HEALTH

Review Of Loris Clinical Information And Pathology Data From The San Diego Zoo: 1982-1995

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Introduction

There is very little published information regarding the medical management of lorises. The following is a review of clinical and pathology data from the San Diego Zoo since 1982 for three species of loris: *Loris tardigradus*, *Nycticebus pygmaeus*, and *Nycticebus coucang*. A summary of mortalities seen at the Duke University Primate Center (Tables 22-24), as well as some clinical data is also included. It is by no means complete but is a start in the compilation of medical information for loris species. Additional and new health information will be published via the Internet in the species.net health database.

Preventive Medicine

Each individual receives an annual examination, including tuberculin testing (upper eyelid using mammalian old tuberculin, 0.1 cc intradermal), complete blood count (CBC), chemistry panel, and rectal culture. Loris rectal temperatures are lower than those expected for other mammalian species; rectal temperatures of anesthetized animals ranges from 86-94½ F (30-30.4½ C) for slender lorises, 88-98½ F (31-36.6½ C) for pygmy lorises, and 92-98½ F (33.3-36.6½ C) for slow lorises. Whittow et al. (1977) reported mean rectal temperatures of unanesthetized lorises as 95.5½ F (35.3½ C) and 96.3½ F (35.7½ C) for day and night measurements respectively. Both Whittow et al. (1977) and Müller (1975) have reported oxygen consumption rates lower for slow lorises than would be expected for a placental mammal and have described the slow loris as a hypometabolic primate. Blood samples can be obtained from either the jugular or femoral vein. The jugular vein is rarely visible or palpable; localization of the jugular vein is based on approximation and pulsations from the carotid artery. Venipuncture is a challenge in slender lorises due to their small size. Animals are vaccinated for tetanus toxoid approximately every five years. Routine fecal exams are performed biannually. Routine weighing is also an important part of the preventive health program. Weight loss trends may not be evident by visual examination and are frequently an indication of an underlying disease process. If not monitored closely, the slow and pygmy lorises have a tendency to become obese.

Anesthesia

Because of their size many lorises can be manually restrained for short, simple procedures.

Table 20: Anesthetic agents used in three loris species at the San Diego Zoo.

Anesthetic agent	**Ketamine**[a]	**Tiletamine/Zolazapam**[b]	**Isoflurane**[c]
Loris tardigradus	ND[d]	ND	Yes
Nycticebus pygmaeus	ND	5-28 mg/kg[e]	Yes
Nycticebus coucang	10-25 mg/kg	4014 mg/kg	Yes

[a] Ketaset, Fort Dodge Laboratories Inc., Fort Dodge, Iowa, 50501 USA.
[b] Telazol, Fort Dodge Laboratories Inc., Fort Dodge, Iowa, 50501 USA. Provides better relaxation than ketamine.
[c] Aerrane, Ohmeda PPD Inc., Liberty Corner, New Jersey, 07938 USA.
[d] ND- use not documented in the SDZ collection.
[e] A wide range of dosages have been used but 8-12 mg/kg is the average dose used. Slow recoveries are associated with the higher doses.

Clinical Pathology

Clinical pathology data is listed at the end of this section. This information has been provided by MedARKS, International Species Information System (ISIS). Unfortunately several large institutions housing loris colonies are not currently part of this data base.

Medical Review

Medical records and necropsy information since 1982 for each animal were reviewed. Clinical problems were classified based on organ system affected or general disease category.

Table 21: Population demographics for loris species reviewed.

	Loris tardigradus	***Nycticebus pygmaeus***	***Nycticebus coucang***
Animals accessioned	3.5	6.8.2	15.14
Births	0.2	3.4.2	5.3
Deaths: neonate	0	1.1	0
Deaths: juvenile	0	0.1	0
Deaths: adult	0.1	2.1	7.7

Cardio-pulmonary disease

Pygmy loris: One animal was diagnosed antemortem with pneumonia based on radiographic evaluation. *Enterobacter sp.* and *Proteus sp.* were cultured from a tracheal wash.

