National Studbook of Clouded leopard (*Neofelis nebulosa*)

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority

December 2009

National Studbook of Clouded leopard (*Neofelis nebulosa*)

Studbook compiled and analysed by

Anupam Srivastav
Parag Nigam

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority

December 2009

Srivastav, A. and Nigam. P. 2009. National Studbook of Clouded Leopard (*Neofelis nebulosa*). Wildlife Institute of India, Dehradun and Central Zoo Authority, New Delhi.

Published as a Technical Report of the CZA assignment for the compilation and publication of the Indian National Studbooks for selected endangered species of wild animals in Indian Zoos.

Acknowledgements

This Studbook is a part of the Central Zoo Authority, New Delhi, assignment to the Wildlife Institute of India, Dehradun, for the compilation and publication of studbooks of selected endangered species of wild animals in Indian zoos. The authors wish to thank the Central Zoo Authority for giving us this opportunity to compile the National Studbook for Clouded Leopard.

We are thankful to Dr. B.R. Sharma, IFS for his kind support and encouragement in the compilation of this work. We are thankful to Shri. P. R. Sinha, Director WII for his guidance and support. We would also like to express our appreciation for the advice and support extended by Dr. V.B. Mathur, Dean Faculty of Wildlife Sciences, WII. The authors also wish to thank all the staff members of the Central Zoo Authority, Specially Dr. B.K. Gupta, Evaluation and Monitoring Officer, Dr. Naim Akhtar, Scientific Officer and Shri. Vivek Goyal, Data Processing Assistant for their advice and support.

The help of the following Zoos holding clouded leopards is gratefully acknowledged in compilation of the studbook data.

Aizawl Zoo (Mizoram Zoo), Aizawal Mizoram
Sepahijala Zoological Park, Agartala, Tripura
Padmaja Naidu Himalayan Zoological Park, Darjeeling, West Bengal
Assam State Zoo, Guwahati, Assam

We also wish to thank Ms. Laurie Bingmann Lackey of ISIS for providing the SPARKS software. Her kind advice and timely help were of great help in compilation of this studbook.

We also express gratitude to Ms. Mandakini Nautiyal for all help rendered and all the faculty and staff members of the WII, for their help and encouragement.

Authors

Contents

Clouded Leopard: Biology and Status

Kingdom	Animalia
Class	Mammalia
Order	Carnivora
Family	Felidae
Scientific Name	*Neofelis nebulosa*
Species Authority	Griffith, 1821
Common Names	Clouded leopard (Eng.) Lamchita, Gecho bagh (Bangla)

Taxonomy of Clouded Leopard

The clouded leopard, named after its distinctive markings - ellipses partially edged in black, with the insides a darker color than the background tawny color, and sometimes dotted with small black spots. The limbs and underbelly are marked with large black ovals, and the back of its neck is conspicuously marked with two thick black lines. The long tail is thick and encircled with black rings, equal to body length (up to 80-90 cm) (Pocock 1939a, Legakul and McNeely 1977, Mehta and Dhewaju 1990). The legs of the clouded leopard are short, but its canines are relatively the longest of any felid (3.8-4.5 cm) and have a very sharp posterior edge. Clouded leopards are intermediate in size between large and small cats: wild adults can weigh between 11-20 kg (Pocock 1939a). Clouded leopards occupy tropical forests at elevations of up to 3000 meters. They are highly arboreal, using trees for resting and hunting. However, they also hunt on the ground. Clouded leopards inhabit primarily evergreen tropical forest but they are also reported from other habitats, such as secondary forest, logged forest, mangrove swamp, grassland, scrub land, dry tropical forest. Their diet consists of birds, primates and small mammals, as well as larger prey, such as porcupines, deer, and wild boar.

Biology

The species in free ranging condition may thrive for about 11 years and 14 – 17 years in captivity. The males and females reach sexual maturity by 20 to 30 months of age. No fixed breeding season is known and reports suggest that it may occur round the year. They make dens in dense undergrowth or tree hollows. Efforts in parental care are

invested by the mother alone. The mother after a gestation period of 85 – 109 days produces a litter consisting of 1 – 5 cubs (average 2). The inter birth interval has been reported to range from 10 – 16 months.

Behavior

Clouded leopards are mostly nocturnal, very secretive and quick. Large feet, short legs, and a long tail make clouded leopards well-adapted for arboreal living; reports from captive animals suggest that it can descend head first. Their high levels of adaptation to arboreal living enable Clouded leopards to hunt in trees, preying on birds, monkeys, and rodents. They are probably solitary animals. A male and female found together, are probably a mating pair, coming together for breeding. A typical clouded leopard has a territory of 30 to 40 square kilometers, with a heavily used core area of 3 to 5 square kilometers. Male and female home ranges overlap substantially.

Distribution

The species range extends from the Himalayan foothills in Nepal through mainland south-east Asia to China. It inhabits mixed evergreen forests in its area of occurrence. The island populations of Sumatra and Borneo have been identified as a separate species *Neofelis diardi* by Buckley- Beason *et.al.* 2006 and Kitchener *et.al* 2006. In India the species *Neofelis nebulosa* occurs in the states of Sikkim, West-Bengal, Assam, Arunachal Pradesh and Tripura. The distribution range of the species is presented in Figure 1.

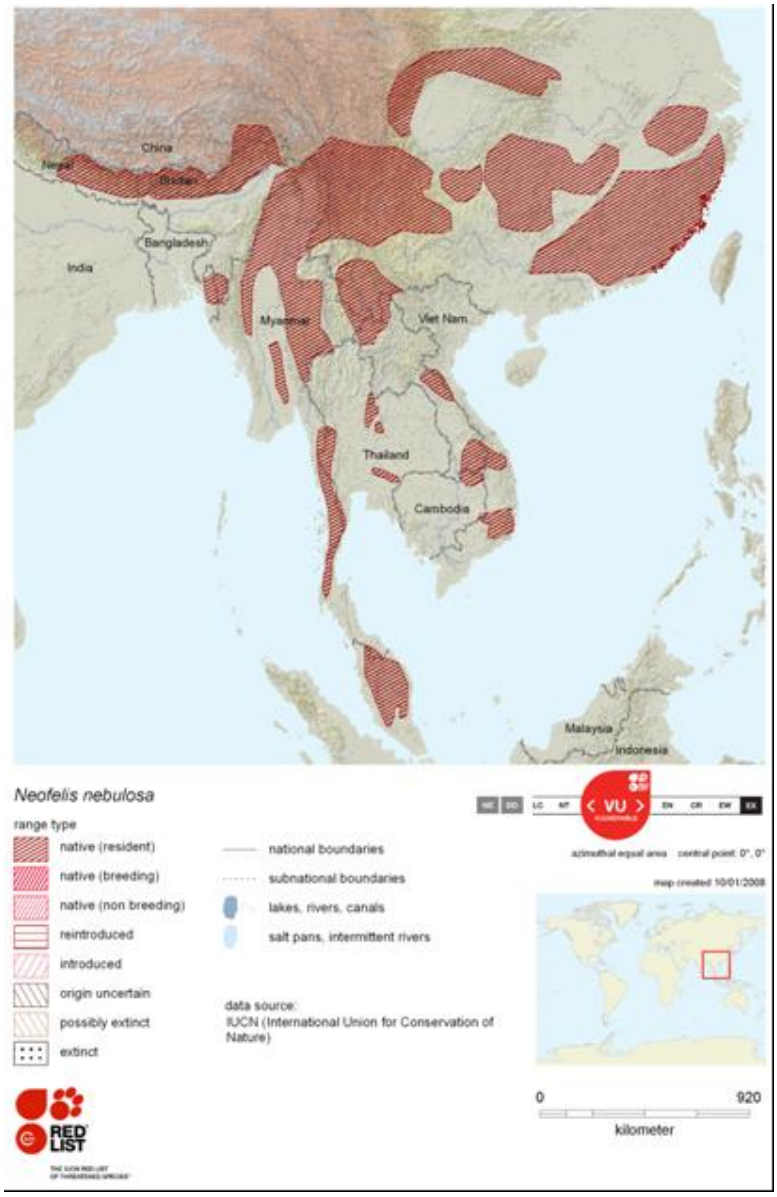


Figure 1 Distribution map of clouded leopard

Threats

The species prefers closed dense forests which are declining at a rapid rate. Habitat destruction and associated loss of cover and prey base has resulted in a rapid decline in population of clouded leopards in the wild. Besides this the species is extensively hunted for the illicit wildlife trade in skins, bones for medicines and meat for exotic dishes.

