SOUTHEASTERN FOUR-EYED OPOSSUM

Philander frenatus (Desmarest, 1804)

TAXONOMY: Class Mammalia; Subclass Theria; Infraclass Metatheria; Magnorder Ameridelphia; Order Didelphimorphia; Family Didelphidae; Subfamily Didelphinae; Tribe Didelphini (Myers et al 2006). Six species are recognised in this genus (Patton & da Silva 1997, Lew 2006, Gardner 2007), one is currently documented as being present in Paraguay. The species is monotypic. The generic name is derived from the first vernacular name "Philander opossum, sive Carigueja" used by Seba (1734) with Philander meaning "man-loving" (Braun & Mares 1995). The specific name *frenatus* is from the Latin meaning "bridled" in reference to the distinctive face pattern.

The genus *Philander* was defined by Brisson (1762), though it is often credited to Tiedemann (1808). However Tiedemann clearly used the name when referring to the *Didelphis* of Linnaeus (JA Allen 1900). In 1998 the International Commission on Zoological Nomenclature determined that Brisson´s name had priority over that of Tiedemann. There has been considerable debate as to which generic name should take precedence for this species with Pine (1973) arguing that *Metachirops* Matschie 1916 is the correct designation for this species and that *Philander* should apply to the Brown Four-eyed Opossum here referred to *Metachirus* Burmeister 1854. However his arguments failed to gain widespread support and *Philander* is the most widely accepted generic name for this species (Nowak 1991, Redford & Eisenberg 1992, Emmons 1999). Based on mtDNA cytochrome-b gene sequences and DNA-DNA hybridisation data *Philander* is the sister group of *Didelphis*. (Castro-Arellano et al. 2000).

Following a number of molecular studies there has been a recent tendency to raise several forms formerly treated as subspecies of *Philander opossum* to species level. Patton & da Silva (1997) first raised *Philander frenata* (=*P.frenatus*) to species level based on sequences of the cytochrome-*b* gene, finding it highly divergent (14%) from all other forms of *P.opossum* used in their analysis.

There is considerable confusion in the recent literature surrounding the nomenclature of the various forms in the genus *Philander*. Three recent detailled reviews of *Philander opossum,* included all the forms now recognised as species but disagreed considerably as to the distribution and nomenclature of the populations involved. In terms of the populations now considered to constitute *Philander frenatus,* Hershkovitz (1997) attributed the southern Brazilian, Paraguayan, Bolivian and eastern Peruvian populations to *P.o.quica* Temminck 1824 and confined *P.o.frenata* (sic) Olfers 1818 to Salvador, Bahía, a separation of taxa which Gardner (2007) considered "inexplicable". Castro-Arellano et al (2000) however applied *P.o.frenatus* to the coastal Atlantic forest subspecies extending from Bahía State in Brazil to Provincia Misiones, Argentina, and used *P.o.azaricus* for the Paraguayan population and animals inhabiting the Pantanal and cerrado of Brazil. Patton & da Silva (1997) considered *P.frenata* to have an entirely Brazilian range that extends from at least the State of Paraná north to Bahía and inland to Minais Gerais and Goias, but noted that the relationship of *P.frenata* to *P.o.azarica* (sic) "remains to be determined". They maintained *azarica* within *P.opossum* without any further justification other than the fact that it is traditionally placed there. Gardner (2007) synonymised *azarica* with *frenatus*. Synonyms are adapted from Gardner (2007):

D[*idelphys*]. *frenata* Illiger 1815:107. Nomen nudum.
D[*idelphys*]. *superciliaris* Illiger 1815:107. Nomen nudum.
D[*idelphys*]. *frenata* Olfers 1818:204. Type locality "Sudamerica". Restricted to Bahía, Brazil by JA Wagner (1843).
D[*idelphys*]. *superciliaris* Olfers 1818:204. Type locality "Sudamerica".