Slow loris: A pronounced heart murmur was noted in one animal. Myocardial amyloidosis and fibrosis were noted histologically at necropsy. One animal was treated several times for sneezing,

congestion, and a purulent nasal discharge. This animal had severe dental disease; the upper respiratory infection may have been secondary to oronasal fistulas. Acute pneumonia was seen in two slow lorises at necropsy.

Renal disease

Pygmy loris: Evidence of renal impairment based on clinical chemistries was seen in one animal. Chronic interstitial nephritis was seen in this as well as one other individual at necropsy.

Slow loris: Four slow lorises had indications of impaired renal function. Clinical chemistries revealed *E. coli* was subsequently cultured from the urine of one of these animals. Another loris with a consistently urine soaked gluteal area was noted to be polydipsic and polyuric. This loris experienced episodes of azotemia and inappetence. Chronic interstitial nephritis was diagnosed histologically at necropsy. Varying degrees of chronic interstitial nephritis were noted in six animals at necropsy. Calcification of the aorta and periosteal proliferation of the proximal ulnas were seen in one loris euthanized due to renal failure.

Hepatic disease

Slender loris: At necropsy, a gall stone was found in a three year old male slender loris housed at Cincinnati Zoo. No other liver pathology was grossly evident. This slender loris had a history of neuromuscular abnormalities (Schulze, personal communication).

Pygmy loris: One loris had an elevated ammonia on serum chemistries. Bile acids were also elevated. Cholelithiasis was seen in this individual, as well as one other, at necropsy.

Neurologic and musculoskeletal disease

Slender loris: One animal was treated for a stifle abscess that healed without complications. *Staphylococcus epidermidis* was cultured from the abscess. It is not known if this was secondary to a bite wound or other trauma.

Pygmy loris: An adult female in late term gestation developed sudden-onset seizures. No cause for the seizures was found antemortem. A thrombosis in the basal artery of the brain was found at necropsy. One animal exhibiting a head tilt was diagnosed with otitis externa/media; this responded to treatment. One loris developed posterior paresis prior to parturition, which resolved post-partum. One animal has been examined twice for episodes of ataxia and tremoring. Nothing definitive has been found on exam and the significance is not clear.

Slow loris: Degenerative changes in the lumbar vertebrae were seen radiographically in a loris that developed posterior paresis. Chondroid degeneration of the vertebrae was noted histologically at necropsy.

Integumentary system

Pygmy loris: One animal was examined for a focal area of skin slough; the etiology was undetermined. Another loris was treated for an ulcerative dermatitis involving both tarsi. Two

animals have been examined for wet abdomens. This has also been observed in other animals. Polydipsia/polyuria secondary to renal disease was ruled out based on clinical chemistries. It is unclear whether the lorises were urinating on themselves, lying in urine, or if this represents some other behavior. Two lorises have been examined for hair loss. No abnormalities were noted on exam or skin biopsy. Again, it is unclear if this was due to over grooming or environmental conditions.

Slow loris: Three lorises have been examined for dermatitis/alopecia involving the lower back or gluteal region. Another loris was examined for urine scald. Urinary incontinence was suspected but not proven. A similar condition has been seen in the pygmy lorises. Several animals have had multiple dermal masses. Some of these were biopsied antemortem; others were diagnosed postmortem. Diagnoses included sweat gland carcinoma, epidermal hyperplasia/hyperkeratosis, epidermal cyst, cystic dilatation of a sweat gland duct, hemangioma, basal cell carcinoma and a apocrine gland cyst.

Neoplasia

Slow loris: See also integumentary system. Lymphosarcoma (multicentric, lymphoblastic) was diagnosed in one adult male which died with severe gastric parasitism. Lymphosarcoma associated with a herpes virus has also been reported in a slow loris from the Wildlife Conservation Society (Stetter et al., 1995). A pygmy loris at the Duke University Primate Center also died due to lymphosarcoma. Other neoplasia diagnosed post-mortem include hepatoma, islet cell tumor, parathyroid adenoma, follicular adenoma of the thyroid, basal cell tumor and multiple eccrine gland tumors. Animals with the above neoplasms ranged in age from 11.5 to 14 years old. In a review of neoplasms in non-human primates, Lowenstine (1986) reported pancreatic adenocarcinoma, prostatic adenocarcinoma, undifferentiated sarcoma, and gelatinous tumors involving the liver and kidney (possible myxosarcoma).