Status

Due to the various threats to the survival of the species in the wild the species has been ranked as Vulnerable [criterion C1+ 2a(i)] of IUCN Red list of Threatened species, version 2009.1 and Schedule I of the Wild Life Protection Act; Govt. of India. It is also protected by legislation in most of its range countries. It is included in CITES Appendix I due to the extensive illicit trade

Scope of the studbook

The present studbook compiles and analyses data for the Indian zoos.

Methods

The data for the present studbook was collected through mailed questionnaires and the CZA website (cza.nic.in). Data for Nagaland Zoological Park, Rangaphar has not been included in the present studbook as the same was not received and is unavailable at both the CZA and ISIS websites. The data collected was entered in SPARKS 1.5 and analyzed using SPARKS 1.5 and PM 2000.

Census

The clouded leopard population in Indian zoos owes its origin to wild caught founder animals. The present population has 25 animals (table 1) of which 11 animals are of wild origin.

Table 1 Population status of clouded leopards in Indian zoos

Zoo Name	Population Status			
	Males	Females	Unsexed	Total
Aizawl Zoo (Mizoram Zoo)	0	1	0	1
Nagaland Zoological Park, Rangapahar *	1	1	0	2
Sepahijala Zoological Park	9	9	0	18
Padmaja Naidu Himalayan Zoological Park	1	1	0	2
Assam State Zoo	2	0	0	2
Total	13	12	0	25

* Population data for Nagaland Zoological Park, Rangapahar is based on Central Zoo Authority Inventory the same is excluded from demographic and genetic analysis due to non availability of data

Sepahajala Zoological Park is the only Indian zoo so far to have bred the species in captivity. Figure 2 presents the census trends in captivity from 1992 – 2008. Table2 presents the location wise listing of live clouded leopard in Indian zoos, and table3 presents historical listing of clouded leopard in Indian zoos.

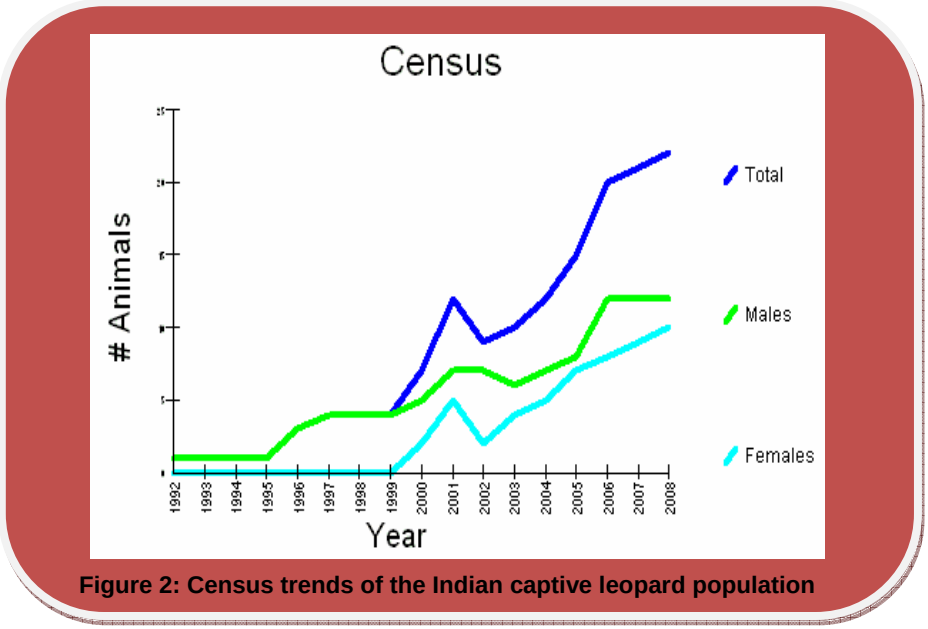


Figure 2: Census trends of the Indian captive leopard population

Table 2 Location wise listing of live clouded leopards in Indian Zoos

Sl. No.	Home Name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Event	Date	Remarks
Assam State Zoo, Guwahati											
1.	Badal	00001		Male	Wild	Wild	????	India Assam	Capture Transfer	1 Jul 1992 1 Jul 1992	
2.	Raja	00016		Male	Wild	Wild	????	India Assam	Capture Transfer	4 Mar 2002 4 Mar 2002	
	2.0.0 (1)										
Sepahijala Zoological Park, Agartala											
3.	Nandan 0006B73987	00002		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	10 Feb 1996 10 Feb 1996	
4.	Tazu 0006B7E31B	00004		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	25 Nov 1997 25 Nov 1997	
5.	Mantu	00007		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	30 Oct 2000 30 Oct 2000	
6.	Deshi 0006B8AC34	00012		Female	Wild	Wild	????	India Sepahijala	Capture Transfer	16 Jul 2001 16 Jul 2001	
7.	Ghaura 0006B7F07E	00013		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	23 Jul 2001 23 Jul 2001	
8.	Rehana 0006B8A0B6	00018		Female	00004	00005	4 May 2003	Sepahijala	Birth	4 May 2003	
9.	Reshmi 0006B887B1	00020		Female	00004	00005	4 May 2003	Sepahijala	Birth	4 May 2003	
10.	Rani	00022		Female	Wild	Wild	????	India Sepahijala	Capture Transfer	24 May 2004 24 May 2004	
11.	Priti 0006B886C0	00024		Female	00013	00005	27 Mar 2005	Sepahijala	Birth	27 Mar 2005	
12.	Zimmi	00025		Male	00013	00005	27 Mar 2005	Sepahijala	Birth	27 Mar 2005	
13.	Pallabi 0006B8958A	00027		Female	00002	00020	24 Apr 2006	Sepahijala	Birth	24 Apr 2006	
14.	Sanjit	00028		Male	00002	00020	24 Apr 2006	Sepahijala	Birth	24 Apr 2006	
15.	Rahul 0006B899A8	00029		Male	00004	00012	13 May 2006	Sepahijala	Birth	13 May 2006	
16.	Nibash 0006B88A82	00030		Male	00002	00018	29 May 2006	Sepahijala	Birth	29 May 2006	
17.	Parul 0006B8836	00032		Female	00002	00018	29 May 2006	Sepahijala	Birth	29 May 2006	

Sl. No.	Home Name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Event	Date	Remarks
18.	Prativa 000B73C0D	00033		Female	00004	00022	19 Mar 2007	Sepahijala	Birth	19 Mar 2007	
19.	Manmohan	00034		Male	00013	00020	12 Mar 2008	Sepahijala	Birth	12 Mar 2008	
20.	Mayabati	00035		Female	00013	00020	12 Mar 2008	Sepahijala	Birth	12 Mar 2008	
9.9.0 (18)											
Padmaja Naidu Himalayan Zoological Park, Darjeeling											
21.	Priti	00026		Female	Wild	Wild	????	India Darjeeling	Capture Transfer	27 Mar 2005 27 Mar 2005	
22.	Nibas 006B88A87	00031		Male	Wild	Wild	????	India Darjeeling	Capture Transfer	29 May 2006 29 May 2006	
1.1.0 (2)											
Aizawal Zoo, Aizawal											
23.	Jenny Jenny	00036		Female	Wild	Wild	????	India Aizawl	Capture Transfer	???? ????	
0.1.0 (1)											
Total 12.11 (23)											

Table 3 Historical listing of Clouded Leopard (*Neofelis nebulosa*) in Indian Zoos