Didelphis quica Temminck 1824:36. Type locality "Brésil". Restricted to Sapitiba (=Sepetiba, Rio de Janeiro) by Pelzeln (1883).
Didelphys [*Metachirus*] *quica* Burmeister 1854:136. Name combination.
Zygolestes enterianus Ameghino 1899:7. Type locality "Argentina".
[*Didelphis* (*Metachirops*)] *quica* Matschie 1916:268. Name combination.
[*Didelphis* (*Metachirops*)] *frenata* Matschie 1916:268. Name combination.
[*Holothylax*)] *quica* Cabrera 1919:48. Name combination.
Metachirus opossum azaricus O.Thomas 1923:604 Type Locality "Sapucay" (=Sapucaí), Departamento Paraguari, Paraguay.
Metachirops quica Bresslau 1927:215. Name combination.
Metachirops opossum quica A Mirando-Ribeiro 1935:37. Name combination.
Met[*achirops*]. *opossum quichua* Krumbiegel 1941:200. Name combination and incorrect spelling.
Met[*achirops*]. *opossum azaricus* Krumbiegel 1941:203. Name combination.
Met[*achirops*]. *opossum frenatus* Krumbiegel 1941:206. Name combination.
Philander opossum azaricus Cabrera 1958:34. Name combination.
Philander opossum quica Cabrera 1958:36. Name combination.
Philander enterrianus Reig 1957:220. Name combination and incorrect spelling.
Philander opossum azarica Patton & da Silva 1997:97. Name combination and incorrect gender.
Philander opossum frenata Patton & da Silva 1997:90. Name combination and incorrect gender.
Philander frenata Patton & da Silva 1997:90. Name combination and incorrect gender.

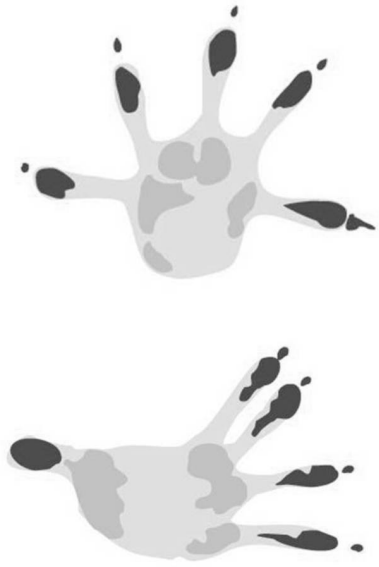
ENGLISH COMMON NAMES: Southeastern Four-eyed Opossum (Gardner 2007), Grey Four-eyed Opossum (in part Castro-Arellano et al 2000)

SPANISH COMMON NAMES: Comadreja de cuatro ojos (Massoia et al 2000), Comadreja de anteojos (Massoia et al 2000), Guayquica overa (Massoia et al 2000, Parera 2002), Mantequera (Massoia et al 2000), Chucha (Massoia et al 2000, Redford & Eisenberg 1992), Cuica común (Massoia et al 2000), Zorro de cuatrojos (Redford & Eisenberg 1992), Zarigüeya de cuatro ojos grís (Emmons 1999), Carachupa cuatro ojos (Cuéllar & Noss 2003), Guaiquica común, Guaiquica overa (Massoia et al 2006).

GUARANÍ COMMON NAMES: Guaikí (Massoia et al 2000, Redford & Eisenberg 1992).

DESCRIPTION: Slender with a large head and elongated, conical rostrum. Pelage short, dense and smooth, each hair pale-based with a darker central band and silvery-tip. The dorsum is dark greyish (tinged browner in older individuals), darker towards the mid-dorsum and becoming paler and whiter towards the flanks. Throat, cheeks and venter are creamy-white. The head is uniform with the body with conspicuous white patches above the eyes (the "spectacles") and less obvious, smaller patches at the anterior base of the ears. The ears are large, rounded and pinkish with blackish borders to the pinnae. The nose, upper lip and feet are naked and pinkish in colour. The prehensile tail is long, furred for the first 5-8cm (approximately 17% of its total length) and greyish at the base with a sharply-demarcated white tip. It is cylindrical, slender, scaly and tapers towards the tip. Hind feet have opposable pollex and hallux, modified for grasping. The maruspium, which opens from the side, is orange in females that bear young and whitish in those that do not. The scrotum of the male is black and breeding males develop a small yellowish patch on the sides in front of the thighs. Females possess between 5 and 9 mammae (usually 7) concealed within the marsupium, arranged in two equal rows with a median teat between them (typically 3-1-3). Juveniles are similar to adults with have finer, softer fur.