Viral disease

Due to chronic health problems (periodontal disease, oculo-nasal discharge) the loris collection experienced several years ago, the possibility for an underlying viral etiology was evaluated. A herpesvirus was observed in lymphocytes on electron microscopy in three of eight slow lorises and one of five pygmy lorises (Worley and Shima, 1991). Some of these animals showed clinical signs, however, others were healthy. At the International Wildlife Conservation Park, herpesvirus was also seen via electron microscopy in lymphocytes from a loris with lymphosarcoma. This loris had a history of chronic intermittent upper respiratory tract infections and periodontal disease. Researchers have been unable to successfully propagate the virus. The significance of this herpesvirus is not yet known.

Dental disease

Pygmy loris: Two animals have been treated for dental disease. One animal had four episodes of facial abscessation associated with dental disease.

Slow loris: Twelve lorises have undergone treatment for dental disease. Five of these have undergone multiple exams for recurrent periodontal disease and/or abscessed teeth. One loris

developed osteomyelitis of the zygomatic arch. Facial swellings have been a common sign in lorises with dental disease. One loris was treated multiple times over a three year period for purulent ocular discharge; this was eventually resolved (several types of bacteria were cultured on different occasions). This animal also had a history of dental disease. One loris was treated for a retrobulbar abscess involving the right eye. This animal also had a history of dental disease. These conditions were thought to be secondary to dental disease.

Trauma

Slender loris: One slender loris is presumed to have died following a fall from the top of the enclosure. A subdural hematoma was the only gross necropsy finding noted.

Pygmy loris: There have been six trauma events requiring medical attention. These have generally been bite wounds in which cellulitis and abscessation developed. One juvenile loris died secondary to septicemia from bite wounds.

Slow loris: There were eleven episodes of bite wounds which required medical attention. One loris developed septicemia secondary to the bite wounds and died. Several animals have required amputation of one or more digits due to bite wounds. Most bite wounds occurred either during introductions or when males escaped from enclosures and fought with other males through cage wire. Another loris died following complications after having become entrapped in a cargo net used for climbing.

Parasitism

Slender loris: Nematodes (unspeciated) were diagnosed from fecal exams in two animals. Microfilaria identified as *Dipetalonema* sp. were seen in the tissues of a slender loris at necropsy prior to 1983 (Griner). They were not thought to have any clinical significance.

Pygmy loris: *Trichuris* was diagnosed on fecal exam in six animals. *Giardia* has been diagnosed on fecal exam in three animals. *Enterobius* was noted on fecal exam of one animal. Hymenlopis-like ova were noted on fecal exam in one animal. Microfilaremia in blood samples was noted in three wild caught animals upon arrival. The animals were treated with ivermectin and microfilaremia was not present on subsequent blood samples. Unidentified microfilaria were seen at necropsy in pygmy loris at Duke University Primate Center.

Slow loris: *Pterygodermatides nycticebi* was diagnosed by fecal exam in three animals. A fourth loris died from anemia secondary to blood loss from gastric parasitism by *Pterygodermatides*. Nonidentified nematodes were diagnosed by fecal exam in four animals. Tapeworms were noted on fecal exam of three lorises; each loris was infected on two separate occasions. *Giardia* sp. was diagnosed by fecal exam in three lorises. *Trichomonas* sp. was seen in the feces of two lorises. One of these had bloody stool and diarrhea. It is not known whether the trichomonads were the cause of the bloody stool, but the condition resolved with treatment. Microfilaria in the blood was noted in one wild caught loris. *Strongyloides* sp., *Physaloptera* sp., *Cryptosporidia* and oxyurids have also been seen in the slow loris collection at the Duke University Primate Center. One animal reportedly died from

an infestation with *Physaloptera*.

Tuberculin responders

Two slender lorises, one pygmy loris, and one slow loris have responded to tuberculin testing (intradermal eyelid). Each individual underwent additional testing that included thoracic radiographs, comparative TB testing, and samples from tracheal washes, gastric washes and rectal swabs for mycobacterial cultures. Results of all diagnostics were normal and cultures were negative.

