HUSBANDRY MANUAL - PHILIPPINE TARSIER (*Tarsius syrichta)*

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D R A F T

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OVERVIEW

This document provides a brief summary of the available literature on the Philippine Tarsier (*Tarsius syrichta*), collating details published in various articles. The husbandry manual has been made possible by those institutions responding to a questionnaire seeking details of husbandry practices for the species. In some instances, details are based on findings for *Tarsius bancanus* or *T. spectrum* as there is no written information for the Philippines Tarsier. Observed differences between exhibit use and behavioural patterns for *T. syrichta* and *T. bancanus* suggest that the two species may occupy differing niches or have different social groupings (Wright et al, 1987).

BACKGROUND

The Royal Melbourne Zoological Gardens has been working collaboratively with the Protected Areas and Wildlife Bureau - Department of Environment and Natural Resources of the Philippines. Several projects have been undertaken including a review of available literature on Philippine Tarsiers to provide reference material for the captive breeding program for this endangered species in the Philippines.

INTRODUCTION

The Philippine Tarsier is one of four species belonging to the genus *Tarsius*, a genus confined to Indonesia and the Philippines. Classified as a Primate, there is some confusion as to whether tarsiers should be included as Prosimians, Anthropoids, or intermediate between the two major Primate groups as tarsiers have features which can equate it to either one.

A curious species, the tarsier has a tail much longer than its body and large membranous ears. The enormous saucer like eyes which dominate the face signify that tarsiers are nocturnal in activity. Typically seen in an erect posture, clinging to vertical branches, tarsiers are renowned for their leaping ability.

The name "tarsier" is derived from the fact that the tarsal region is elongated, a trait of both tarsiers and galagoes (Napier & Napier, 1985).

The tarsier is unique amongst Primates in that its diet consists of essentially only live food items and it consumes no vegetable matter (Mc Nab & Wright 1987).

The restricted distribution of tarsiers, and their confinement to tropical forests which have suffered immense degradation, renders all species threatened with the Philippines Tarsier being designated endangered (IUCN, 1990) [The Philippines Tarsier is not listed in the 1994 Red Data Book].

Surprisingly little is known of tarsiers, field studies have been limited, and the species have proved difficult to maintain in captivity. However, data continues to be collected, field studies are underway and there are plans to expand captive populations both to enable further research and to establish a re-introduction program.

CLASSIFICATION

CLASS:	Mammalia
ORDER:	Primates
Family:	Tarsiidae
Genus:	*Tarsius*
Species:	*syrichta*

TAXONOMIC NOTES

The Philippine Tarsier is one of four species

within the genus *Tarsius*, the other three species being *Tarsius spectrum* (Spectral Tarsier), found only on Sulawesi, *Tarsius bancanus* (Western or Malaysian Tarsier), found in Indonesia and a dwarf form, *Tarsius pumilis*, confined to the mountain forests of Sulawesi and known only from a few Museum specimens (Musser & Dagosto 1987, after Jenkins, 1987)

The Philippine Tarsier was thought to have three distinct subspecies (Niemitz 1984a), but it is now considered to be a monotypic species (Jenkins 1987).

Historically, tarsiers have been associated with rodents (jerboa), marsupials (opossum) or monkeys. Later it has been associated with the prosimian Primates or alternatively considered intermediate between lemurs and monkeys (Jenkins 1987). *Tarsius* is the sole genus within the family Tarsiidae. Earliest indication of the family is found in fossils of the Eocene period from Europe (Napier & Napier, 1985). Although there is only one living genus, four fossil genera are known: *Microchoerus, Necrolemur, Nannopithex* and *Pseudoloris* (Napier & Napier, 1985). It has been noted that the genus *Tarsius* is possibly the oldest extant genus of mammals, having been in existence for some 50 million years (Roberts et al, 1984).

Today, the classification of tarsiers at suborder level remains unresolved with three major views persisting. Initially tarsiers were grouped with anthropoids based on the structure of their rhinarium (Pocock 1918 after Jenkins, 1987), the placentation and foetal membranes (Hubrecht 1908 & Luckett 1947a after Jenkins, 1987, and molecular and biochemical data (Baba et al 1975 after Jenkins, 1987). The second view to include tarsiers as prosimians is held by Simpson (1945, after Jenkins, 1987) and Simons (1972, after Jenkins 1987), based on the homology of tarsier chromosomes with prosimians (Poorman et al 1985, after Jenkins 1987). The reproductive cycle of tarsiers shows no shared derived features with those of anthropoids (Wright et al, 1986). The final theory is based on fossil evidence (Gingerich 1973, 1974,1975a and 1975b after Jenkins, 1987) which suggests that tarsiers be included in a separate group intermediate between prosimians and anthropoids because of similarities between tarsiers and fossil pleisiadiforms. It has been suggested that the characteristics of small mass, insectivorous or insectivorous/frugivorous diet, low basal rate and low body temperature may be characteristics found in the earliest primates. The physiological similarities that tarsiers share with Prosimians may be due to similar diet and body size rather than phylogenetic association (McNab & Wright, 1987).

GEOGRAPHIC DISTRIBUTION

The type locality for the Philippine Tarsier was described as Luzon, however as there are no subsequent records of the species occurring on Luzon, the type locality has been disputed (Niemitz 1984, after Jenkins, 1987).

(Map to be included at a later date)

Today, the geographic range of the Philippine Tarsier is somewhat restricted, being confined to Mindanao, Bohol Island, Samar Island and Leyte Island, all in the Philippines (Honacki et al 1982, Wolfheim, 1983, Jenkins, 1987). Details of distribution are not known (Wolfheim, 1983).

Forty to fifty million years ago, tarsier like animals were widespread, occurring in Europe, Asia and North America.