CRANIAL CHARACTERISTICS: Skull is narrow and slender. *Philander* has a relatively large brain in comparison with other Didelphids (Redford & Eisenberg 1992). Bony palate with four fenestrae. Sagittal and occipital crests are well-developed in adults and auditory bullae are small. Hershkovitz (1997) gave the following measurements for his *P.o.quica* which refers in part to this species: *Condylobasal Length:* male 66.4mm (60-76.4mm, n=78), female 62.8mm (57.1-72.4mm, n=76); *Zygomatic Width* male 35.5mm (30.7-43.7mm, n=75), female 31.1mm (28-38.3mm, n=67); *Preorbital Width:* male 12.6mm (10.8-15.7mm, n=36), female 11.6mm (9.7-14.7, n=42); *Postorbital Width:* male 8.4mm (7.4-9.1mm, n=77), female 8.4mm (7.5-9.9mm, n=67); *Braincase Width:* male 20.2mm (18.2-23.1mm, n=71), female 19.7mm (18-21.9mm, n=67); *Palate Length:* male 38.3mm (34.1-44.8mm, n=75), female 39.2mm (35.1-44.6mm, n=71).



DENTAL CHARACTERISTICS: I5/4 C1/1 P 3/3 M 4/4 = 50. First incisor largest on upper row, absent on lower mandible. Upper canine long, slender and decurved, lower canine similar but smaller. Premolars unicuspid with two roots. Upper P1 about half the size of P2, and P3 deciduous. Young at weaning lack molars, the molars then begin to appear in sequence. Upper M1 longer and larger than M2. Upper M4 about half the size of M3. Lower m2 or m3 largest, lower m4 smallest. The appearance of M4 is accompanied by the loss of P3. Dentition is complete at 1 year of age. From this point on age can be determined by tooth wear. Body mass continues to increase after full eruption of molars (Hershkovitz 1997). Hershkovitz (1997) gave the following measurements for his *P.o.quica* which refers in part to this species: *Length i-m4:* male 34.4mm (32-37.7mm, n=78), female 32.9mm (30.5-38mm, n=71); *Length m1-m4:* male 12.7mm (11.6-14.4mm, n=80), female 12.5mm (11.2-14.5mm, n=78). Astúa de Morães et al. (2001) describe supernumerary molars in two museum specimens. Specimen MZ267 shows an extra upper molar on each side. On the left side the extra tooth resembles a small M4, whilst the real M4 resembles a typical M3. On the right side the extra tooth is somewhat deformed and shows evidence of wear. In both cases they are cluttered on the M4 and the crowns are on a different occlusal plain. Specimen MZ5769 also shows an extra upper molar on each side. The right molar is partially erupted, dislocated and with the occlusal plain posteriorly located. The left tooth is deformed and somewhat ovoid though the occlusal plain is aligned with the series of other molars.

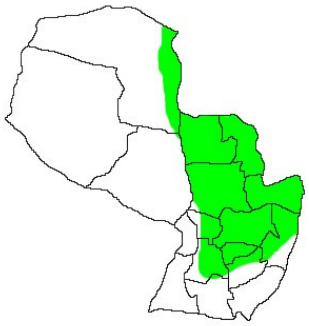
GENETIC CHARACTERISTICS: 2n=22. FN=20. Karyotype with 10 uni-armed autosomes with terminal centromeres, an acrocentric X and a minute Y (Castro-Arellano et al. 2000).

TRACKS AND SIGNS: Similar to *Didelphis* sp but smaller with digits III and IV of the hindfoot in close proximity (Massoia et al 2006).

EXTERNAL MEASUREMENTS: A large and robust, cat-like Didelphid, with tail slightly longer than the head and body. Males initially the same size of females, but outgrow them by maturity. Captive individuals may reach much larger sizes than wild individuals, and largest wild individuals are not necessarily the oldest. Dental size, fixed at eruption, is the true indicator of body size (Hershkovitz 1997). Vieira (1997) gave the following mean measurements for 15 specimens from Rio de Janeiro and Teresópolis, Brazil: **HB:** 26.53cm; **TA:** 26.90cm; **FT:** 3.46cm; *Claw* 0.17cm; *Foot Width* 2.62cm; *Arm* 4.37cm; *Forearm* 4.94cm; *Leg* 4.09cm, *Foreleg* 5.09cm; *Forelimb* 9.31cm; *Hindlimb* 11.05cm; **WT:** 398g (220-680g). Vieira et al (2008) noted **WT:** 292g (+/-155g, range 85-595g) for 14 individuals (9 males and 5 females) in the Serra do Mar, Brazil.