Sl. No.	Home Name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Event	Date	Remarks
1.	Badal	00001		Male	Wild	Wild	????	India Assam	Capture Transfer	1 Jul 1992 1 Jul 1992	
2.	Nandan 0006B73987	00002		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	10 Feb 1996 10 Feb 1996	
3.	Raja	00003		Male	Wild	Wild	????	India Patna Patna	Capture Transfer Death	26 Jul 1996 26 Jul 1996 8 Sep 2003	
4.	Tazu 0006B7E31B	00004		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	25 Nov 1997 25 Nov 1997	
5.	Shilpi	00005		Female	Wild	Wild	????	India Sepahijala	Capture Transfer Death	9 Jun 2000 9 Jun 2000 30 Jul 2006	
6.	Ritul	00006		Female	Wild	Wild	????	India Sepahijala	Capture Transfer Death	28 Aug 2000 28 Aug 2000 4 Mar 2002	
7.	Mantu	00007		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	30 Oct 2000 30 Oct 2000	
8.	Alam	00008		Male	Wild	Wild	????	India Sepahijala	Capture Transfer Death	19 May 2001 19 May 2001 28 Mar 2002	
9.	Sumita	00009		Female	Wild	Wild	????	India Sepahijala	Capture Transfer Death	19 May 2001 19 May 2001 1 Apr 2002	
10.	Minu	00010		Female	00002	00005	13 Jun 2001	Sepahijala	Birth Death	13 Jun 2001 5 Apr 2002	
11.	Khaled	00011		Male	00002	00005	13 Jun 2001	Sepahijala	Birth Death	13 Jun 2001 1 Jul 2001	
12.	Deshi 0006B8AC34	00012		Female	Wild	Wild	????	India Sepahijala	Capture Transfer	16 Jul 2001 16 Jul 2001	
13.	Ghaura 0006B7F07E	00013		Male	Wild	Wild	????	India Sepahijala	Capture Transfer	23 Jul 2001 23 Jul 2001	
14.	Unk1	00014		Unsexed	00004	00006	1 Mar 2002	Sepahijala	Birth Death	1 Mar 2002 1 Mar 2002	

Sl. No.	Home Name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Event	Date	Remarks
15.	Unk2	00015		Unsexed	00004	00006	1 Mar 2002	Sepahijala	Birth Death	1 Mar 2002 3 Mar 2002	
16.	Raja	00016		Male	Wild	Wild	????	India Assam	Capture Transfer	4 Mar 2002 4 Mar 2002	
17.	Supriya	00017		Female	00004	00005	19 Jul 2002	Sepahijala	Birth Death	19 Jul 2002 29 Aug 2002	
18.	Rehana 0006B8A0B6	00018		Female	00004	00005	4 May 2003	Sepahijala	Birth	4 May 2003	
19.	Subash	00019		Male	00004	00005	4 May 2003	Sepahijala	Birth Death	4 May 2003 30 Jul 2003	
20.	Reshmi 0006B887B1	00020		Female	00004	00005	4 May 2003	Sepahijala	Birth	4 May 2003	
21.	Siddik 0006B8AEFC	00021		Male	Wild	Wild	????	India Sepahijala	Capture Transfer Death	23 Apr 2004 23 Apr 2004 29 Feb 2008	
22.	Rani	00022		Female	Wild	Wild	????	India Sepahijala	Capture Transfer	24 May 2004 24 May 2004	
23.	Ashok	00023		Male	00013	00005	27 Mar 2005	Sepahijala	Birth Death	27 Mar 2005 23 Sep 2005	
24.	Priti 0006B886C0	00024		Female	00013	00005	27 Mar 2005	Sepahijala	Birth	27 Mar 2005	
25.	Zimmi	00025		Male	00013	00005	27 Mar 2005	Sepahijala	Birth	27 Mar 2005	
26.	Priti	00026		Female	Wild	Wild	????	India Darjeeling	Capture Transfer	27 Mar 2005 27 Mar 2005	
27.	Pallabi 0006B8958A	00027		Female	00002	00020	24 Apr 2006	Sepahijala	Birth	24 Apr 2006	
28.	Sanjit	00028		Male	00002	00020	24 Apr 2006	Sepahijala	Birth	24 Apr 2006	
29.	Rahul 0006B899A8	00029		Male	00004	00012	13 May 2006	Sepahijala	Birth	13 May 2006	
30.	Nibash 0006B88A82	00030		Male	00002	00018	29 May 2006	Sepahijala	Birth	29 May 2006	
31.	Nibas 006B88A87	00031		Male	Wild	Wild	????	India Darjeeling	Capture Transfer	29 May 2006 29 May 2006	
32.	Parul 0006B8836	00032		Female	00002	00018	29 May 2006	Sepahijala	Birth	29 May 2006	
33.	Prativa 000B73C0D	00033		Female	00004	00022	19 Mar 2007	Sepahijala	Birth	19 Mar 2007	

Sl. No.	Home Name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Event	Date	Remarks
34.	Manmohan	00034		Male	00013	00020	12 Mar 2008	Sepahijala	Birth	12 Mar 2008	
35.	Mayabati	00035		Female	00013	00020	12 Mar 2008	Sepahijala	Birth	12 Mar 2008	
36.	Jenny Jenny	00036		Female	Wild	Wild	???? 	India Aizawl	Capture Transfer	???? ????	

TOTALS: 18.16.2 (36)

Population planning and Recommendations

The species has a global programme for its ex- situ conservation as well. The Indian captive population is a part of the much larger global captive population. In view of the above it is envisaged that a target of achieving a population size of 100 individuals with an equal sex ratio spread over 4 or more zoos during the next 10 years would serve the purpose of maintaining the species in captivity for insurance. It has to be ensured that these 100 individuals form a demographically stable and genetically viable population.

The current captive population of clouded leopard in India is 23, spread over 4 zoos. This population has a high genetic diversity of 0.8455, a low mean kinship value of 0.0811 and founder genome equivalents equals 3.24, *i.e*. the present captive population is suitable for initiating a genetically viable and demographically stable population.

Genetic Diversity (GD) The heterozygosity expected in a population if the population were in Hardy-Weinberg equilibrium. Gene diversity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating. The proportional gene diversity (as a proportion of the wild or source population) is the probability that two alleles from the same locus sampled at random from the population will be identical by descent.

Mean kinship (MK) The mean kinship coefficient between an animal and all animals (including itself) in the living, captive-born population. The mean kinship of a population is equal to the proportional loss of gene diversity of the descendant (captive-born) population relative to the founders and is also the mean inbreeding coefficient of progeny produced by random mating. Mean kinship is also the reciprocal of two times the founder genome equivalents.

Founder Genome Equivalents (fge) The number of equally represented founders with no loss of alleles (retention = 1) that would produce the same gene diversity as that observed in the living, descendant population. Equivalently, the number of animals from the source population that contain the same gene diversity as does the descendant population. The gene diversity of a population is 1 - 1 / (2 * fge). In Goals, FGE is the number of founder genomes that will be incorporated into the population for each new founder added. A fge of .4 means that each new founder only contributed 40% of a founder genome to the population.

It was not possible to run the goals scenario in PM2000 that models genetic diversity and population sizes over a predefined period of time because of small number of known age individuals in the captive population. Hypothetical pairings (table 4) were

carried out for living individuals using PM2000. The report generated provides the inbreeding coefficients of the hypothetical offspring. Accordingly table 5 lists pairs which produce offspring with inbreeding which may not be appropriate for breeding and table 6 lists pairs which may be used to produce genetic diversity. The movement of animals from one zoo to another should be minimized while implementing the pairings.

Table 4 Ordered list of mean kinships by sex

Males						Females				
Studbook No.	**Mean Kinship**	**% Known**	**Age**	**Location**		**Studbook No.**	**Mean Kinship**	**% Known**	**Age**	**Location**
00001	0.000	100.0	17	Assam		00012	0.035	100.0	0	Sepahijala
00002	0.055	100.0	0	Sepahijala		00018	0.119	100.0	7	Sepahijala
00004	0.093	100.0	0	Sepahijala		00020	0.132	100.0	7	Sepahijala
00007	0.025	100.0	0	Sepahijala		00022	0.032	100.0	0	Sepahijala
00013	0.079	100.0	0	Sepahijala		00024	0.098	100.0	5	Sepahijala
00016	0.025	100.0	8	Assam		00026	0.020	100.0	0	Darjeeling
00025	0.100	100.0	5	Sepahijala		00027	0.106	100.0	4	Sepahijala
00028	0.108	100.0	4	Sepahijala		00032	0.100	100.0	3	Sepahijala
00029	0.078	100.0	4	Sepahijala		00033	0.075	100.0	3	Sepahijala
00030	0.101	100.0	3	Sepahijala		00035	0.118	100.0	2	Sepahijala
00031	0.025	100.0	0	Darjeeling		00036	0.020	100.0	0	Aizawl
00034	0.121	100.0	2	Sepahijala						