ECOLOGY

Habitat

As with other species of tarsier, the Philippine Tarsier is found in tropical rainforest, within 10^{o} latitude of the equator, often in low lying and coastal areas. The Philippine Tarsier usually occupies edge habitat or secondary growth, with preference being given to areas of regenerating growth. Tarsiers tend to frequent the understorey where insects are abundant. The trunks of trees and larger branches are a likely harbour for insects and are consequently used by foraging tarsiers (Napier 1985). Bamboo thickets or dark hollows are sought for sanctuary during daylight hours. Tarsiers can be found between 0M and 8M above the ground, with greatest incidence and most activity being reported for heights between 2M and 3M above ground level (Niemitz, 1984).

Activity Rhythm:

Nocturnal and crepuscular in character, Philippine Tarsiers can be described as inactive, spending the greater part of even their "active period" resting on vertical perches. The Philippine Tarsier has low basal rates of energy expenditure and has a low body temperature (McNab & Wright, 1987). There is no evidence that tarsiers indulge in periods of torpor, possibly reflecting a year round supply of adequate prey items (McNab & Wright, 1987). Active tarsiers consume 60-80% energy predicted for resting animals of their body mass (Roberts, 1985), and it is suggested that their foraging technique enables conservation of energy.

Diet

Tarsiers feed almost exclusively on live prey and do not consume vegetation (Roberts et al, 1984). Insects (moths, butterflies, cicadas, termites, crickets, mantids, ants, grasshoppers, cockroaches and beetles), lizards, spiders. Other species of tarsier are reported to eat various other invertebrate classes. Large orthopterans are suggested as being a major component of the diet (Davis, 1962, after McNab & Wright, 1987). Tarsiers have also been reported to tackle a number of vertebrate species including snakes, bats, birds and rodents (Niemitz, 1984).

Vision appears to play a vital role in location of prey; tarsiers housed in total darkness produce few faeces, suggesting an inability to capture prey (Roberts et al, 1984). The tarsier will perch and watch for moving prey items, pouncing upon them and dispatching them quickly by biting. Tarsiers will close their eyes to prevent injury when hunting larger insects. Tarsiers are remarkably successful in their ability to capture prey, of 313 observed attempts to capture food, 88% were successful. Of these 20% involved "reach out and grab", 29% involved a "single jump and catch", with 51% requiring 2-3 short leaps then capture (Roberts 1985). It appears that tarsiers adopt a "sit and wait" strategy when foraging, rather than probing about in the fashion of shrews, possibly an effective way of minimising energy expenditure.

Predators

Owls are listed as the \main predator of tarsiers (Napier & Napier, 1967), other predators include the Slow Loris, Giant Civet and various species of snake (Roberts et al, 1984), undoubtably tarsiers may be hunted by any arboreal predator. The Philippine Tarsier is not known to be hunted by humans (Rabor, 1968, after Wolfheim 1983) but many die in transit when captured for the "pet trade".

MORPHOLOGY

General Morphology

Tarsiers are small primates, head and body length being about 120mm. The body is quite compact, upper arms are short, whilst forearms are relatively long, legs are long,

particularly the tarsal region, and the tail is also long. The face is broad with a short muzzle, and unlike other prosimians, the nostrils are surrounded by haired skin (Jenkins, 1987). The face is dominated by two large eyes which are directed forwards, with an iris of yellow-brown colour. The ears are large and membranous. The pelage is short and more dense dorsally, being of a grey-brown but tinged with red-brown (Napier & Napier, 1967). The palms and soles are naked, having large tactile pads. The third digit of the manus is longest (Typically the fourth digit being longest for prosimians). Has claws on the second and third digits of the hind feet and nails on all other digits (Weichert 1970). The nails are relatively small and described as flakes. The hand is prehensile, but the pollex cannot be opposed (Napier 1985).

Males have an epigastric gland on the venter, circum-oral glands are present (upper lip), and glands are also present in the circum-anal region (Jenkins 1987). The scrotum is large and sparsely haired with a median raphe, enclosing the bulk of the penis; the glans penis has numerous, parallel, longitudinal sulci, between which lie rows of minute spicules, there is no os penis (Jenkins 1987). Two or three pairs of mammae are present.

Weights and Dimensions

Dimension	_	_
Body Weight		
Range (Grams)	95-165	70-154
Head & Body Length		
Range (mm)	85-159	95-160
Tail Length		
Range (mm)	135-274	189-239

(taken from Napier & Napier, 1967)

Internal Characters

Napier & Napier (1967) note the following important and distinguishing aspects of tarsier morphology:-

Skull

Rounded, moderate prognathism is masked by relatively huge forwards facing orbits, The post-orbital bar closes the orbit laterally, but closure incomplete postero-laterally. The brain case is rounded and foramen magnum sited well forward. The auditory bulla is prominent and the extended ear bone forms a bony tube, a characteristic of Old World Monkeys, apes and man. Mandible is slender with a ramus short and ascending, two halves of lower jaw meet in a V-shaped synostosis.

Vertebral Column

7 cervical, 12-13 thoracic, 6 lumbar, 3 sacral and 23-30 coccyx, the transverse ligament of the atlas is ossified (pers. obs. by Napier & Napier).

Limbs

The femoral head is cylindrical in shape, shaft being extremely long, 3rd trochanter is prominent. A unique trait of the tarsier amongst primates is its fused tibia and fibula in the distal third of their length. Combined with the elongated tarsus, this adaptation facilitates leaping (Napier & Napier, 1985).

Gastro-intestinal

Stomach is simple and small intestine arranged in simple loops, the caecum and large intestine are approximately equal in length, large intestine lacks flexures or coils.

