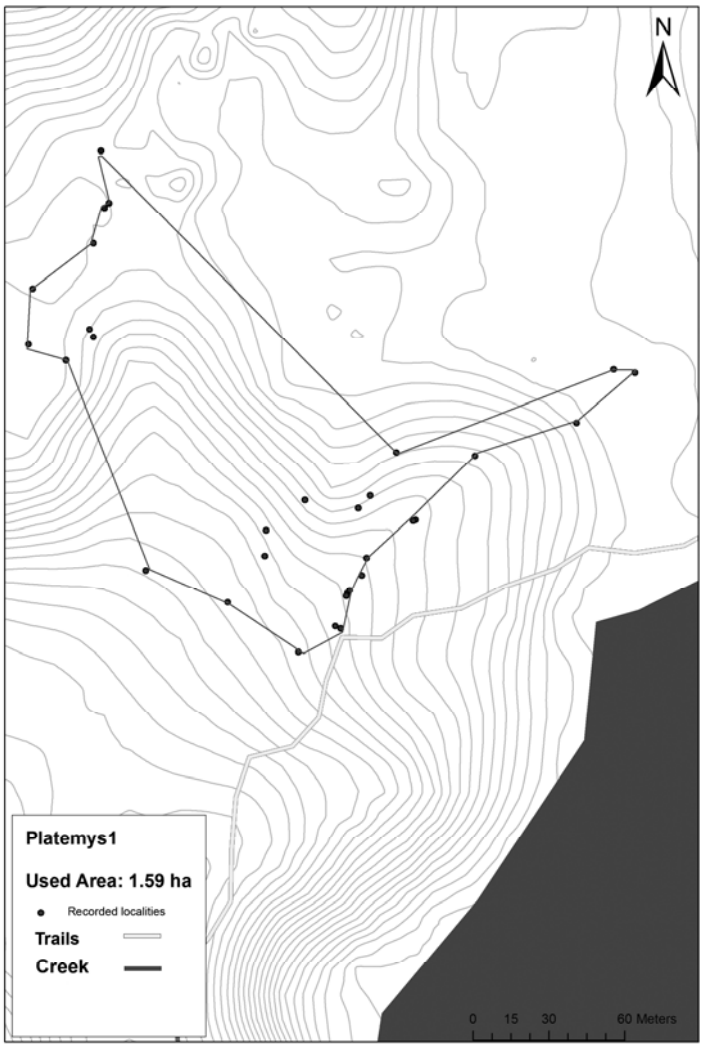
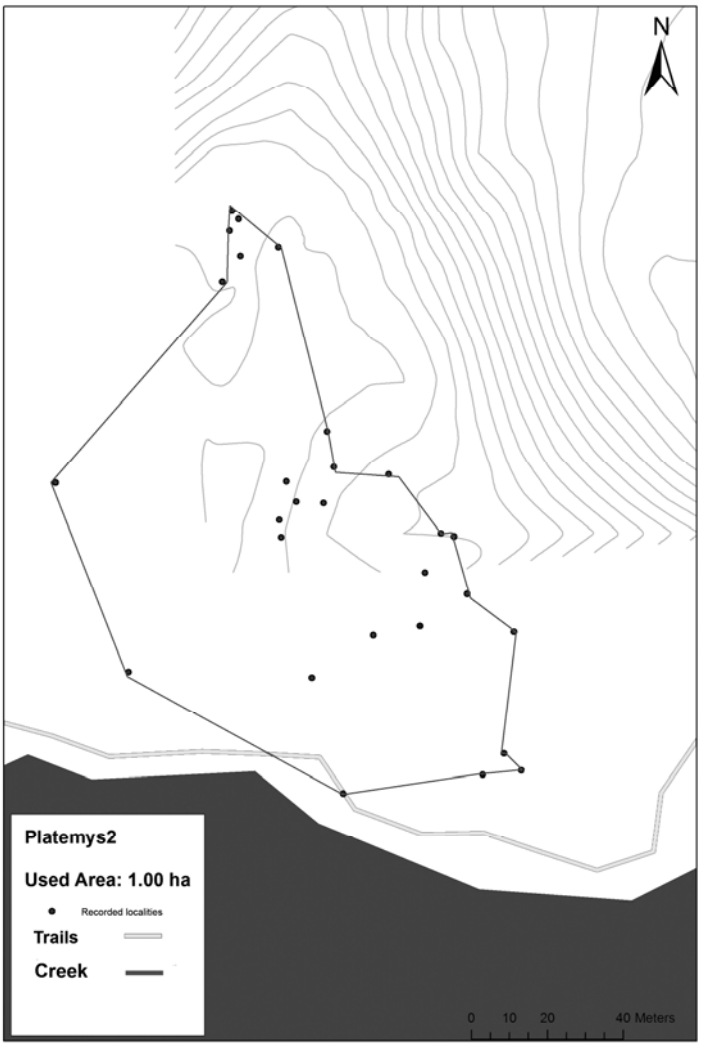