Table 5 Pairs not recommended for breeding

Sire	Dam	Inbreeding coefficient	Sire	Dam	Inbreeding coefficient
00025	00027	0.063	00029	00033	0.125
00025	00032	0.063	00030	00020	0.125
00028	00024	0.063	00034	00018	0.125
00028	00033	0.063	00034	00027	0.125
00029	00027	0.063	00025	00035	0.188
00029	00032	0.063	00028	00032	0.188
00029	00035	0.063	00030	00027	0.188
00030	00024	0.063	00034	00024	0.188
00030	00033	0.063	00013	00024	0.250
00030	00035	0.063	00013	00035	0.250
00034	00032	0.063	00025	00024	0.250
00034	00032	0.063	00028	00020	0.250
00034	00033	0.063	00028	00027	0.250
00025	00018	0.125	00029	00012	0.250
00025	00020	0.125	00030	00018	0.250
00028	00018	0.125	00030	00032	0.250
00028	00035	0.125	00034	00020	0.250
00029	00018	0.125	00034	00035	0.250
00029	00020	0.125			

Table 6 Pairs recommended for breeding

Sire	Dam	Inbreeding coefficient		Sire	Dam	Inbreeding coefficient
00007	00012	0.000		00025	00022	0.000
00007	00018	0.000		00025	00026	0.000
00007	00020	0.000		00025	00033	0.000
00007	00022	0.000		00025	00036	0.000
00007	00024	0.000		00028	00012	0.000
00007	00026	0.000		00028	00022	0.000
00007	00027	0.000		00028	00026	0.000
00007	00032	0.000		00028	00036	0.000
00007	00033	0.000		00029	00022	0.000
00007	00035	0.000		00029	00024	0.000
00007	00036	0.000		00029	00026	0.000
00013	00012	0.000		00029	00036	0.000
00013	00018	0.000		00030	00012	0.000
00013	00020	0.000		00030	00022	0.000
00013	00022	0.000		00030	00026	0.000
00013	00026	0.000		00030	00036	0.000
00013	00027	0.000		00031	00012	0.000
00013	00032	0.000		00031	00018	0.000
00013	00033	0.000		00031	00020	0.000
00013	00036	0.000		00031	00022	0.000
00016	00012	0.000		00031	00024	0.000
00016	00018	0.000		00031	00026	0.000
00016	00020	0.000		00031	00027	0.000
00016	00022	0.000		00031	00032	0.000
00016	00024	0.000		00031	00033	0.000
00016	00026	0.000		00031	00035	0.000
00016	00027	0.000		00031	00036	0.000
00016	00032	0.000		00034	00012	0.000
00016	00033	0.000		00034	00022	0.000
00016	00035	0.000		00034	00026	0.000
00016	00036	0.000		00034	00036	0.000
00025	00012	0.000				

A serious cause of concern in the captive clouded leopard population in Indian zoos is the low fecundity levels and poor survival rate of offspring produced. Possible causes for this low fecundity might be improper housing and/or husbandry of clouded leopards. Enclosure designs must take into consideration the secretiveness of the species and its adaptations to arboreal life. If natural methods of reproduction fail then assisted reproductive techniques must be thought of as an option. Presently only Sepahijala Zoological Park has a breeding population, the other zoos housing clouded leopards may look at the option of acquiring some animals either from Sepahijala or other

institutions and initiate steps necessary to development of self sustainable captive populations with possible surpluses for future reintroductions.

Demographic analysis

Census

The year wise census trends are presented in figure 2 and table 7 respectively. The living population of clouded leopards in Indian zoos has an almost equal number of individuals of both captive and wild origin. The two individuals from Nagaland Zoological Park have been excluded from the census details in table 7 due to non availability of data.

Table 7 Census details of captive clouded leopard population in Indian zoos

Years	Total	Females	Males	Unsexed	Wild Caught	Captive Born
1992	1	0	1	0	1	0
1993	1	0	1	0	1	0
1994	1	0	1	0	1	0
1995	1	0	1	0	1	0
1996	3	0	3	0	3	0
1997	4	0	4	0	4	0
1998	4	0	4	0	4	0
1999	4	0	4	0	4	0
2000	7	2	5	0	7	0
2001	12	5	7	0	11	1
2002	9	2	7	0	9	0
2003	10	4	6	0	8	2
2004	12	5	7	0	10	2
2005	15	7	8	0	11	4
2006	20	8	12	0	11	9
2007	21	9	12	0	11	10
2008	22	10	12	0	10	12

Age Structure

PM2000 was used to model the stable age structure. Figure 3 and table 8 represent the age structure of the known age individuals of the living Indian captive population of clouded leopards. The results obtained for stable age distribution (modeled data) suggest that a higher birth rate is required to maintain a stable population, whereas the

actual population has lower recruitment in the first two years of life for both males and females and during the 5th and 6th years for females.

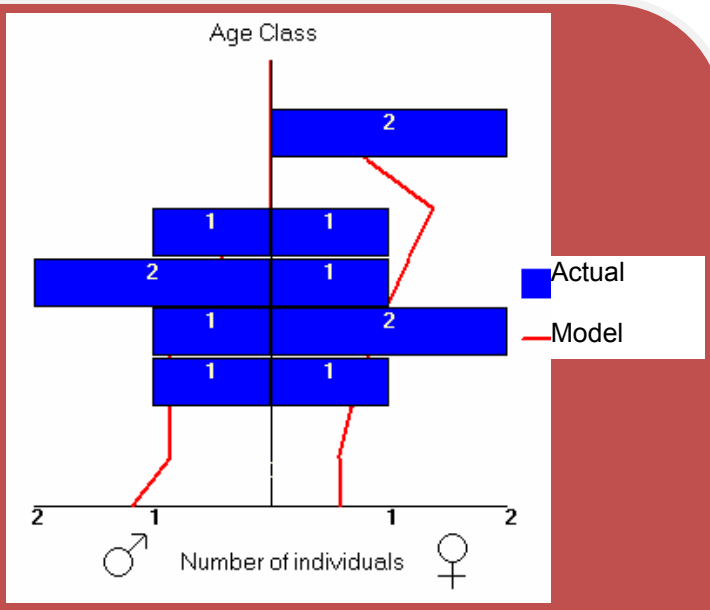


Figure 3 Age distribution of captive clouded leopard

Table 8 Age distribution of captive clouded leopard in Indian zoos

Age (x)	Males		Females	
	Actual	Stable	Actual	Stable
0	0	1.18	0	0.59
1	0	0.85	0	0.58
2	1	0.85	1	0.69
3	1	0.85	2	0.82
4	2	0.85	1	0.97
5	1	0.42	1	1.16
6	0	0.00	0	1.37
7	0	0.00	2	0.81
8	0	0.00	0	0.00

Total Males = 12.0
Total Females = 11.0
Unknown Age Males = 7.0
Unknown Age Females = 4.0

Life tables

Life table on the basis of sex was generated using SPARKS 1.5 and is presented below in table. The life table is based on an extremely small sample size of 19 individuals therefore meaningful conclusions can not be drawn from it, and its utility for predictions is poor. The indicators fecundity (Mx) and mortality (Qx) are of great importance in

developing population plans. However, Mx for males is 0 as none of births are attributable to known age males. For the same season generation length (T), Net reproductive rate (R_0), population growth rate (λ) and the intrinsic rate of increase(r) could not be calculated for males.