Miscellaneous

Pygmy loris: One loris was diagnosed with a detached left retina. No cause for the detachment could be found on funduscopic or slit lamp examination. Because this was a confiscated animal, trauma was proposed as the likely etiology. Three animals have had hypothermic episodes; the lorises were found either on the ground or minimally responsive and cold to the touch. These episodes were attributed to cool environmental temperatures.

Slow loris: An abdominal abscess was diagnosed at necropsy in another loris being treated for abnormal behavior and weight loss. *Campylobacter jejuni* was isolated from a geriatric animal prior to death from renal failure.

Summary

Trauma has been a major cause of morbidity and mortality at San Diego Zoo as well as at the Duke University Primate Center. Bite wounds have resulted in the deaths of animals at both institutions. Marked cellulitis with secondary necrosis is a frequent sequelae to bite wounds. Asian folklore depicts the slow loris as a venomous animal (Wilde, 1972). Research has been unable to definitively prove this theory. There is speculation that brachial gland excretions mixed with saliva are potentially toxic, and this could explain the tissue reactions following bite wounds. Animals should be observed closely for evidence of wounds, especially when new introductions are taking place. Any suspected wounds should be followed up with a minimum of a good visual inspection to determine if an examination with anesthesia is necessary. Housing design should not allow physical contact between adjacent enclosures.

Dental disease also contributed significantly to case morbidity. Viral infection has been suggested as a cause for the widespread periodontal disease, but dietary considerations should not be overlooked. Chronic periodontal disease and open root canals can be a source for disseminated bacterial infections. Diets consisting primarily of soft food items should be avoided; some type of biscuit or pellet should be included to promote hygiene. Proper dietary management will reduce the incidence of dental disease. To detect dental problems early a thorough oral evaluation and dental prophylaxis should be performed each time a loris is examined.

Respiratory disease was not as common as trauma and dental disease in this collection; however, upper respiratory infections have been a common clinical entity seen at the Duke University Primate Center. Ten animals have been treated one or more times for an upper respiratory tract infection. Two other conditions frequently seen in the slow lorises at the Duke University Primate Center were

Meibomian gland abscessation and conjunctivitis.

Renal disease was an important cause of morbidity and mortality, especially in older animals. In a review of Zoological Society of San Diego necropsy data from 1964 to 1978, Griner diagnosed chronic interstitial nephritis in a slender loris and a slow loris. Renal disease contributed to 20% of deaths in slow lorises at the Duke University Primate Center. Renal function should always be evaluated, particularly when examining older animals.

While parasitism was the direct cause of death in only two animals, a variety of parasites have been diagnosed on fecal exam or incidentally at necropsy. Any wild caught animal should be considered parasitized and treated appropriately. There are several papers regarding parasitism in loris species that have not been reviewed but are included in the literature citations.

Tables

Table 22: Mortality in *Nycticebus coucang* at the Duke University Primate Center 1980-1994.

Organ system affected/disease process	**Number of animals affected/total**
Renal disease	5/24
Pulmonary disease	4/24
Neonatal mortality	4/24
Bacterial septicemia	3/24
Neo lasia	2/24
Chronic heart failure	2/24
Chronic sinusitis	1/24
Parasitic infestation	1/24
Bite wounds	1/24

Table 23: Mortality in *Nycticebus pygmaeus* at the Duke University Primate Center 1988-1994.

Organ system affected/disease process	**Number of animals affected/total**
Renal disease	1/9
Urethral calculi	1/9
Neo lasia	1/9
Peritonitis	1/9
Bite wounds	1/9
Hemorrhagic syndrome	2/9
Neonatal mortality	2/9

Table 24: Mortality in *Loris tardigradus* at the Duke University Primate Center 1985-1994.

Cause of death	**Number of animals affected/total**
Neonatal mortality	12/14
Bite wounds	2/14

Table 25: ISIS Clinical Pathology Reference Ranges in Slow Loris *Nycticebus coucang* as per July 1, 1996.