The following mean post-cranial measurements were noted by Carvalho et al (2000) for Brazilian specimens (n=7): *Ulna* 40.2mm; *Forearm* 43.9mm; *Humerus* 33.2mm; *Tibia* 42.1mm; *Foreleg* 50.7mm; *Femur* 39.2mm. Hershkovitz (1997) gave the following measurements for his *P.o.quica* which refers in part to this species: **HB:** male 26cm (20-30cm, n=60), female 25.5cm (22-33cm, n=57); **TA:** male 29.2cm (19.5-35.5cm, n=63), female 27.59cm (22-31cm, n=55); **FT:** male 4cm (2.9-4.8cm, n=64), female 3.8cm (3.2-4.6cm, n=53); **EA:** male 3.4cm (2.2-4.2cm, n=44), female 3.3cm (2.2-4.3cm, n=46). Hingst et al (1998) gave the **WN:** 0.1g (+/-0.04) and **TL** of new borns: 9-11mm.

SIMILAR SPECIES: The only other species to share the "eyes" of this species is *Metachirus nudicaudatus*, which is most easily distinguished by its brownish pelage. When viewed frontally note that the white spots above the eyes are smaller and more widely-spaced in *Metachirus*. The second pair of "eyes" are much reduced and located in front of the ears in this species, those of *Metachirus* being more extensive and located behind the ears. The tail of *Philander* is proportionately shorter and furred at the base for the first 6 to 8 cm, as well as being bicoloured with a clearly demarcated tip - that of *Metachirus* is naked to the base and becomes gradually paler along its length. Structurally the snout is more pointed and the legs are longer



in *Metachirus* than in this species. Female *Metachirus* do not possess a pouch. Finally note that *Metachirus* is almost exclusively terrestrial in behaviour, whilst *Philander* freely takes to the trees when foraging.

DISTRIBUTION: This species is found in Paraguay, northern Argentina (Provincia Misiones, records from Provincias Formosa and Chaco may refer to this species or *Philander opossum*) and southwestern Brazil (coastally from Bahía to Rio Grande do Sul at least as far south as Marica). In Paraguay it is scantily distributed through eastern Paraguay and the eastern part of Departamento Alto Paraná, the Paraguayan Pantanal. Brown (2004) listed the following specimens for Paraguay: Departamento Concepción; Rio Aquidaban, Paso Horqueta (Creighton 1979, UMMZ); Aca Poi (Wharton 1950, USNM); Departamento Cordillera; Tobati, 12 km N (Myers 1973, MVZ); Departamento Central; Luque, 17 km E (Koford 1972, MVZ; Myers 1976, UMMZ). The specific identity of Chaco populations remains to be determined and they may prove to be referable to the species *Philander opossum* (Robert Owen pers. comm.).

HABITAT: Essentially an Atlantic Forest species, this opossum has proved itself to be adaptable and able to colonise a variety of habitats, though it shows a preference for forested areas close to rivers or swamps, typically with dense leaf litter and rocky areas (Moura et al 2005). In Brazil they are found most commonly in humid forest, but also occur in drier and scrubbier restinga habitat. In Paraguay they are typically associated with humid and semi-humid evergreen forests, such as the Atlantic Forest and the seasonally-inundated forests of the Pantanal. The water balance of *Philander* suggests that it is an obligate inhabitant of mesic environments (Fonseca & Cerqueira 1991).

ALIMENTATION: Omnivorous but primarily carnivorous, taking mainly invertebrates and small vertebrates supplemented with fruit. Nowak (1991) lists small mammals, birds and their eggs, reptiles, amphibians, insects, freshwater crustacea, snails, earthworms, fruit and carrion as dietary items.

Foraging Behaviour and Diet Cáceres (2004) examined 14 fecal samples from Atlantic Forest in the Serra do Mar, southern Brazil, finding invertebrates in 100% of samples, vertebrates in 57% and fruit in 29%. In order of prevelance this consisted of: Coleoptera 57%, Opiliones 50%, Aves 36%, Diplopoda 36%, Blattaria 36%, Hymenoptera (ants) 29%, Pulmonata 21%, Orthoptera 21%, Decapoda 21%, Mammalia 21%, Reptilia 14% and fruits of *Monstera adansoni, Ficus luschnatiana* and unidentified Solanaceae all 7% each. Germination rates of 97% and 100% were recorded for *Monstera* and *Ficus* seeds respectively that had passed through the gut of this species, indicating its role as an occasional seed disperser for certain tree species.