Table 9 Life table of captive clouded leopard population in Indian zoos

Age Class	MX Male	NMXM	MX Female	NMXF	QX Male	NQXM	QX Female	NQXF	PX Male	LX Male	PX Female	LX Female
1	0	5.78	0	7.93	0.44	9	0.3	10	0.56	1	0.7	1
2	0	4.7	0	6.7	0	4.7	0	6.7	1	0.56	1	0.7
3	0	4	0.18	5.69	0	4	0	5.69	1	0.56	1	0.7
4	0	2.61	0.25	4.08	0	2.61	0	4.08	1	0.56	1	0.7
5	0	0.66	0.38	2.66	0	0.66	0	2.66	1	0.56	1	0.7
6	0	0	0	2	0	0	0	2	1	0.56	1	0.7
7	0	0	0	1.12	0	0	0	1.12	1	0.56	1	0.7
8	0	0	0	0	0	0	0	0	1	0.56	1	0.7
0	0	0	0	0	0	0	0	0	1	0.56	1	0.7

Males	Females
T = 0	T = 3.247
Ro = 0.000	Ro = 0.567
λ = 0	λ =0.84
r = 0	r = -0.175

Gestation Period was assumed as 89 days
(4 deaths out of 19 arriving within 30 days of birth date)
17 specimens of unknown age were ignored
3 birth events to known age parents were tabulated for Mx
(Average of 6 births to female parents and 0 births to male parents.)
7 death events with known age were tabulated for Qx

Fecundity Rate [Mx] The average number of same-sexed young born to animals in that age class. The fecundity rates provide information on the age of first, last, and maximum reproduction.
Mortality Rate [Qx] the proportion of individuals that die during an age class. It is calculated from the number of animals that die during an age class divided by the number of animals that were alive at the beginning of the age class (i.e.-"at risk")
Generation Length [T] defined as the average age at which a female (or male) produces offspring. It is not the age of first reproduction. Males and females often have different generation lengths.
Net Reproductive Rate [Ro] if each animal were to replace itself each generation, the net reproductive rate would be 1.00 and the population would remain the same size. A growing population has an Ro greater than 1.0 and a declining population less than 1.0.
Growth Rate per Year [lambda] a year growth rate of 1.11 means a 11% per year increase.
Intrinsic Rate of Increase [r] the exponential rate at which a population with a stable age distribution grows.

Population projections

Population projection for the captive clouded leopard population in Indian zoos was generated using PM2000 for the next 20 years. Tables 10 and 11 show the number of births (#born) and the number of individuals required in each age class required each year to maintain a demographically stable population over the next 20 years. The projections were generated for a target population size 100 to be achieved in the next 10 years, and the subsequent maintenance of a demographically stable population for the subsequent 10 years. Figure 4 depicts the number of individuals of both sexes required yearwise to maintain a stable population of 100 individuals over a span of the next 20 years.

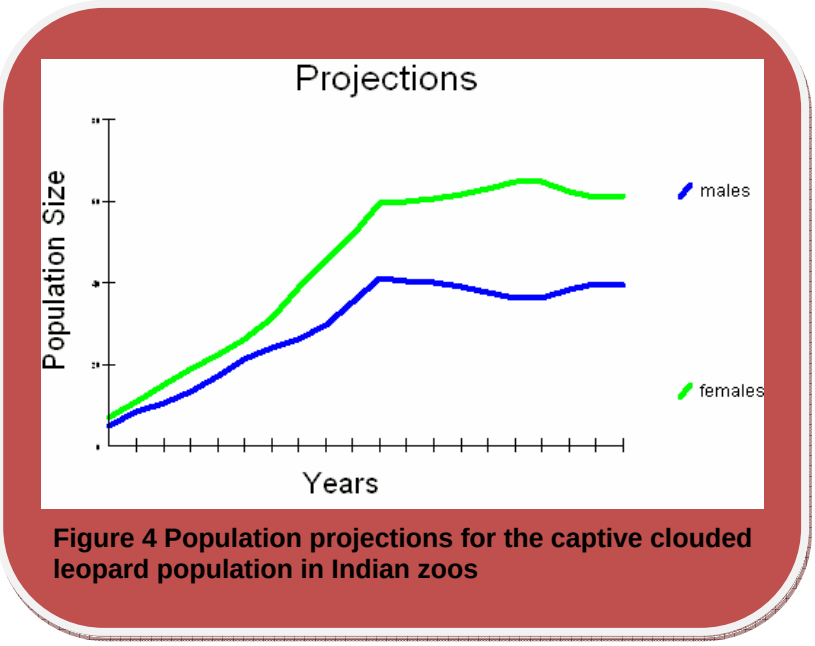


Figure 4 Population projections for the captive clouded leopard population in Indian zoos

Table 10 Births and pairs required for the next 10 years

Year	# Births	# Pairs
0	9.2281	18.5
1	8.846412	17.7
2	9.535173	19.1
3	11.56422	23.1
4	13.03889	26.1
5	12.64089	25.3
6	13.03526	26.1
7	16.68071	33.4
8	21.15524	42.3
9	25.34336	50.7
10	10.36355	20.7

Table 11 Population projections for the captive clouded leopard population

		Years																				
		0.00	**1.00**	**2.00**	**3.00**	**4.00**	**5.00**	**6.00**	**7.00**	**8.00**	**9.00**	**10.00**	**11.00**	**12.00**	**13.00**	**14.00**	**15.00**	**16.00**	**17.00**	**18.00**	**19.00**	**20.00**
# Born		0.00	13.89	13.17	13.73	14.70	14.80	16.33	19.39	24.63	30.80	34.66	19.39	16.93	18.19	21.47	25.74	27.01	26.19	23.44	19.97	20.28
Age Class	**0.00**	0.00	11.32	10.74	11.19	11.98	12.06	13.31	15.80	20.08	25.10	28.25	15.80	13.80	14.83	17.50	20.98	22.02	21.34	19.10	16.27	16.53
	1.00	0.00	0.00	8.75	8.30	8.65	9.26	9.32	10.29	12.22	15.52	19.40	21.84	12.21	10.67	11.46	13.53	16.21	17.02	16.50	14.76	12.58
	2.00	2.00	0.00	0.00	8.75	8.30	8.65	9.26	9.32	10.29	12.22	15.52	19.40	21.84	12.21	10.67	11.46	13.53	16.21	17.02	16.50	14.76
	3.00	3.00	2.00	0.00	0.00	8.75	8.30	8.65	9.26	9.32	10.29	12.22	15.52	19.40	21.84	12.21	10.67	11.46	13.53	16.21	17.02	16.50
	4.00	3.00	3.00	2.00	0.00	0.00	8.75	8.30	8.65	9.26	9.32	10.29	12.22	15.52	19.40	21.84	12.21	10.67	11.46	13.53	16.21	17.02
	5.00	2.00	2.00	2.50	1.50	0.00	0.00	6.81	6.45	6.73	7.20	7.25	8.00	9.50	12.07	15.09	16.99	9.50	8.30	8.91	10.52	12.61
	6.00	0.00	1.00	1.00	2.00	1.00	0.00	0.00	4.86	4.61	4.80	5.15	5.18	5.72	6.79	8.62	10.78	12.13	6.79	5.93	6.37	7.52
	7.00	2.00	0.00	0.50	0.50	1.00	0.50	0.00	0.00	2.43	2.31	2.40	2.57	2.59	2.86	3.39	4.31	5.39	6.07	3.39	2.96	3.18
	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		12.0	19.32	25.49	32.24	39.68	47.52	55.65	64.64	74.93	86.76	100.48	100.53	100.58	100.66	100.79	100.92	100.91	100.72	100.59	100.63	100.71

Target population of 100 individuals at the end of ten years

Genetic Analyses

The viability of a captive population is dependent upon its genetic variability. This genetic variability is a function of the founder contribution and the avoidance of inbreeding by regulating mating choices. A genetic analysis of captive clouded leopard population was carried out using PM2000. Table 12 summaries the genetics of the Indian captive clouded leopard population.

Table 12 Genetic summary of the captive clouded leopard population

	Current	Potential
Founders	6	6
fge	3.24	6.17
Founder Genomes Surviving	4.75	11.93
GD	0.8455	0.9581
GV	0.8022	0.9233
MK	0.0811	
Mean F	0.0000	
Percent Known	100.0%	

Captive births: 19 Wild origin: 17

Table 13 summaries the founder contribution in the living population of clouded leopards in captivity in India. Studbook number 00004 (male) and 00005 (female) are overrepresented while most of the founders or potential founders are underrepresented or not represented at all respectively. This is not in consonance with the principle of captive breeding; according to which all founder animals must have an equal chance of contributing their genes to the population to ensure that as much as possible of the wild genetic diversity is retained in the captive population.