Figure 1


N
Platemys2
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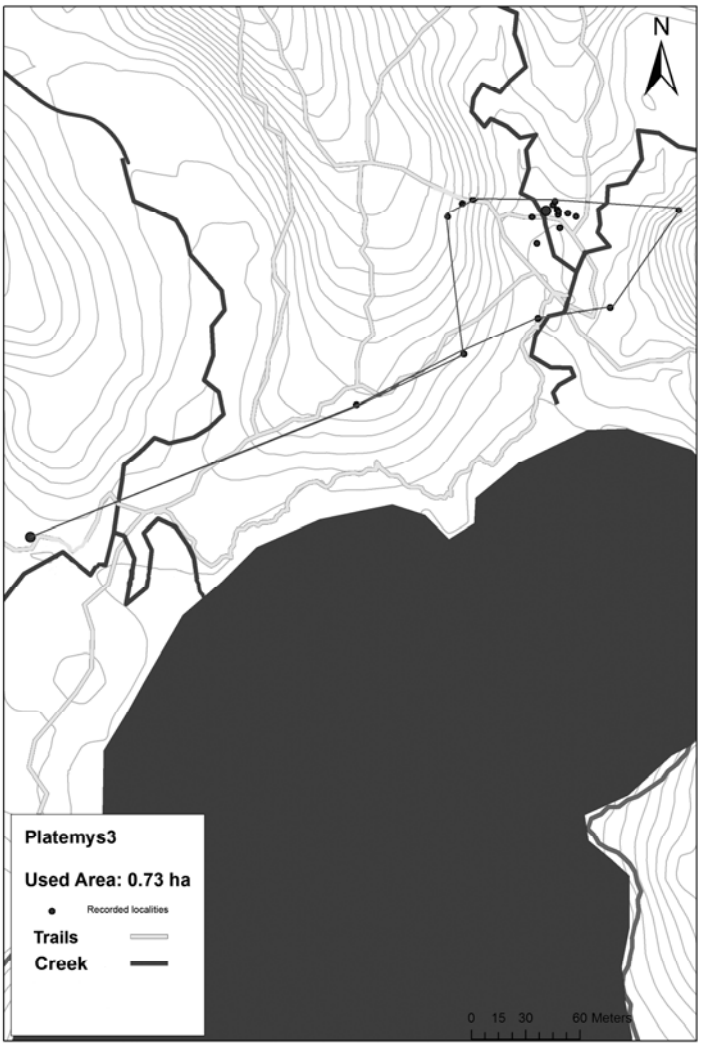
Recorded localities
Trails
Creek
0 10 20 40 Meters