Visual System

The cornea is protuberant, the pupil contracts to a horizontal slit, retina is comprised wholly of rods, but a macula and well formed fovea are present (Hill, 1955). The eye is remarkably immobile, which is compensated by the tarsier's ability to rotate its head 180^{o} (Napier & Napier, 1985).

Dentition: 2/1,1/1,3/3,3/3=34

The upper central pair of incisors is large and closely apposed, whilst the lateral pair is small. The lower incisors are small and erect. The canines are projecting, although rather small. The premolars show a simple conical form in the lower jaw, and in the upper jaw $P.^{2,3}$ have a well-developed internal cingulum. The upper molars are tritubercular, and in the lower jaw molars are tuberculo-sectorial. $M._{1,2}$ are quadriscuspid and $M._3$ shows a deep talonid basin with a hypoconulid cusp.

Genetic Biology

The diploid number is 80, rendering tarsiers as the genus with the highest diploid number of any mammal (Klinger, 1962 & Reutner Janusch 1973).

BEHAVIOUR

Locomotor Behaviour

Only very small primates such as the tarsier are capable of feeding on vertical trunks, curving fingers for clinging aid this activity. Tarsiers demonstrate the typical "resting stance" of vertical clingers by holding their bodies upright and prehensile feet grasping the trunk (Napier & Napier, 1985), the transversely ridged underside of the tail also provides support.

Biomechanical evidence suggests that the locomotory adaptations of the tarsier work best when the animals are perched on vertical or near vertical surfaces (Roberts, 1985). In order to leap, the hind-limbs extend in a frog-like fashion, projecting the tarsier to a different trunk or stem (Napier 1985). Tarsiers are able to leap both forward and backwards, the latter being facilitated by rotating the head 180^o so that vision is focused in the direction of the leap. Following take-off, the body from below the neck twists along the long axis, to cancel the "neck twist" (Napier & Napier, 1985). When landing is imminent, the hind limbs swing forward, with feet being the first part of the body to have contact with the perch (refer to Fig 3). The leaps are very quiet, giving the impression of tarsiers suddenly appearing and disappearing, explaining why tarsiers are called "ghost monkeys".

To facilitate vertical clinging, it has been calculated that the minimum clinging angle for a clinging animal to maintain sufficient frictional force to allow it to stay on the branch is an arc of 136^o (Cartmill 1974, after Roberts and Cunningham, 1976). Given the digit size of tarsiers, a branch having a diameter of 2.6 cm would be optimal (Roberts and Cunningham, 1986). Tarsiers have indeed shown a preference for branches having relatively small circumference. Another possible reason for this preference is that smaller branches enable fine-tuned control for jumping that facilitates better aim for locomotion and prey capture (Roberts 1985).

When on the ground, the Philippine Tarsier is capable of bipedal locomotion, or will move quadrupedally similar to a rabbit grazing (Napier & Napier, 1985).

Vocalizations

Tarsiers in general appear to be "fairly silent", but the Philippines Tarsier is reported to be more vocal than other species (Wright et al, 1987). A "chit-chit" sound is reported to be made when females are in oestrum (Hill, 1953 & Wright et al, 1986). At least fifteen types of vocalizations have been described for tarsiers (Napier 1985). More research is required to determine a vocal repertoire for the Philippine Tarsier.

Social Behaviour

It is thought that Philippine Tarsiers are monogamous (Napier 1985, Barrett, 1984, after Chivers), although social groupings have not been described in full detail. There is little sexual dimorphism between male and female tarsiers which tends to

support the theory that they are monogamous (Napier & Napier, 1985). MacKinnon and MacKinnon (1980) reported that the Spectral Tarsier (*T. spectrum)* forms stable pairs, and most groups observed consisted of a pair and their progeny. Roberts et al (1984) suggest that the Western Tarsier is not monogamous in the strict sense of the word, and that the social system more closely resembles that of a solitary carnivore rather than a primate.

Vocal, visual and olfactory signals are used for communication. Adult males will mark prominent branches within their territories, using urine secreted from epigastric glands (Napier & Napier, 1985). Marking of territories has also been observed in captive animals. In captivity, individuals appear social, with allogrooming being noted (Haring & Wright, 1989).

There appears to be an overlap in the ranges of members of the opposite sex, but ranges are exclusive for liked sexed individuals. Niemitz (1984) found that the territory of a male would overlap the territory of only one female, and that the ranges of females did not overlap the range of more than one male. Territory size is estimated at about one hectare, with a core area including resting sites. Home range size can be up to 3 hectares (Roberts, 1984) with home range for males being larger than for females (Niemitz, 1984). Juveniles tended to remain in the core area, whilst adults ranged further (MacKinnon & MacKinnon 1980). Juveniles weighing more than 80gms were subjected to aggressive interactions from their mothers, and consequently ranged beyond the "home" territory. Findings of Niemitz (1984) suggest that only subadult Bornean Tarsiers move around much, and that such individuals are unlikely to migrate further than 1 kilometre. In 1983, male and female pair members were caught in the same mist nest within an hour (Wright et al 1987), demonstrating a close association between individuals within a pair.

Whilst certain aspects of the behavioural repertoire suggest a monogamous mating system, other elements would support one male mating with several females. Hopefully further studies will reveal mating systems for tarsiers.

REPRODUCTION

A female Philippine Tarsier gives birth to one well developed infant after a gestation period of 178 days (Haring and Wright 1989). Emmons (after McNab & Wright, 1987) suggested this to be the most effective reproductive strategy in a tropical habitat with high rates of predation. Some papers indicate a seasonality to breeding seasons (Fogden 1974, Napier & Napier, 1967, Roberts 1984), whilst others suggest that breeding can occur at any time of the year (Van Horn & Eaton, 1979). Perhaps, the most likely explanation to these two theories is that breeding can be influenced by climatic conditions, such as no breeding occurs during times of drought, and following drought periods, females appear to reproduce synchronously as indicated by Wright et al (1987).