Table 13 Founder statistics of the captive Indian clouded leopard population

Studbook #	Sex	Age	Representation	Contribution	Allele Retent.	Potential Ret.	*Descendants*
00002	M	0	0.1667	2.0000	0.9460	1.0000	*4.00*
00004	M	0	0.2917	3.5000	0.9375	1.0000	*10.00*
00007	M	0	0.0000	0.0000	0.0000	1.0000	*0.00*
00012	F	0	0.0417	0.5000	0.5000	1.0000	*1.00*
00013	M	0	0.1667	2.0000	0.9330	1.0000	*4.00*
00022	F	0	0.0417	0.5000	0.5000	1.0000	*1.00*
00026	F	0	0.0000	0.0000	0.0000	1.0000	*0.00*
00031	M	0	0.0000	0.0000	0.0000	1.0000	*0.00*
00036	F	0	0.0000	0.0000	0.0000	1.0000	*0.00*
00001	M	0	0.0000	0.0000	0.0000	1.0000	*0.00*
00005	F	0	0.2917	3.5000	0.9285	0.9285	*10.00*
00016	*M*	*0*	*0.0000*	*0.0000*	*0.0000*	*1.0000*	*0.00*

Representation Proportion of the genes in the living, descendant population that are derived from that founder. I.e., proportional Founder Contribution.
Contribution Number of copies of a founder's genome that are present in the living descendants. Each offspring contributes 0.5, each grand-offspring contributes 0.25, etc.
Allelic Retention The probability that a gene present in a founder individual exists in the living, descendant population.
Potential When used in regard to genetic measures, Potential refers to the values that could be obtained if alleles in the population could be optimally extracted from the alleles presently in the population. Thus, all matings would have to be optimal, and the best alleles would have to be transmitted to each offspring. Potentials define upper limits of what could be achieved with perfect genetic management, assuming that no new founders are imported into the population.

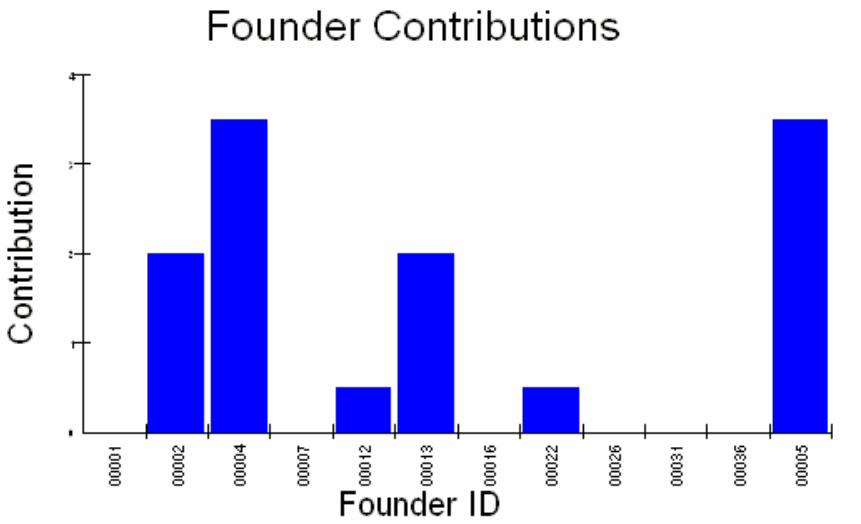


Figure 5 Founder contributions in the captive clouded leopard population

Table 14 presents a genetic summary of the living population of clouded leopards. The information contained is of use in determining pairings.

Reproductive Value (Vx) The expected number of offspring produced this year and in future years by an animal of age x.
Prob lost (PrLoss) Probability that a random allele from the individual will be lost from the population in the next generation, because neither this individual nor any of its relatives pass on the allele to an offspring. It is assumed that each individual will produce a number of future offspring equal to its reproductive value, Vx.
First Order Kinship Equivalents (Foke) The number of first-order kin (siblings or offspring) that would contain the number of copies of an individuals alleles (identical by descent) as are present in the captive-born population. Thus an offspring or sib contributes 1 to FOKE; each grand-offspring contributes 1/2 to FOKE; each cousin contributes 1/4 to FOKE. FOKE = 4*N*MK, in which N is the number of living animals in the captive population.
Genome Uniqueness (GU) Probability that an allele sampled at random from an individual is not present, identical by descent, in any other living individual in the population. GU-all is the genome uniqueness relative to the entire population. GU-Desc is the genome uniqueness relative to the living non-founder, descendants.
Kinship Value (KV) The weighted mean kinship of an animal, with the weights being the reproductive values of each of the kin. The mean kinship value of a population predicts the loss of gene diversity expected in the subsequent generation if all animals were to mate randomly and all were to produce the numbers of offspring expected for animals of their age.

Table 14 Genetic summary of individuals in the living captive leopard population in India

Sl. No.	Studbook #	Sex	Sire	Dam	Age	Location	Vx	% Known	F	MK	KV	GU - All	GU - Descend	Prob Lost	FOKE	# Offspring	Local ID
1.	00002	M	Wild	Wild	0	Sepahijala	0.00	100.0	0.0000	0.0833	0.0967	0.0540	-1.0000	0.5455	4.00	6	Nandan
2.	00004	M	Wild	Wild	0	Sepahijala	0.00	100.0	0.0000	0.1458	0.1564	0.0625	-1.0000	0.4288	7.00	8	Tazu
3.	00007	M	Wild	Wild	0	Sepahijala	0.00	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	1.0000	0.00	0	Mantu
4.	00012	F	Wild	Wild	0	Sepahijala	1.18	100.0	0.0000	0.0208	0.0000	0.5000	-1.0000	0.1957	1.00	1	Deshi
5.	00013	M	Wild	Wild	0	Sepahijala	0.00	100.0	0.0000	0.0833	0.0906	0.0670	-1.0000	0.6228	4.00	5	Ghaura
6.	00022	F	Wild	Wild	0	Sepahijala	1.18	100.0	0.0000	0.0208	0.0627	0.5000	-1.0000	0.1349	1.00	1	Rani
7.	00026	F	Wild	Wild	0	Darjeeling	1.18	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	0.1957	0.00	0	Priti
8.	00031	M	Wild	Wild	0	Darjeeling	0.00	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	1.0000	0.00	0	Nibas
9.	00036	F	Wild	Wild	0	Aizawl	1.18	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	0.1957	0.00	0	Jenny
10.	00001	M	Wild	Wild	17	Assam	0.00	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	1.0000	0.00	0	Badal
11.	00016	M	Wild	Wild	8	Assam	0.00	100.0	0.0000	0.0000	0.0000	1.0000	-1.0000	1.0000	0.00	0	Raja
12.	00018	F	00004	00005	7	Sepahijala	0.00	100.0	0.0000	0.1875	0.1564	0.0165	0.0290	0.4317	9.00	2	Rehana
13.	00020	F	00004	00005	7	Sepahijala	0.00	100.0	0.0000	0.2083	0.1873	0.0015	0.0055	0.3487	10.00	4	Reshmi
14.	00024	F	00013	00005	5	Sepahijala	0.00	100.0	0.0000	0.1354	0.0921	0.0550	0.1265	0.6351	6.50	0	Priti
15.	00025	M	00013	00005	5	Sepahijala	0.00	100.0	0.0000	0.1354	0.0921	0.0580	0.1200	0.6191	6.50	0	Zimmi
16.	00027	F	00002	00020	4	Sepahijala	0.38	100.0	0.0000	0.1667	0.1760	0.0000	0.0710	0.3428	8.00	0	Pallabi
17.	00028	M	00002	00020	4	Sepahijala	0.00	100.0	0.0000	0.1667	0.1420	0.0000	0.0575	0.4497	8.00	0	Sanjit
18.	00029	M	00004	00012	4	Sepahijala	0.00	100.0	0.0000	0.1042	0.0782	0.0000	0.5660	0.3167	5.00	0	Rahul
19.	00030	M	00002	00018	3	Sepahijala	0.00	100.0	0.0000	0.1563	0.1265	0.0000	0.0640	0.4977	7.50	0	Nibash
20.	00032	F	00002	00018	3	Sepahijala	0.70	100.0	0.0000	0.1563	0.1893	0.0000	0.0640	0.2702	7.50	0	Parul
21.	00033	F	00004	00022	3	Sepahijala	0.70	100.0	0.0000	0.1042	0.1723	0.0000	0.5590	0.1574	5.00	0	Prativa
22.	00034	M	00013	00020	2	Sepahijala	0.00	100.0	0.0000	0.1667	0.1389	0.0000	0.0555	0.4714	8.00	0	Manmohan
23.	00035	F	00013	00020	2	Sepahijala	1.01	100.0	0.0000	0.1667	0.2295	0.0000	0.0585	0.1924	8.00	0	Mayabati

A perusal of Table 15 suggests that there is no problem of inbreeding in the current captive clouded leopard population in India. The captive population has a good representation of founder genomes. Accordingly, while making breeding choices locations should be given greater importance than other criteria as movements over long distances can be avoided by pairing animals at the same location or moving animals to a minimal distance.