Carvalho et al (1999) recorded the following animal items in 4 fecal samples at Poço das Antas, Rio de Janeiro, Brazil (results as expressed as percentage of samples in which the item was present): Coleoptera 100%, Hymenoptera 50%, Arachnida 50%, Diptera 25% and Rodentia 25%. Plant material consisted of: *Piper* sp 66.7%, *Piper molicomum* 33% and unidentified 3%.

Ceotto et al (2009) studied the diet of the species in a disturbed rural area in Sumidouro, Rio de Janeiro. As with previous studies they found no difference in diet between sexes, whilst juveniles took proportionately less vertebrates than adults (presumably related to inferior body size and tooth development). The species was found to take more vertebrate prey than sympatric *Didelphis aurita*, whilst consumption of fruit and invertebrates was approximately the same in both species. However *D.aurita* consumed a wider variety of fruit and whilst the diversity of invertebrates was similar the composition was different, with *Philander* consuming crustacea and mollusca, *D.aurita* taking mainly litter-dwelling arthropods. It was suggested that these dietary differences reduce competition and allow for co-existence of the two species.

Cáceres (2006) lists the following additional plant species recorded in the diet of this species *Anthurium harrisii* (Araceae), *Aechmaea nudicaulis* (Bromeliaceae), *Passiflora mucronota* (Passifloraceae) and *Paulinia weimanniaefolia* (Sapindaceae).

Diet in Captivity Santori et al (1997) compared the diet of wild animals at Barra de Maricá, Rio de Janeiro with the preferences of laboratory animals. They found no significant difference in diet between

sexes and whilst wild data showed that subadults and adults consumed more vertebrate prey than juveniles, this did not translate to a preference under laboratory conditions and perhaps represented greater experience in foraging in wild animals. More invertebrates were consumed during humid months and more fruit during dry months, the juicy fruits acting as a water source in the dry restinga environment when standing water is scarce. Caged animals were able to survive on a pure animal diet if water was provided, but could not survive on a pure fruit diet. The following food items were recorded in 180 fecal samples taken from wild individuals (results as expressed as percentage of samples in which the item was present): Vertebrate prey included the rodent *Akodon cursor* 6.6% and reptiles *Mabuya* sp. 2.2%, *Tropidurus torquatus* 1.1%, *Ameiva ameiva* 1.1% and an unidentified snake 0.6%. Unidentified vertebrate remains belonged to mammals 2.2%, birds 2.7% and reptiles 3.9%. In order of prevalence the following invertebrate remains were recorded: Unidentified Coleoptera 47.8%, Formicidae 45.6%, Blattaria 27.2%, Unidentified Orthoptera 8.9%, Tettigoniidae 7.2%, Chilopoda 5.5%, Diplopoda 3.9%, Scarabaeidae 3.3%, Araneae 3.3%, Diptera pupae 2.8%, Mollusca 2.2%, Acari 1.7%, Unidentified Hymenoptera 1.7%, Isoptera 1.7%, Locustidae 1.1%, Hemiptera 1.1%, Diptera 1.1%, Scorpiones 1.1% and Unidentified Arachnida 1.1%. The following were all present in one sample (0.6%) Opiliones, Scolopendromorpha and Dermaptera. Unidentified fruits were present in 36.7% of samples.

Cerqueira et al (1990) found bacon to be the most effective bait for trapping this species. Barros et al (2008) used Tomahawk traps baited with a "mixture of banana, oat, peanut butter and minced bacon, placed on top of a manioc slice" whilst Cáceres (2004) trapped the species using banana and cod liver oil.

Hershkovitz (1997) fed a captive individual with beef, chicken legs, insects, peanut butter and banana. It dispatched live mice instantly by crunching the head and neck in its jaws and consuming everything "flesh, entrails, skin or bones". Prepared food was consumed at night even when provided during the day. Following feeding the animal groomed its forequarters, sides and underparts without paying particular attention to the pouch and none to the young. Hingst et al (1998) maintained a breeding colony of individuals by feeding them banana, orange, quail eggs, chicken and beef, supplemented twice a week with commercial dog mix, cod liver oil, Tenebrionidae larvae and live mice.