Test	Mean	Std. Dev.	N	Min. Value	Max. Value	# of Ind.	# of zoos
Alanine Aminotransferase	96	93	29	25	539	23	6
Albumin (Colorimetry)	3.5	0.4	14	2.9	4.2	11	5
Alkaline Phosphatase	196	118	29	81	518	23	7
Amylase	1573	263	5	1204	1884	5	2
Aspartate Aminotransferase	116	36	19	83	226	16	6
Bicarbonate	22.3	4.9	3	19.0	28.0	3	2
Blood Urea Nitrogen	16	8	31	5	34	24	8
Body Temperature	35.5	0.9	24	34.0	37.0	17	4
Calcium	10.1	1.3	28	7.7	13.8	22	6
Carbon Dioxide	20.6	3.8	10	16.0	28.0	7	4
Chloride	109	7	24	98	124	19	7
Cholesterol	417	245	22	0	810	17	6
Creatine Pho hokinase	42	34	6	17	108	6	13
Creatinine	0.7	0.5	29	0.1	2.5	22	6
Eosinophils	0.020	0.044	5	0.000	0.099	5	3
Gamma Glutamyltransferase	25	7	7	10	30	7	2
Globulin (Colorimetry)	4.1	0.8	13	2.3	5.2	10	5
Glucose	121	40	34	54	245	25	8
Hematocrit	42.0	5.6	54	25.0	53.0	35	8
Hemoglobin	13.9	2.0	40	9.2	17.5	30	7
Iron	190	25	4	161	216	4	2
Lactate Deh dro enase	304	288	11	117	1092	11	5
Lipase	42	0	1	42	42	1	1
Lymphocytes	5.763	3.178	12	1.120	10.50	10	5
MCHC	33.0	2.9	39	26.0	38.9	30	7
Monocytes	0.039	0.045	10	0.000	0.096	9	5
Mean Corpuscular Hemoglobin	24.6	2.2	18	20.6	28.1	14	6
Mean Corpuscular Volume	72.6	4.1	18	65.1	77.9	14	6
Neutrophilic Bands	0.150	0.141	2	0.050	0.250	2	2
Nucleated Red Blood Cells	2	4	10	0	13	9	6
Phosphorus	4.1	1.9	26	1.4	10.4	20	6
Platelet Count	297	151	7	107	584	4	2
Potassium	4.0	0.9	26	2.5	5.8	21	7
Red Blood Cell Count	5.84	0.70	18	3.93	6.94	14	6
Reticuloc tes	0.7	0.0	1	0.7	0.7	1	1
Segmented Neutro hils	3.327	2.320	12	0.734	9.150	10	5
Sodium	148	8	26	138	168	21	7
Total Bilirubin	0.2	0.2	21	0.0	0.8	17	6
Total Protein (Colorime)	7.2	1.1	23	4.8	8.9	19	6
Total Protein (Refractometer)	10.0	0.3	2	9.8	10.2	2	1
Triglyceride	441	535	10	90	1631	10	3
Uric Acid	2.1	1.0	14	0.8	3.8	14	4
White Blood Cell Count	9.618	4.602	13	3.190	17.6	11	5

Table 26: ISIS Clinical Pathology Reference Ranges in Pygmy Loris *Nycticebus pygmaeus* as per July 1, 1996.