Table 15 Inbreeding Coefficient of Clouded Leopards in Indian Zoos

Studbook #	Sex	Age	Location	% Known	F
00001	M	17	Assam	100.0	0.0000
00002	M	0	Sepahijala	100.0	0.0000
00004	M	0	Sepahijala	100.0	0.0000
00005	F	0	Sepahijala	100.0	0.0000
00006	F	0	Sepahijala	100.0	0.0000
00007	M	0	Sepahijala	100.0	0.0000
00010	F	1	Sepahijala	100.0	0.0000
00011	M	0	Sepahijala	100.0	0.0000
00012	F	0	Sepahijala	100.0	0.0000
00013	M	0	Sepahijala	100.0	0.0000
00014	U	0	Sepahijala	100.0	0.0000
00015	U	0	Sepahijala	100.0	0.0000
00016	M	8	Assam	100.0	0.0000
00017	F	0	Sepahijala	100.0	0.0000
00018	F	7	Sepahijala	100.0	0.0000
00019	M	0	Sepahijala	100.0	0.0000
00020	F	7	Sepahijala	100.0	0.0000
00022	F	0	Sepahijala	100.0	0.0000
00023	M	0	Sepahijala	100.0	0.0000
00024	F	5	Sepahijala	100.0	0.0000
00025	M	5	Sepahijala	100.0	0.0000
00026	F	0	Darjeelin	100.0	0.0000
00027	F	4	Sepahijala	100.0	0.0000
00028	M	4	Sepahijala	100.0	0.0000
00029	M	4	Sepahijala	100.0	0.0000
00030	M	3	Sepahijala	100.0	0.0000
00031	M	0	Darjeelin	100.0	0.0000
00032	F	3	Sepahijala	100.0	0.0000
00033	F	3	Sepahijala	100.0	0.0000
00034	M	2	Sepahijala	100.0	0.0000
00036	F	0	Aizawl	100.0	0.0000

References

1. Buckley-Beason, V., W. Johnson, W. Nash, R. Stanyon, J. Menninger, C. Driscoll, J. Howard, M. Bush, J. Page, M. Roelke, G. Stone, P. Martelli, C. Wen, L. Ling, R. Duraisingam, P. Lam, S. O'Brien. 2006. Molecular Evidence for Species-Level Distinctions in Clouded Leopards. *Current Biology*, 16: 2371-2376.
2. IUCN. 1996. "Clouded Leopard, Neofelis nebulosa" (On-line). IUCN/SSC Cat Specialist Group. Accessed March 21, 2009 at http://www.catsg.org/catsgportal/cat-website/20_cat-website/home/index_en.htm.
3. Kitchener, Andrew C., Mark A. Beaumont, and Douglas Richardson. Geographical Variation in the Clouded Leopard, Neofelis nebulosa, Reveals Two Species. *Current Biology* 16, 2377-2383, December 5, 2006.
4. Mehta, J.N. and Dhewaju, R.G. 1990. A note on the record of clouded leopards in Nepal. *Tiger Paper* 17(1):21-22.
5. Pocock, R.I. 1939a. *The fauna of British India, Mammalia, I. Primates and Carnivora, 2d edn.* London: Taylor and Francis
6. Sanderson, J., Khan, J., Grassman, L. & Mallon, D.P. 2008. *Neofelis nebulosa*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <http://www.iucnredlist.org/>. Downloaded on **13 October 2009**.

Bibliography

1. Beacham, W., K. Beltz. 1998. *Beacham's Guide to International Endangered Species, Vol. 2*. Osprey, Florida: Beacham Publishing Corp..
2. Groombridge, B. and Jenkins, M.D. 2002. *World Atlas of Biodiversity*. Prepared by the UNEP World Conservation Monitoring Centre. University of California Press, Berkeley, USA.
3. Nowak, R.M. 1999. *Walkers Mammals of the World*. Sixth edition. John Hopkins University Press, Baltimore.
4. Pollak, J. P., R. C. Lacy and J. D. Ballou. 2005. Population Management 2000, version 1.213. Chicago Zoological Society, Brookfield, IL.
5. Yamada, J.K. and Durrant, B.S. 1989. Reproductive parameters of clouded leopards *(Neofelis nebulosa). Zoo Biol.* 8:223-231.

Glossary of Terms

Demographic Terms

Age Distribution -- A two-way classification showing the numbers or percentages of individuals in various age and sex classes.

Ex, Life Expectancy – Average years of further life for an animal in age class x.

Lambda, λ (Population Growth Rate**)** -- The proportional change in population size from one year to the next. Lambda can be based on life-table calculations (the expected lambda) or from observed changes in population size from year to year. A lambda of 1.11 means a 11% per year increase; lambda of .97 means a 3% decline in size per year.

lx, Age-Specific Survivorship – The probability that a new individual (e.g., age 0) is alive at the *beginning* of age *x*. Alternatively, the proportion of individuals which survive from birth to the beginning of a specific age class.

Mx, **Fecundity** – The average number of same-sexed young born to animals in that age class. Because SPARKS is typically using relatively small sample sizes, SPARKS calculates Mx as 1/2 the average number of young born to animals in that age class. This provides a somewhat less "noisy" estimate of Mx, though it does not allow for unusual sex ratios. The fecundity rates provide information on the age of first, last, and maximum reproduction.

Px, Age-Specific Survival – The probability that an individual of age *x* survives one time period; is conditional on an individual being alive at the beginning of the time period. Alternatively, the proportion of individuals which survive from the beginning of one age class to the next.

Qx, Mortality – Probability that an individual of age *x* dies during time period. Qx = 1-Px
The proportion of individuals that die during an age class. It is calculated from the number of animals that die during an age class divided by the number of animals that were alive at the beginning of the age class (i.e.-"at risk").

Risk (Qx or Mx) – The number of individuals that have lived during an age class. The number at risk is used to calculate Mx and Qx by dividing the number of births and deaths that occurred during an age class by the number of animals at risk of dying and reproducing during that age class.

Vx, **Reproductive Value** – The expected number of offspring produced this year and in future years by an animal of age x.

Genetic Terms

Allele Retention – The probability that a gene present in a founder individual exists in the living, descendant population.

Current Gene Diversity (GD) -- The proportional gene diversity (as a proportion of the source population) is the probability that two alleles from the same locus sampled at random from the population will be identical by descent. Gene diversity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating, and if the population were in Hardy-Weinberg equilibrium.

Effective Population Size (Inbreeding N_e) -- The size of a randomly mating population of constant size with equal sex ratio and a Poisson distribution of family sizes that would (a) result in the same mean rate of inbreeding as that observed in the population, or (b) would result in the same rate of random change in gene frequencies (genetic drift) as observed in the population. These two definitions are identical only if the population is demographically stable (because the rate of inbreeding depends on the distribution of alleles in the parental generation, whereas the rate of gene frequency drift is measured in the current generation).

FOKE, First Order Kin Equivalents – The number of first-order kin (siblings or offspring) that would contain the number of copies of an individuals alleles (identical by descent) as are present in the captive-born population. Thus an offspring or sib contributes 1 to FOKE; each grand-offspring contributes 1/2 to FOKE; each cousin contributes 1/4 to FOKE. FOKE = 4*N*MK, in which N is the number of living animals in the captive population.

Founder – An individual obtained from a source population (often the wild) that has no known relationship to any individuals in the derived population (except for its own descendants).

Founder Contribution -- Number of copies of a founder's genome that are present in the living descendants. Each offspring contributes 0.5 whereas each grand-offspring contributes 0.25, etc.

Founder Genome Equivalents (FGE) – The number wild-caught individuals (founders) that would produce the same amount of gene diversity as does the population under study. The gene diversity of a population is 1 - 1 / (2 * FGE).

Founder Genome Surviving – The sum of allelic retentions of the individual founders (i.e., the product of the mean allelic retention and the number of founders).

Founder Representation – Proportion of the genes in the descendant population that derives from that founder. I.e., proportional Founder Contribution.