Astúa de Morães et al. (2003) experimentally tested the proportions of protein, lipid, carbohydrate and fibre in the diet of adults (n=51) and juveniles (n=17) of this species under laboratory condtions. Mean proportions per 100g dry weight of food were: protein ad. 10.62g (+/-3.75), juv. 8.82g (+/-3.63); lipid ad. 2.31g (+/-1.46), juv. 1.71g (+/-0.87); carbohydrate ad. 11.54g (+/-5.09), juv. 7.65g (+/-4.44); fibre ad. 1.76% (+/-0.45), juv. 1.54% (+/-0.57). Santori et al (2004) described and illustrated the gut morphology of this species and associated it with dietary habits, whilst Santori et al (1995) made comparisons with *Didelphis aurita*.

REPRODUCTIVE BIOLOGY: This species is considered an "r-strategist", in other words its reproductive behaviour favours a rapid rate of population increase. Such strategies are typical of species inhabiting short-lived environments or those that undergo large fluctuations in population size (Hershkovitz 1997).

Seasonality Breeding apparently can occur throughout the year but seems to be affected by resource availability, leading to breeding seasonality in some areas. Breeding has been recorded from August to February in Misiones Argentina, but Barros et al (2008) found no evidence of seasonality of breeding in the species at Poço das Antas Biological Reserve, Rio de Janeiro, with receptive females being found throughout the year except June and September. Cerqueira et al (1993) found breeding to be seasonal in restinga in southeastern Brazil with no reproductive females encountered from March to June. Gentile et al (2000) found breeding to begin in either July or August in Sumidouro, a rural area in Rio de Janeiro State and that from August to January almost all females were engaged in reproductive activity. Last weaning occurred in March, or less often April.

Barros et al (2008) noted that the fragmented forest in which they worked experienced edge effects which can affect the resource availability in a way that more continuous blocks of forest would not, leading to a possible change in the breeding patterns and the ability to breed during months in which it may not be possible in a more continuous block. Males are sexually active throughout the year but the testes vary seasonally in size, though not in mass or spermatogenesis. Barros et al (2008) found no relationship between rains and the presence of receptive females. They recorded a mean litter size of 5,

with a range of 1 to 8 (n=21) and young were found throughout the year excpet June, October and November. Hershkovitz (1997) mentioned a female ("Barbara") with six pouched captured in Minas Gerais during October.

Pregnancy In northeastern Argentina the observed range of litter size is from 4 to 6. A litter from Paraguay photographed by José Luis Cartés contained 5 young. The gestation period is from 13 to 30 days (Cimardi 1996). Females may abort a brood by stopping lactation if there is insufficient food available to her. Ovarian cycling is suspended during lactation but not during gestation, the act of suckling being key to the suspension of the cycle. In Brazil a litter with 4 males and 1 female young was found. Young removed from the pouch during early lactation show no difficulties in reattaching to the nipple (Hingst et al 1998). Pouched young are pink, completely naked and the eyes visible as black spots beneath the skin. Ears are absent and internal organs are visible through the skin.

Hingst et al (1998) provided the following reproductive data for a captive colony. Breeding was achieved only between August and February suggesting a seasonal cycle. Breeding success increased from 10.7% to 28.6% if the male and female were allowed sensory contact via a wire fence prior to being placed together and there was no indication of female-induced oestrus by the presence of a male. Pairs were kept together for seven days, longer periods of contact effecting no increase on breeding success. Aggression between pairs was common resulting in frequent tail mutilation but never death. They were observed to mate several times during a 15 minute period, after which time they returned to showing agonistic behaviour. Gestation was recorded at 13 to 14 days and there was a post-lactation oestrus. Early interruption of lactation resulted in 50% mating success rate. Litter size ranged from 1 to 10 with a mean of 5.5 (+/-2.4). Seven teats were found to be present in all females and on three occasions more than 7 young were born, those unable to find a teat dying within the first 24 hours. Mean litter size at weaning was 4 (+/-1.9). Sex ratio was initially biased towards males at 11-20 days, but by weaning the sexual bias had disappeared. 54.5% of young were successfully weaned (55 of 101 individuals). Young weaned at 70 to 80 days with a mean mass of 35.7 g (+/-4.8). Young not physically separated from the mother at weaning ran the risk of being cannibalised by her.