Test	Mean	Std. Dev.	N	Min. Value	Max. Value	# of Ind.	# of zoos
Alanine Aminotransferase	89	46	15	45	207	11	2
Albumin (Colorimet)	3.6	0.8	5	2.4	4.6	5	1
Alkaline Phos hatase	88	32	9	53	135	7	2
Amylase	570	40	2	542	598	2	1
Aspartate Aminotransferase	101	28	14	48	148	11	2
Blood Urea Nitrogen	25	10	17	14	45	12	3
Body Temperature	35.5	1.0	11	34.0	38.0	6	1
Calcium	10.2	1.3	10	7.8	11.8	8	2
Carbon Dioxide	22.0	1.0	3	21.0	23.0	3	1
Chloride	105	4	4	101	109	4	1
Cholesterol	302	41	10	233	379	8	2
Creatine Phophokinase	138	149	4	43	360	4	1
Creatinine	0.3	0.1	5	0.3	0.4	5	3
Gamma Glutamyltransferase	47	25	9	19	91	7	2
Globulin (Colorimetry)	3.0	0.3	5	2.6	3.4	5	1
Glucose	181	80	15	102	422	11	2
Hematocrit	42.1	6.7	21	24.9	51.0	14	4
Hemoglobin	15.6	3.2	20	8.6	23.0	13	4
Lactate Dehydrogenase	137	36	4	95	180	114 4	1
Magnesium	3.10	0.57	2	2.70	3.50	2	1
MCHC	37.3	7.8	20	20.0	63.9	13	4
Mean Corpuscular Hemoglobin	26.0	3.3	20	16.6	31.4	13	4
Mean Corpuscular Volume	71.6	21.9	21	43.2	154.1		4
Nucleated Red Blood Cells	1	0	6	1	2	6	2
Phosphorus	6.1	2.1	4	4.2	8.9	4	1
Platelet Count	440	235	5	134	781	5	1
Potassium	3.9	0.6	4	3.0	4.4	4	1
Red Blood Cell Count	6.21	1.66	21	3.31	11.10	14	4
Sodium	143	1	4	142	144	4	1
Total Bilirubin	0.3	0.2	9	0.1	0.6	7	1
Total Protein (Colorimet)	6.5	0.8	16	4.8	7.6	11	2
Triglyceride	79	35	10	19	150	8	2
Uric Acid	1.5	0.6	6	0.9	2.3	5	2

Table 27: ISIS Clinical Pathology Reference Ranges in Slender Loris *Loris tardigradus* as per July 1, 1996.

Test	Mean	Std. Dev.	N	Min. Value	Max. Value	# of Ind.	# of zoos
Alanine Aminotransferase	64	13	4	48	79	4	1
Albumin (Colorimetry)	4.1	0.0	1	4.1	4.1	1	1
As artate Aminotransferase	47	18	5	33	76	5	1
Blood Urea Nitrogen	39	7	7	27	47	6	2
Calcium	10.0	0.0	1	10.0	10.0	1	1
Carbon Dioxide	24.0	0.0	1	24.0	24.0	1	1
Chloride	113	2	2	111	114	2	1
Cholesterol	228	18	2	215	241	2	1
Creatinine	0.3	0.1	2	0.3	0.4	2	2
Eosinophils	0.001	0.000	1	0.001	0.001	1	1
Globulin (Colorimetry)	2.4	0.0	1	2.4	2.4	1	1
Glucose	182	60	7	103	264	6	1
Hematocrit	43.3	5.9	9	30.0	50.2	8	3
Hemoglobin	15.1	1.6	9	11.6	16.9	8	3
Lymphocytes	7.040	0.000	1	7.040	7.040	1	1
MCHC	35.1	1.8	9	32.5	38.7	8	3
Monocytes	0.000	0.000	1	0.000	0.000	1	1
Mean Corpuscular Hemoglobin	27.7	1.6	9	23.9	29.4	8	3
Mean Corpuscular Volume	78.9	4.1	9	71.4	83.5	8	3
Nucleated Red Blood Cells	11	17	3	0	31	3	2
Phosphorus	3.9	0.0	1	3.9	3.9	1	1
Platelet Count	150	0	1	150	150	1	1
Potassium	4.0	0.0	1	4.0	4.0	1	1
Red Blood Cell Count	5.47	0.63	9	4.20	6.37	8	3
Segmented Neutro hits	0.980	0.000	1	0.980	0.980	1	1
Sodium	148	1	2	147	148	2	1
Total Bilirubin	0.3	0.1	6	0.2	0.5	5	1
Total Protein (Colorimetry)	6.1	0.6	6	5.5	7.0	5	1
Uric Acid	1.8	0.5	2	1.4	2.1	2	1
White Blood Cell Count	8.910	0.000	1	8.910	8.910	1	1