Details of oestrus cycle

Oestrus Cycle 24±3 days

Females have an oestrus cycle of about 24 days. During oestrus the external genitalia of the female becomes enlarged for a period of 2-3 days (Wright et al 1986). Hill (1953) has recorded menstruation, whilst Wright (1987) did not observe any indication of menstruation.

Males will inspect the genitals of females in oestrus, (Harrison 1963), and vocalizations may be heard (Hill, 1953). Males will chase females, and copulation ensues without extensive courtship behaviour. A

female may only be sexually receptive for one day during the cycle (Wright et al, 1987). A thick opaque discharge from the vagina has been observed a couple of days after copulation (Wright et al, 1987), whilst Hill (1953) reports that a vaginal plug is extruded a few days after copulation.

The following is taken from Reproductive Cycles in *Tarsius bancanus*, by Wright, Izard and Simons, 1986:-
The oestrus cycle for tarsiers has been divided into four stages indicated as follows:

a) Diestrus:
Leucocytes predominate, epithelia cells are small, rounded and fewer than leucocytes

b) Proestrus:
Leucocytes fewer in number than epithelial cells, which are increased in size, but still rounded

c) Oestrus:
Epithelial cells are angular and anucleate and cornified, no other cell types are present

d) Metoestrus:
Epithelial cells are clumped, leucocytes have reappeared

Cytological criteria are distinctly different from those described for Old World Monkeys (nuclei in vaginal epithelial cells)

The oestrus cycle is calculated as the first reappearance of leucocytes after two sequential oestrus periods.

Owing to the small size of tarsiers it was not appropriate to collect blood samples, and it was also difficult to collect urine samples to complement findings of vaginal smears.

Vaginal oestrus was calculated to last between 1 and 3 days, metoestrus to last between 1 and 3 days, the average length of the oestrus cycle was 25.9 days (which is longer than for most prosimians). Visually detectable swelling of genitals lasted an average of 7.8 days per oestrus cycle. The labia minora were enlarged, turgid and bright pink during proestrus and oestrus, whilst in dioestrus, and pregnancy the labia minors were deflated and became pale in colour. Pronounced genital swellings are atypical for monogamous mating systems. There was no indication of menstruation, previous reports of menstruation may actually have been vaginal bleeding following miscarriage. The vaginal opening remained perforate both between periods of oestrus and during pregnancy. Sixteen days after miscarriage, a female was observed to show genital swellings, with a second female being observed to have genital swellings 13 days after the death of a 3 day old infant.

Changes in testicular size of males were not correlated with breeding activity.

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The following is taken from Observations of courtship and copulation in *T.bancanus*, from Wright, Toyana & Simons, 1986a.:
The male becomes interested in the female during proestrus by sniffing the female's genitals and urine. The female produces agonistic vocalizations and pushes the male away. When in oestrus the female will initiate courtship behaviour indulging in genital displays achieved by bringing the hind-legs to the ears to reveal a swollen and red vulva which contrasts sharply to the white fur of the inner thigh. The male responds by chirruping, and then sniffs the female's genitals whilst she is urinating. The male urine marks, and then the female jumps away. This procedure is repeated at 10-15 minute intervals. After 60-90 minutes of such behaviour, copulation occurs. The

male approaches the female from below, mounts her dorsally, clasping the female above the chest, he may bite the female in the centre of the back. A series of quick pelvic thrusts occurs with both shallow and deep penetration, the number of thrusts observed for seven copulations ranged between 61 and 190. The last 3-5 thrusts were deeper and slower (lasting 5-10 seconds) with the final thrust (ejaculatory pause) lasting 20-30 seconds with the male stationary. Copulation would terminate with the female jumping away producing an agonistic chitter.

The female would rub her body all over on various fixtures within the exhibit for 8-20 minutes whilst the male remained basically stationary, but grooming his erect red penis. No evidence of copulatory plugs (reported by Hill, 1953) was found. Only one copulation was observed during a six hour observation period, and this occurred during the first hour of the "nocturnal light cycle".

Vaginal smears indicated whole sperm with tails only once during the oestrus cycle, incomplete sperm (no tails) were noted on 2-4 days (sperm can persist within the vagina for up to 72 hours). Vaginal oestrus lasted 1-3 days. The male continued to check the female during metoestrus (1-2 days) but was rejected by the female.

It appears that copulation occurs only once during each oestrus. Such a low frequency of copulations is rare in both anthropoids and prosimians. The frequency of copulation (1-2 times per night) and length of copulation (60-90 seconds) suggest that tarsiers fit the model for monogamous mating, or a one male breeding system. Monogamous groups generally tend to display little solicitation of the male by the female.

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Embryology

During embryological stages the Mullerian ducts are fused to form the uterus. In the tarsier, fusion of these ducts is incomplete, thus part of the uterus resembles two horns (Napier & Napier, 1985), whilst the lower part of the uterus is fused.

In the tarsier as with anthropoids, the placenta is haemochorial: the capillaries of the chorion burrowing into the blood vessels of the uterine wall, consequently there is direct contact between foetal and maternal blood (Napier 1985). There are no shared derived features of reproduction that link tarsiers with anthropoids (Wright, Izard & Simons, 1986).

Gestation Period 178 days
(Haring & Wright 1989, Izard, Wright & Simons, 1985)

Birth

Reported Birth Weight (gms)	20-31.5
Body length at birth (mm)	66-72

Labour is reported as lasting between 20 minutes and 7 hours (??), and that problems can occur during labour because of the relatively large size of the newborn (weight of newborn = 20% weight of adult female). Pregnancy can be detected by weight increase of the female, and extended abdomen.