Development Hingst et al (1998) documented the appearance of the following stages in the development in 12 captive-reared animals: Sexual characteristics at 15 days (+/-2.7); Vibrissae at 30.3 days (+/-3.4); Ears open at 52.5 days (+/-4.3); Mouth open at 57.7 days (+/-3); Eyes open at 62.5 days (+/-2.5). Juveniles are weaned at 68-75 days when they weigh 50-75g (100-200g for captive individuals). The nest phase lasts as little as 8 to 15 days before dispersal of the young, with members of the litter becoming more anti-social towards each other following weaning. Survival chances of a litter is greatly affected by the age of the mother. Females <11 months old and >17 months old have the highest mortality rate of offspring (Gentile et al 1995).

Males reach sexual maturity rapidly at 7 months, and females are sexually mature by 6 or 7 months, though the first oestrus is not until 15 months. The reproductive life of the average female is short. (Redford & Eisenberg 1992, Castro-Arellano et al. 2000).

Age of first reproduction for a captive bred female was 352 days, whilst males first bred at 282 days. Wild females were estimated to breed by 210 days.

GENERAL BEHAVIOUR: ***Activity Levels*** Adults are generally solitary, nocturnal and predominately terrestrial. The eyes shine orange under torchlight (Hershkovitz 1997).

Locomotion The species is largely terrestrial when foraging though somewhat semi-arboreal in overall behaviour (Massoia et al 2000, Nowak 1991). Vieira (1997) described the species as a terrestrial scamperer. However, it is an excellent climber and though it frequently uses the subcanopy, it does not apparently reach the canopy (Cunha et al 2002). The reduced forelimbs and larger hindlimbs are an adaptation for jumping, necessary in a semi-arboreal animal which must avoid obstacles on the forest floor and have the necessary agility to move through tree branches (Vieira 1997).

Delciellos & Vieira (2006) studied arboreal locomotion of this species on horizontal branches in PN Serra dos Orgãos, Rio de Janeiro State, Brazil. A maximum velocity of 5.24 (+/-0.14) x body length/second was recorded on support branches of 5.08cm diameter, and a minimum velocity of 4.37 (+/-0.19) x body length/second was recorded on support branches of 2.54cm diameter. Minimum number of strides per second was 3.96 (+/-0.12) on support branches of 2.54cm and maximum number

of stride lengths per second was 4.63 (+/-0.09) on support branches of 5.08cm diameter. Range of stride length was from 1.10 to 1.13 x body length. Maximum velocity is reached by increasing stride frequency (Delciellos & Vieira 2007).

Delciellos & Vieira (2009) investigated climbing performance of this species on nylon ropes of three diameters 0.6cm, 0.9 and 1.25cm. Respective velocities (stride length x stride frequency) of 0.53 (+/-0.20), 0.81 (+/-0.30) and 1.23 (+/-0.66) were recorded for the three rope diameters. Number of strides per second respectively were 1.15 (+/-0.25), 1.65 (+/-0.44) and 1.88 (+/-0.61) for the three rope diameters. Stride length when related to body length was 0.45 (+/-0.11), 0.48 (+/-0.09) and 0.62 (+/-0.14) respectively.

Home Range Gentile et al (1997) estimated home range to vary between 0.12-1ha with a mean of 0.4ha in restinga habitat at Barra de Maricá, Rio de Janeiro. Range size did not vary between the wet and dry season. Male range size remained more or less constant (mean 0.28ha +/-0.13 during breeding season, 0.37ha +/-0.28 during the non-breeding season), but that of females increased significantly during the reproductive season (mean 0.57ha +/-0.27 during breeding season, 0.17ha +/-0.08 during the non-breeding season). Immature animals did not differ from adults in the size of their home ranges. Ranges were found to overlap more as population density increased, though mean range size was unchanged and territories were found to overlap irrespective of the sexes of the occupants. There is little or no contact or antagonism between adults provided that sufficient resources exist (Redford & Eisenberg 1992) and no dominance hierarchy amongst adults.

Pires et al (2002) detected a rate of movement between forest fragments of 7.5% at Poço das Antas, Rio de Janeiro and noted no statistical difference in the movements between the sexes. Gentile & Cerquiera (1995) performed a mark-recapture study on this species in the Brazilian restinga at Barra de Maricá, Rio de Janeiro State, Brazil. Sampling a 4ha site they found that 51.8% of movements were less than 30m from the original capture site. Gentile et al (2004) correlated population density with leaf production and litter fall with a 5 and 7 month time lag in Rio de Janeiro, Brazil.