Figure 2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Platemys3
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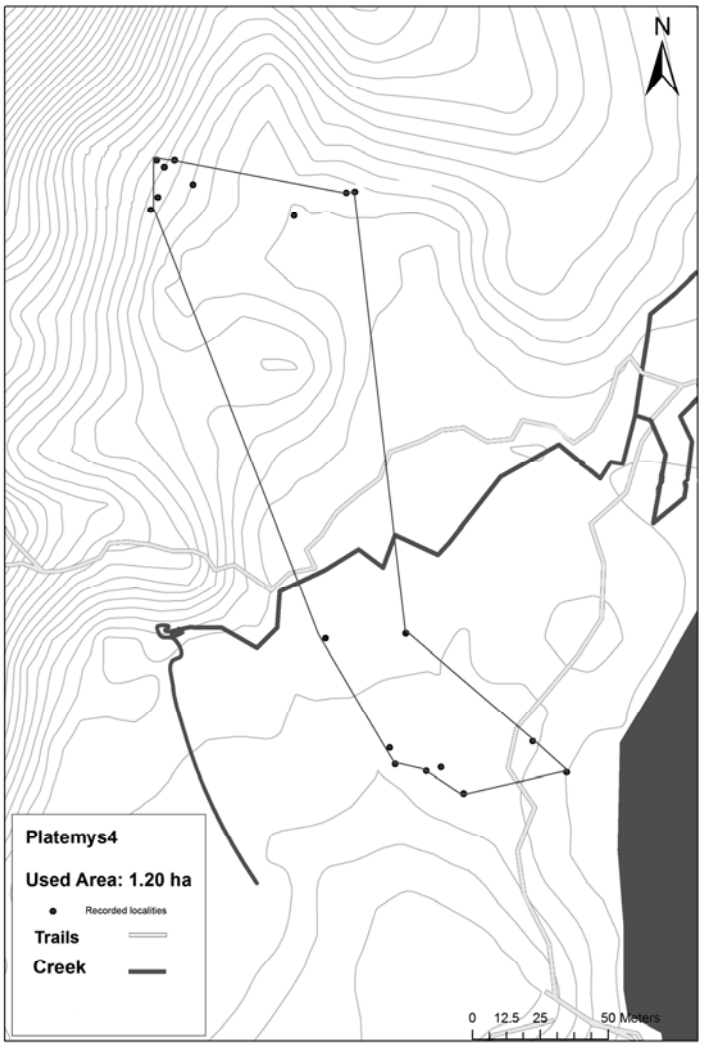
Recorded localities
Trails
Creek
0 15 30 60 Meters

Figure 3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Platemys4
Used Area: 1.20 ha
Recorded localities
Trails
Creek
0 12.5 25 50 Meters

Figure 4

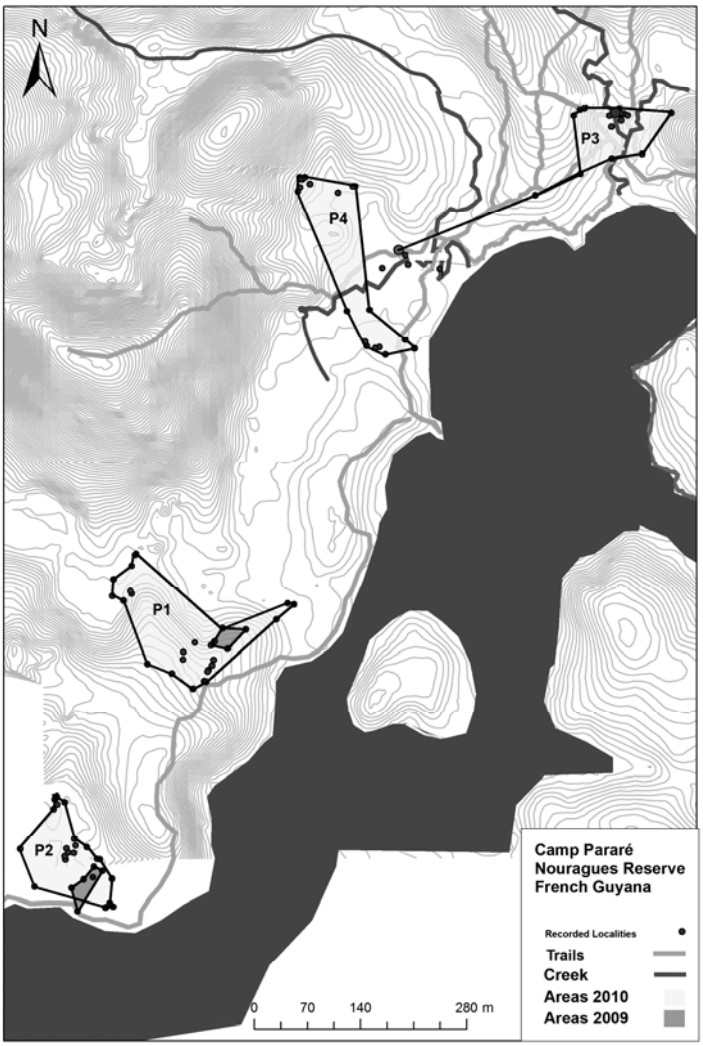
N
P1
P2
P3
P4
Camp Pararé
Nouragues Reserve
French Guyana
Recorded Localities
Trails
Creek
Areas 2010
Areas 2009
0
70
140
280 m