A newborn Philippine Tarsier is precocial, being well furred and having open eyes.

Development/care of infant

An infant tarsier is "parked" by the female from an early age, whilst the female forages, no nest is built. The infant clings to the female's abdomen, or alternatively, a female may carry an infant in her mouth. Juvenile tarsiers are capable of climbing at 2 days, jumping at 4 days, and show the complete adult locomotory repertoire at 19 days (Fodgen, 1974). Roberts (1985) reports

that the first leaps are not made until the infant tarsier is about 25 days old. The first solid foods are taken between 45 and 60 days. Last nursing bouts were observed when infants were aged about 65 days, and mother and juvenile ceased to regularly sleep together when young are aged about 85 days. The oldest infant to be observed being carried by its mother was aged 49 days.

In captivity juveniles begin to forage on the floor of their enclosure when aged about 10 weeks. By 16 weeks of age, all capture of prey was arboreal, which co-incides with development of visual-muscular co-ordination (Roberts, 1985).

CONSERVATION

The wild population of Philippines Tarsiers is estimated to be less than 2,500 (Primate GCAP Report, 1993). Studies are underway to determine habitat usage of Philippine Tarsiers, and more accurate population estimates.

The Philippine Tarsier is listed as endangered in the 1990 IUCN Red Data Book. The IUCN/SSC Primate Specialist Group (Eudey 1987) identifies the need to determine the distribution and status of the Philippine Tarsier. Only one third of the Philippines land area is thought to remain as forest due to logging and slash and burn agriculture. Surveys are required in order to find suitable protected areas in which to establish reserves for Philippine Tarsiers.

The CBSG Report for September 1991 states "for taxa which are designated as critical, endangered or vulnerable and have low numbers in captivity, it is recommended that more of the same taxa be brought into captivity rather that other closely related taxa, until PVA's are completed", the Philippine Tarsier is cited as an example species meeting these criteria."

The Philippine Tarsier has been given a priority 2 classification by the CBSG with taxonomy and distribution data being highly recommended. This report also notes that insufficient fieldwork has been completed in Asia, and that zoological space available to Asian species needs to be increased (Stevenson & Foose, 1991).

Factors affecting the population of the Philippine Tarsier are destruction of forest habitat (Rabor 1968, after Wolfheim, 1983) and increasing agriculture, such as slash and burn. Philippines Tarsiers are not usually hunted. No parks or reserves occur within the range of the Philippines Tarsier (Mittermeier, 1977, after Wolfheim, 1983).

In order to implement appropriate conservation measures there is a need to complete field studies to assess size of populations, and document localities in which the Philippine Tarsier occurs.

A wildlife sanctuary for the Philippines Tarsier has been proposed in the Municipality of Corella in Bohol. A bill appropriating 2 million pesos for the propagation and preservation of the species is pending in Philippine Congress.

The Philippines Department of Environment and Natural Resources (D.E.N.R.) has engaged a private group, A. T. Viri Wildlife Research Foundation, Inc., to work with the Protected Areas and Wildlife Bureau and the University of the Philippines College of Forestry in Los Banos to conduct a long term study and breeding program in the Makiling Forest Hontiveros, 1991).

HUSBANDRY DETAILS

CAPTIVITY

The Philippine Tarsier is a difficult species to maintain in captivity and little success has been gained in maintaining colonies of this endangered primate. Although several births have occurred in captivity, few infants have survived to maturity.

Any institution wishing to obtain Philippine Tarsiers must ensure that they have a facility which provides appropriate temperatures and humidity levels. Provision of adequate amounts of live prey items is a critical factor in ensuring the survival of tarsiers held in captivity.

Although the Philippine Tarsier has been known in captivity for over 50 years (Wright et al 1987), it is rarely exhibited in zoos; only three institutions are listed as holding the Philippine Tarsier in Volume 32 of the International Zoo Yearbook (Olney & Ellis, 1993), not all of these institutions having tarsiers on public display. Approximately 100 specimens have been brought into the United States and Europe during the last 45 years. The longevity record for a captive tarsier is 12 years. A female specimen, one of 30 tarsiers brought to the U.S. by Wharton in 1948 (Wright et al, 1987) and wildcaught during April 1947 in Mindanao died at Philadelphia Zoo in June 1959. The animal died during a winter storm when the heating failed; as no signs of senility were found following post mortem, it is suggested that tarsiers have a longevity of about 20 years.

During 1983 Simons and Wright caught 12 *T. bancanus* in Sabah which were subsequently brought to the United States. The second stage of this program was the capture of twenty *T. syrichta* from Bohol which were brought to Duke University Primate Center (DUPC) in 1985 (Wright et al, 1987).

Captive Breeding Record

There are various reports of Philippine Tarsiers being born in captivity - recently births have occurred at Cincinnati (2), Lincoln Park (1) and DUPC (2). However, the infants rarely survive beyond a few days. Of the two born at DUPC, one was stillborn, and the other was successfully hand-reared (Haring & Wright 1989).

Captive Behaviour

Survival in captivity appears to be dependent on an individual's ability to forage for prey items. It is important that husbandry staff monitor the performance of individuals to ensure that they are healthy. A good time for making such appraisals is soon after the "night light" has come on (Wright et al, 1987).

Philippine Tarsiers sleep on poles, horizontal platforms, and even on the ground (in other species of tarsier, resting on the ground usually indicates poor health, but is not cause for alarm in the case of *T. syrichta*).