Refuges Nests of this species were always between rocks close to running water in PN Serra dos Orgãos, Rio de Janeiro (Moura et al 2005). Southeastern Four-eyed Opossums sleep curled into a ball, and though the true eyes are not visible, the "false eyes" are and give the appearance of an animal that is alert and awake (Castro-Arellano et al. 2000). Miles et al (1981) describes nests of the species in tree hollows and tree forks 8-10m, as well as nests in cavities behind butressed tree roots.

Defensive Behaviour On release from a trap 93% of animals in Brazil used terrestrial escape routes (Castro-Arellano et al. 2000). Moura et al (2005) noted that released individuals ran towards rocky areas near streams. Disturbed *Philander* may climb trees to avoid danger, but when cornered this species threatens with the mouth open whilst making hissing sounds (Emmons 1999, Massoia et al 2000) and is prepared to defend itself aggressively (Nowak 1991). Herskovitz (1997) notes that cornered animals may adopt a bipodal or tripodal stance and lurch forward at the agressor with open mouth. Hingst et al (1998) note that the animal must be handled by the tail with vigorous shaking movements of the hand to avoid them climbing up the arm and biting. Animals should be caught and retrained by holding firmly behind the neck with one hand and restraining the tail with a gloved hand.

Mortality An individual hit by a car in Argentina was reported by Comita (1989).

Parasites Hershkovitz (1997) lists the following parasites for this species: Nematoda *Rhopalia horridus* and *Viannaia conspicua;* Coleoptera *Amblyopinus henseli;* Siphonaptera *Adortaopsylla antiquorum, Ctenocephalides felis, Rhopalopsyllus lutzi, Tritopsylla* (=*Adoratopsylla*) *intermedia* and *Xenopsylla cheopsis.* Limardi (2006) notes the following ectoparasites of this species in Brazil: Siphanoptera *Craneopsylla minerva* (Stephanocircidae); *Adoratopsylla ronnai* and *Adoratopsylla sinnuata* (Ctenophthalmidae); Acari: Metastigmata *Ixodes loricatus, Amblyomma striatum* (Ixodidae). Thatcher (2006) gives the following endoparasite for Brazil: Protozoa *Trypanosoma cruzi.*

VOCALISATIONS: Hissing noises accompany threat behaviour and they may utter a "long, chattering cry" when disturbed (Massoia et al 2000, Nowak 1991). Clicks, chirps and hisses are used in communication (Redford & Eisenberg 1992).

HUMAN IMPACT: Occasional damage to fruit crops and cornfields has led to them receiving a bad reputation in parts of their range where they are more abundant (Cimardi 1996). In Paraguay this species is

rarely encountered and interviews with locals performed by Lowen et al (1996) failed to find any reference to the species. Its human impact in Paraguay is therefore minimal. A closely-related species acts as a reservoir for *Trypanosoma cruzi* and is eaten in certain parts of its range eg Guyana, though the flesh is said to be foul-smelling. It does not figure as a regular dietary item for the indigenous tribes in Paraguay, but with infection rates varying between 5% and 40% in French Guiana it is a potential source of infection. Snake venom inhibition is exhibited by the sera of this species which has made it an important laboratory animal (Hingst et al 1998).

CONSERVATION STATUS: Globally considered to be of Low Risk Least Concern by the IUCN, see http://www.iucnredlist.org/search/details.php/40516/all for the latest assessment of the species. It is likely under-recorded in Paraguay but has no doubt disappeared from large areas of its former range as a result of conversion of forest to agriculture. It is not listed for the Mbaracayú Biosphere Reserve (Esquivel 2001) and Lowen et al (1996) did not record it during extensive surveys of the Atlantic Forests of eastern Paraguay in 1992 and 1995, nor did they interview locals who were familiar with the species. Pires et al (2005) reported increased capture rates of this species in Atlantic forest fragments after fire when compared to capture rates before fires at Poço das Antas, Rio de Janeiro. Massoia et al (2006) describe the species as common without being abundant in Argentina.

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FIGURE 1- (FPMAM12PH)
Southeastern Four-eyed Opossum
Philander frenatus.
Juvenile. Location unknown, undated.
Photo José Luis Cartes.

FIGURE 2 - (FPMAM13PH)
Southeastern Four-eyed Opossum
Philander frenatus.
Litter. Location unknown, undated.
Photo José Luis Cartes.