Figure 5

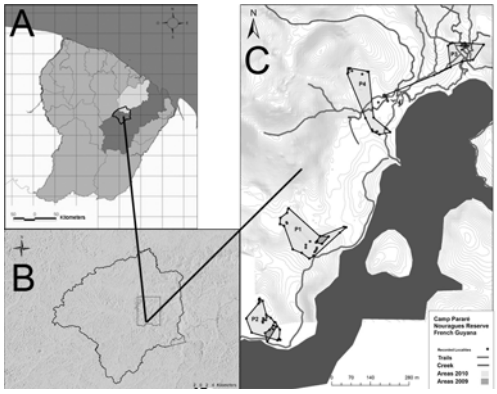
A
B
C
N
Camp Parare
Nouragues Reserve
French Guyana
Trails
Creek
Areas 2010
Areas 2009

Figure 6

APPENDIX 2: Tables

Table 1:

ID	year	sex	CL (mm)	CW (mm)	PL (mm)	PW (mm)	M (g)	Date	time	transmitter frequency
P1	2009	F	137	95	127	66	n.m.	06.02.2009	15:00	150,102 MHz
P2	2009	M	146	92	128	60	n.m.	07.02.2009	23:15	150,033 MHz
P1	2010	F	137	95	127	66	259	05.02.2010	10:24	150,102 MHz
P2	2010	M	149	92	133	61	292	05.02.2010	11:11	150,033 MHz
P3	2010	M	149	98	137	65	289	28.01.2010	morning	150,124 MHz
P4	2010	M	154	97	139	63	312	07.02.2010	21:41	150,152 MHz

Table 2:

specimen	year	study days	trackings	total distance (m)	MD (m)	SD (m)	Min (m)	Max (m)
P1	2009	4	5					
P2	2009	5	5					
P1	2010	14	23	503	23	24	0	89
P2	2010	14	21	686	31	39	0	148
P3	2010	13	24	648	31	74	0	312
P4	2010	11	20	581	34	61	0	200

Table 3:

specimen	MDD (m)	SD (m)	Min (m)	Max (m)	MDN (m)	SD (m)	Min (m)	Max (m)
P1	12	14	0	35	31	25	14	89
P2	13	18	0	43	37	47	0	148
P3	1	2	0	5	1	4	0	10
P4	11	11	0	30	58	84	0	200
Total	10*	13	0	43	37*	51	0	200

Table 4:

Fecal contents (N = 2)	Stomach contents (N = 4)
Berries	Amphibian eggs (Bufonidae)
Decapoda	Amphibian eggs (Microhylidae)
Oligochaeta	Cicadoidea
Orthoptera	Diplopoda
	Nematocera
	Oligochaeta
unidentified plant Material	

Appendix III: Figure and table legends

Figure 1: Tracking points of specimen P1 (female).

Figure 2: Tracking points of specimen P2 (male).

Figure 2: Tracking points of specimen P3 (male).

Figure 2: Tracking points of specimen P4 (male).

Figure 5: Map of the study area along the Arataye river. Marked areas with light filling indicate areas of activity 2010, marked areas with dark filling indicate areas of activity 2009.

Figure 6: Location of the study area. A: Map of French Guyana. Highlighted = The two districts (Roura, Regina) the Reserve stretches across. B: Map of the Nouragues Reserve. Camp Pararé is located near the Southern border. C: Surroundings of Camp Pararé with highlighted areas of activity. For details see fig. 5.

Table 1: Studied individuals of *P. platycephala*. Abbreviations: CL = Carapace length, CW = Carapace width, PL = Plastron length, PW = Plastron width, M = Mass, Date = Date of first capture, n.m. = not measured with a scale

Table 2: Total distances covered by *P. platycephala*. Abbreviations: MD = mean distance between trackings, SD = standard deviation, Min = minimum distance covered between trackings, Max = maximum distance covered between trackings

Table 3: Distances covered divided per night and day. MDD = mean covered distance per day, SD = standard deviation, Min = minimum distance covered, Max = maximum distance covered, MDN = mean distance covered per night. * indicates statistical significanct difference between night and day

Table 4: Results of the dietary analysis of 4 positive stomach samples and 2 fecal samples of *P. platycephala*