The peak activity period has been found to be immediately after the night light comes on. The activity cycle is 20 minute bouts of feeding and travelling at 3 hour intervals, the rest of the time being spent sleeping or motionless. Roberts et al (1984) suggests a trimodal activity cycle. Roberts (1985) states that 20-45% of nightly captures of prey items are made in the first hour of "darkness", the period of activity being followed by a 30-60 minute rest period, then further cycles of activity and rest. Most feeding is done between 1M and 2M, and on branches having angles between 45^{o} and 90^{o}. Activity later in the night tends to be non-foraging and includes behaviours such as grooming, scent-marking, patrolling and interactions with other individuals.

Tarsiers are fragile animals and respond poorly to handling, it is important to minimise handling (recommended that routine examinations be limited to four times a year). Tarsiers also require high humidity (80% being optimum) or problems such as dry skin occur. Tarsiers perish if temperatures drop below 18 ^{o}C.

Vocalizations
Juveniles in distress have been heard to utter high pitched whistling calls. A whistling sound is the only vocalization reported.

HUSBANDRY DETAILS

ENCLOSURE DETAILS
Enclosure Dimensions
The following dimensions for enclosures were reported:

Height:	200cm-450cm
Width:	200cm-360cm
Depth:	190cm-510cm

Where possible, enclosures should be larger rather than smaller to accommodate foraging activities and enable "spacing" between individuals (Roberts, 1985).

Enclosure Construction
All the institutions responding to the questionnaire housed their Philippine Tarsiers in enclosures inside buildings. Various media were used for construction of enclosures including concrete floor and walls, wooden roof and walls, concrete block and wood walls. A glass viewing panel at the front of the enclosure facilitates observation of tarsiers. Consideration needs to be given to the escape/entrance of prey items to the exhibit. And in buildings that are routinely sprayed for invertebrate pests, consideration must be given to effects that insecticides will have on prey items and consequently tarsiers. Care should be taken not to expose the tarsiers to drafts.

Roofing
All institutions described roofing as closed.

Substrate
It is important that a soft substrate be provided, particularly if juveniles are present. Substrates used include cyprus bark mulch, sand, woodchips and peat. It's beneficial to use a substrate which holds moisture to increase the overall humidity of the enclosure. Providing a soft substrate is strongly recommended if females are pregnant to reduce injury to "falling" infants.

Fixtures
A variety of vines, branches and vertical bamboo poles (both natural and plastic) have been used as enclosure furnishings. Optimal diameter for vertical fixtures is 2.5 - 3.0 cm. It's important to include numerous vertical poles, as these enable the tarsiers to leap. Tarsiers like to sit on shelves and thick horizontal branches. Dark, secluded areas should be provided so that tarsiers can take refuge during daylight hours.

Light Cycle
A 12:12 light:dark, or 11.5:12.5 light:dark light cycle appears to be optimal. For the daylight period Duro-lite Vita-lite fluorescent tubes have been used with success, and for the night-time cycle incandescent red light bulbs are appropriate. Alternatively, 2 X 200 watt white incandescent lights can be used for "daylight" and a blue 20 watt incandescent light can be used for "moonlight". It is important that tarsiers have some light with which to see their food items.

Heating
it is important that temperature does not fall below 18 ^{o}C, so heating should be provided if climatic conditions necessitate, ideally

temperatures should be maintained between 25°C and 30°C. Warm air ducted heating is one method used. Tarsiers display only marginal ability for temperature regulation (McNab & Wright, 1987).

Nestboxes/Shelter

Nestboxes measuring 30cm high X 25cm wide X 45cm long, with an entrance hole having a diameter of 12.5cm have been used. At the National Zoo a variety of nestboxes is provided to Spectral Tarsiers as follows:

Cardboard: 61cm X 61cm X 30.5cm
Wood: 61cm X 25.4cm X 30.5cm
Fibreglass: 78.7cm X 30.5cm X 35.6cm

All of these have "square entrance holes" measuring 17cm X 17cm. Nestboxes are placed so that there is a forked branch or two intersecting branches near the entrance, providing a "resting" point for tarsiers entering or exiting boxes.

Tarsiers select "secretive places" to sleep in, so nestboxes should be located accordingly, such as amongst dense foliage. Not all institutions provide nestboxes. If no nestbox is provided ensure that dark, secure refuges can be found in the enclosure.

Climate Control

It's important to keep both the temperature and humidity levels relatively high. Humidity can be increased by spraying the entire exhibit 3-4 times daily. The temperature must not fall below 18 °C and humidity should be maintained at about 80%. If humidity falls below 50% animals become noticeably uncomfortable, drink frequently and develop flaky patches of skin (Roberts, 1985). Take care to exclude drafts. To aid ventilation, partially louvred doors are recommended.

Outdoor enclosures

Niemitz (1984) housed semi-wild *T. bancanus* in an enclosure measuring about $90M^2$ and having a volume of about $320M^3$. The height of the enclosure varied from 3.5M to 3.6M. 24mm wire mesh was used for the walls and roof, the mesh being nailed to existing trees. The mesh enabled a variety of invertebrates to access the enclosure. A plastic bowl having a diameter of 50 cm and partially filled with dirt acted as a pond.

Wire mesh is a suitable material for walls and roof of the enclosure. The enclosure should be positioned so as not to be exposed to strong winds (it may be necessary to provide windbreaks). Soil makes a suitable substrate, and the exhibit can be planted, with additional furnishings such as vertical bamboo poles with nestboxes also included. Whilst invertebrates and other prey items are able to enter the enclosure via the mesh, it should also be remembered that live food items will be able to escape, so care must be taken to ensure that tarsiers are able to capture adequate food supplies. It may well be appropriate to have a combination of indoor/outdoor enclosures, so during inclement/cooler weather the tarsiers can be housed in a heated environment (consideration should be given to whether you want to keep tarsiers in a normal or reversed light cycle). Overhead sprinkler (misting) systems are recommended to increase humidity levels within enclosures.