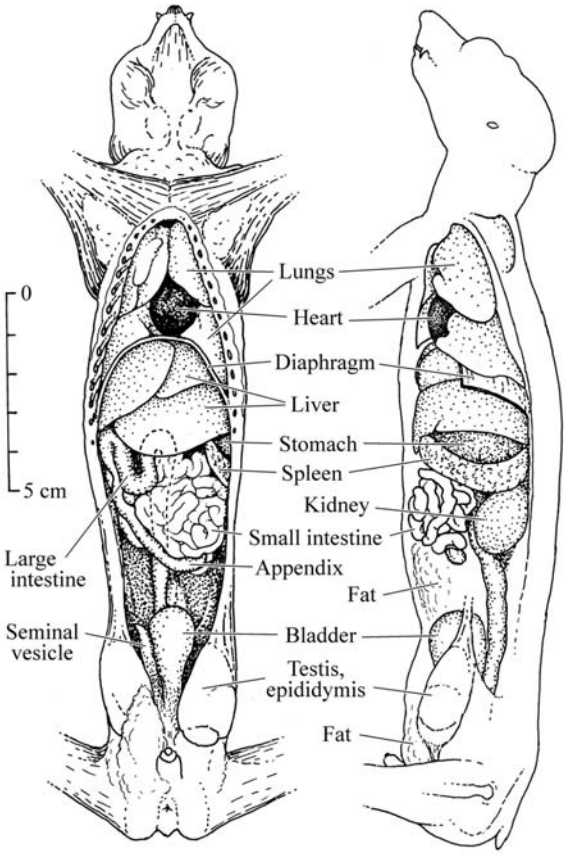

Figure 26: Anatomy of the slender loris

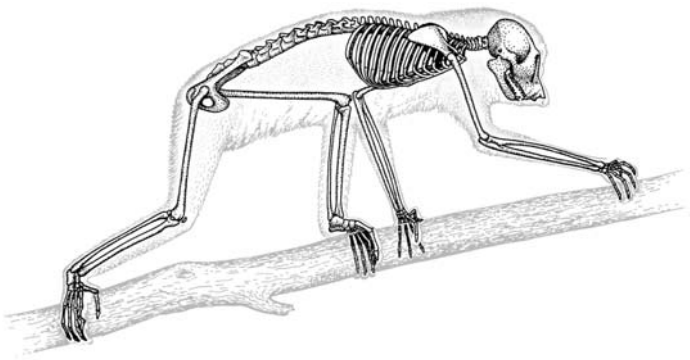

Figure 27: Skeletal structure of the slender loris.

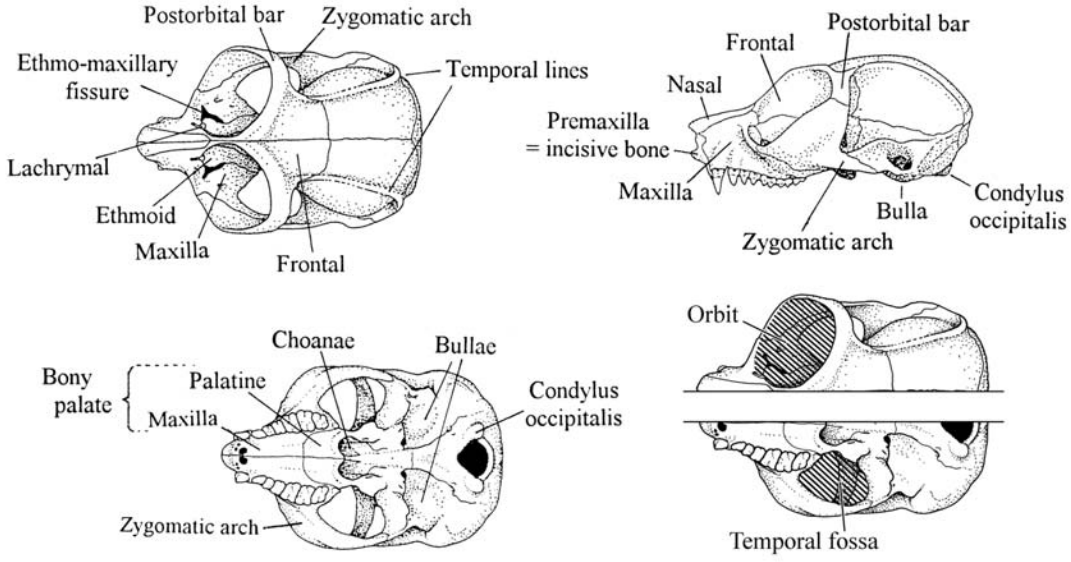

Figure 28: Skull morphology of the slender loris.