GROUPING OF ANIMALS

Number of animals per exhibit

This ranges from 1 to 5. Sex ratios used include 1.1, 1.2, 1.3 and 3.2. All these combinations work without aggression between individuals. It has even been reported that newborn infants are not subjected to aggression from unrelated individuals (this is not so for other tarsier species). The species appears to do well in multi-male groups.

Different groups have been housed within

visual contact of one another. No studies have been made to determine if such arrangement has positive, null or negative effects on animals.

Introducing specimens

Suggested that individuals be introduced to an unfamiliar exhibit simultaneously. If it is necessary to use an enclosure which one individual has been housed in, remove the animal, thoroughly scrub out enclosure to remove olfactory signals, then introduce all specimens. At Duke University Primate Center (DUPC), animals have been successfully introduced without having visual contact prior to introduction.

DIET

Locusts appear to be a favoured food item, other food items used are crickets, cicadas, katydids, mantids, grass-hoppers, dragon-flies, house-flies, hissing cockroaches, wolf spiders, mealworms, shrimps, crabs, salamanders, skinks, Anolis lizards, geckoes, house sparrows, raw meat and baby mice, a mixture of cereal/honey/egg/protein concentrate and fruit mixture which was eaten only occasionally. Moving objects are preferred. Tarsiers do not like foraging on the ground, so it's important to encourage prey items to climb. As a rough guide, allow about 20-30 crickets to be eaten per animal per day.

At DUPC, crickets for tarsiers are fed apples, crushed high-protein Purina monkey chow, Zeigler Brother's cricket diet and fresh water. As crickets are calcium deficient, their diet must be appropriately supplemented to ensure that tarsiers gain enough calcium. It's been found that supplementary diet of crickets is retained in the gut and not digested, providing benefit to tarsiers.

The Oregon Primate Center maintained a group of Philippine Tarsiers for some time feeding them on a diet of ground chicken necks and house-crickets, with occasional Anolis Lizard, neonatal mice and mealworms. Powdered milk and vitamin enriched water were also available to the tarsiers. It was suggested that attempts to feed the tarsiers a predominantly non-living diet would be successful, and that the condition of the tarsiers "does not indicate that they have a critical need for exclusively live and active prey" (Evans, 1967).

An average of 1000 crickets per tarsier per week should be allowed.

Water should be provided ad libitum. Drippers appear to be favoured by tarsiers, alternatively tarsiers have been observed licking water from leaves, etc., following misting of enclosure.

Protocol for husbandry - as used at National Zoological Park

As tarsiers are sensitive to disturbance and novel situations a protocol for routine operations in the building housing tarsiers has been established as follows:

Keeper arrives 0715 hours

a) Check for location of individual and record their site in log book

b) Locate and collect faecal deposit, record location, count pellets and weigh total

c) Check temperature and humidity in each room both in the morning and before lights are out (1600 hours)

d) Collect dead crickets from each room

e) Wash and refill water containers

f) Hose floor and mist each room three times daily

g) Remove cricket feed dishes from each room. Dishes are replaced after final misting for day

h) Clean out cricket holding containers daily, remove dead crickets. Change water, give fresh food, etc.

i) Swab walls in rooms two times per week (Mondays and Thursdays). Use dilute TBQ solution in 2 gallon bucket of hot water

j) Change foot baths

k) Check functioning of blue "moon" lights. (It has been found that faecal output drops dramatically if animals have no light source during night hours.)

l) Clean and feed Anolis and Oriental Roach colonies

m) Sweep and wash floors in service areas two times a week

n) take all rubbish from building to incinerator

o) Undertake care of other species in building as appropriate

BREEDING AND REPRODUCTIVE BEHAVIOUR

Oestrus cycle: 24±3 days

Oestrus may be indicated by the male actively pursuing the female, and whistling vocalizations might be heard. Oestrus is indicated by various visual cues, such as vulval rubbing by the female, and increased scent marking and vocalizations by the male. Whilst a female is in oestrus she tends to scent mark three times more frequently than males (Wright et al 1986). Generally the male copulates from the rear, with the female clinging to a vertical pole or other fixture.

There has been no evidence of seasonal reproductive cyclicity when Philippine Tarsiers have been kept under a constant light cycle.

Pregnancy/care of pregnant female

Gestation Period: 6 months (178 days)

Advanced pregnancy can be detected by a distended abdomen. Gestation is about 6 months (178 days). It is important not to stress a pregnant female. Extra food items should be provided. During the last two months of pregnancy a female can double her normal food intake. Additional soft substrate should be provided as parturition approaches (in the event of the infant falling). Labour can be difficult, so it's wise to maintain constant observation checks of the female as she approaches parturition.

Based on *T. bancanus* (Izard et al, 1985), weight gain shown by pregnant females is much more noticeable during the last months of pregnancy. A female weighing 117 gms on the day of copulation gained 6 gms during the first two months of pregnancy, 7 gms in the second two months, and 19 gms in the final two months, resulting a total weight gain of 32 gms. The female gave birth to an infant weighing 28.5 gms, the placenta weighed 2.5 gms and the female weighed 119 gms post parturition. A second female who was pregnant when wildcaught gained 39 gms during the last two months of pregnancy. She weighed 179 gms just prior to parturition and 150 gms after giving birth to an infant weighing 26 gms.

Female Spectral Tarsiers become noticeably more aggressive to males prior to parturition. Females with young will drive

away males, and males have been known to kill infants (Roberts et al, 1984). Such behaviour has not been reported for the Philippines Tarsier.

Birthweight: 20 - 31.5 gms

Interbirth Intervals

The following interbirth intervals have been recorded: 202 days, 274 days, 243 days, 187 days, 406 days (Haring & Wright 1989).

Care of offspring

The female will park her newborn infant from day one. Interest may be shown in juveniles by unrelated adults. No special care for infants was reported. It appears that there is no need to remove animals from natal groups other than to prevent inbreeding.

Handrearing Infants

An article "Hand-Raising a Philippine Tarsier *Tarsius syrichta*" by Haring and Wright appears in Zoo Biology 8:pp265-279 (1989). This article gives an account of the only successful hand-raising of any species of tarsier.

HEALTH AND MEDICINE

Gradual deterioration in tarsier health has been observed on several occasions, resulting in demise of the animal. No particular reasons for such declines have been suggested. Some minor eye problems have been encountered, these have been successfully treated with topical eye medication. Nematodes and Strongyles have been reported, but no anthelmintics suggested.

Wright et al (1986) suggested that tarsiers observed to be losing condition should be placed in a small cage where it will readily be able to obtain food. A rapid decline follows if such animals are left in large cages.

Haring and Wright (1989) reported that an infant tarsier being hand-raised appeared to lose condition and with pelage changing from red-brown to grey in colour. The infant was placed in the sun for 15 minute periods, four times a week over two weeks, which appeared to alleviate the problem.

Post mortems of tarsiers have indicated the following (Roberts, 1985):

- trichomoniasis in females following miscarriage
- degenerative liver and kidney condition
- pneumonia
- cerebral haemorrhage in newborn specimens

Parasites

Wildcaught Spectral Tarsiers at the National Zoo were found to have the following parasites:- cestodes, capillaria, acanthocephalans and unidentified larvae. Brack and Niemitz (1984) report incidence of the following parasites in wildcaught tarsiers:

I. Protozoa
Chilomastix tarsii
Chilomastix sp.
Trichomonas foetus
Trichomonas sp.
Eimeria sp.

II. Metazoa
a) Nematoda
Trichuris sp.
Subulura peramata
Spiruroid
Enterobius sp.
Trichostrongylids
Filaria laevis
Hookworms
Physocephalus sexalatus
Moniliformis moniliformis
b) Cestoda
Hymenolepis sp. (H.nana-

group)
Hymenolepsis diminuta
Spargana

Ectoparasites include mites, probably belonging to the family Psoroptidae living on the surface of the skin. An ixodid tick was removed from an adult female tarsier. Mosquitoes (Culicidae) may be a vector for Filaraia and other blood parasites.

The above reports are for the Western Tarsier and Spectral Tarsier.

A limited faecal analysis of Philippine Tarsiers revealed several types of ova, including those resembling both hookworm and *Taenia sp.* and *Trichuris trichiura* (Evans, 1967).

Faeces:
Tarsiers generally defecate daily, maximum recorded interval being 4 days. Irregularity is generally associated with sexual excitement. Faeces are firm, ovoid/fusiform pellets being dark brown to black in colouration. Faeces are generally odourless, except during sexual activity when faeces of the female will smell more than those of the male.

It takes 3 days for food to pass through the alimentary tract. (Mitchell & Erwin, 1986).

Anaesthesia
The suggested method for small Prosimians is pentobarbitone sodium given intravenously using 27 gauge needle and tuberculin syringe to the inner thigh. Ketamine hydrochloride and xylazine are suggested as suitable anaesthetics (Poole 1987)

Treatment
As tarsiers are prone to stress resulting from change in routine, or extensive handling, treatments must be administered in a fashion minimizing interference. Roberts (1985) reports successful treatment for parasites by administering anthelmintics mixed as a palatable paste, and applied to the thigh of a tarsier using a tongue depressor. Given a tarsier's fastidious nature for grooming, the paste was applied just prior to the animal becoming active, and was licked off almost immediately, thus the quantity of drug consumed was known.

Normal Body Temperature: 33.8 ^{o}C

Weights and Dimensions

Body Weight		
Range (Grams)	95-165	70-154
Head and Body length		
Range (mm)	85-159	95-160
Tail length		
Range (mm)	135-274	189-239

HANDLING ANIMALS
Capture
Mist nets have been used to successfully capture tarsiers in the wild. It has been found that pairs will be caught in the same net, ensuring that individuals are compatible. 56% of tarsiers captured were caught in nets placed between 0M and 1M above the ground, with 91% of captured animals being caught in nets placed between 0M and 2M above the ground. Once caught, specimens must undergo an acclimitization period to determine their suitability for captivity. If animals don't settle down, they should be released. One to four weeks should be ample to acclimate a tarsier.

Shipment
Many tarsiers have met their demise in transit. Best results have been obtained by carrying tarsiers as hand luggage, keeping

them in the passenger cabin of aeroplanes. This not only enables tarsiers to be fed and watered, but enables them to remain at a constant temperature.

Catching in enclosures

Several methods have been used. A lightweight net with small netting cloth or catching animals either in mid-leap or immediately after they land, by grabbing them, with a gloved hand, from the back of the head. A removable nestbox is a good way of capturing animals by hand, the door to the box being closed when the tarsier is in the box. This is perhaps an advantage of using nestboxes. Tarsiers can be transported in either nestboxes or cloth bags.

Being fragile, tarsiers respond poorly to handling. A regime of four routine health checks per year is suggested (Wright et al '87). Conversely, Lincoln Park weigh tarsiers on a weekly basis.

SUMMARY

A great deal more research is required to gain a greater understanding of the requirements of the Philippine Tarsier, including aspects such as mating systems and size of existing wild populations. Previous experience indicates that the species is difficult to maintain in captivity, and care must be taken to provide tarsiers with optimal conditions and adequate prey items.

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TABLE OF CONTENTS