GU, Genome Uniqueness – Probability that an allele sampled at random from an individual is not present, identical by descent, in any other living individual in the population. GU-all is the genome uniqueness relative to the entire population. GU-Desc is the genome uniqueness relative to the living non-founder, descendants.

Inbreeding Coefficient (F) -- Probability that the two alleles at a genetic locus are identical by descent from an ancestor common to both parents. The mean inbreeding coefficient of a population will be the proportional decrease in observed heterozygosity relative to the expected heterozygosity of the founder population.

KV, Kinship Value – The weighted mean kinship of an animal, with the weights being the reproductive values of each of the kin. The mean kinship value of a population predicts the loss of gene diversity expected in the subsequent generation if all animals were to mate randomly and all were to produce the numbers of offspring expected for animals of their age.

Mean Generation Time (T) -- The average time elapsing from reproduction in one generation to the time the next generation reproduces. Also, the average age at which a female (or male) produces offspring. It is not the age of first reproduction. Males and females often have different generation times.

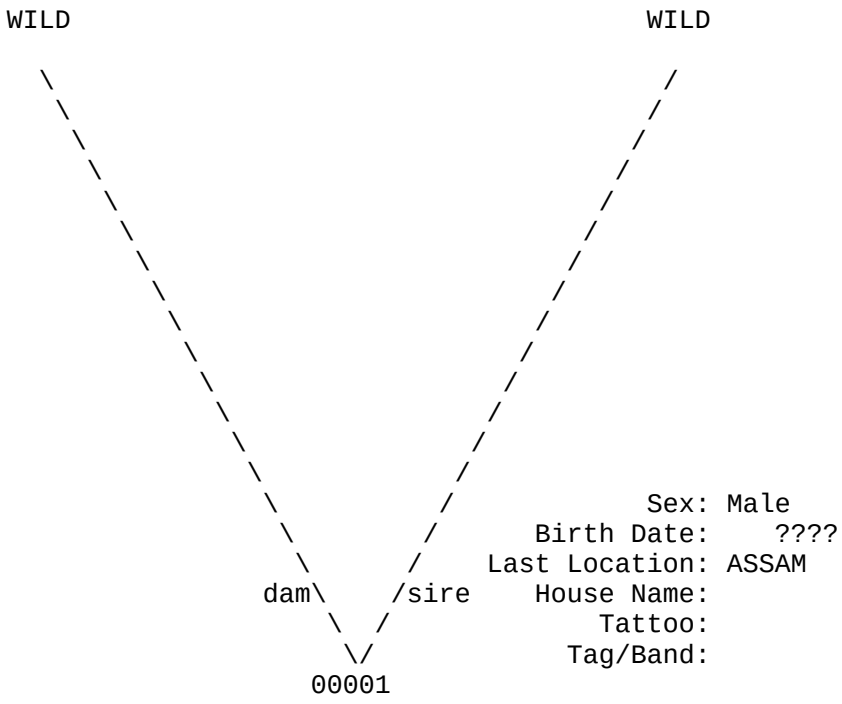
Mean Kinship (MK) -- The mean kinship coefficient between an animal and all animals (including itself) in the living, captive-born population. The mean kinship of a population is equal to the proportional loss of gene diversity of the descendant (captive-born) population relative to the founders and is also the mean inbreeding coefficient of progeny produced by random mating. Mean kinship is also the reciprocal of two times the founder genome equivalents: MK = 1 / (2 * FGE). MK = 1 - GD.

Percent Known -- Percent of an animal's genome that is traceable to known Founders. Thus, if an animal has an UNK sire, the % Known = 50. If it has an UNK grandparent, % Known = 75.

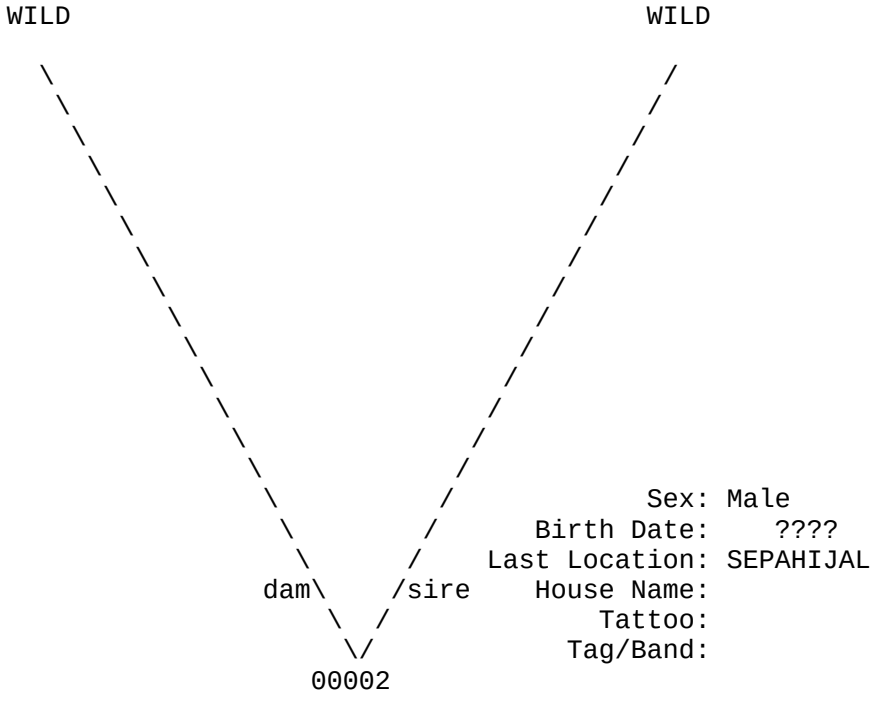
Prob Lost – Probability that a random allele from the individual will be lost from the population in the next generation, because neither this individual nor any of its relatives pass on the allele to an offspring. Assumes that each individual will produce a number of future offspring equal to its reproductive value, Vx.

Appendix 1
Pedigree Chart Report CLOUDED LEOPARD Studbook

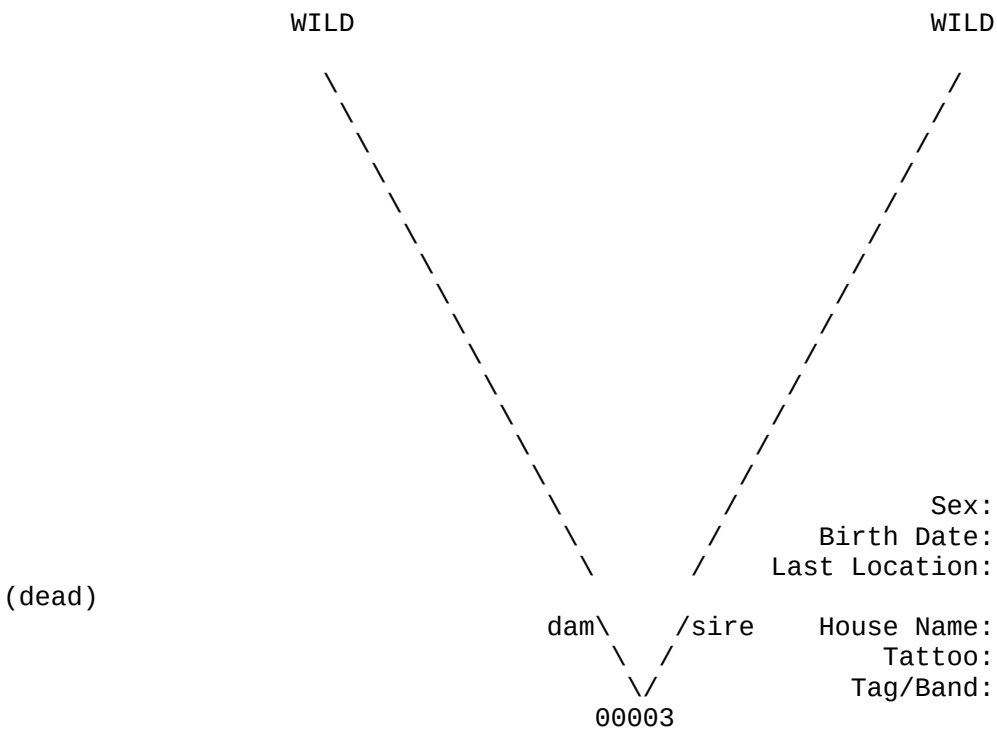
Studbook Number: 00001



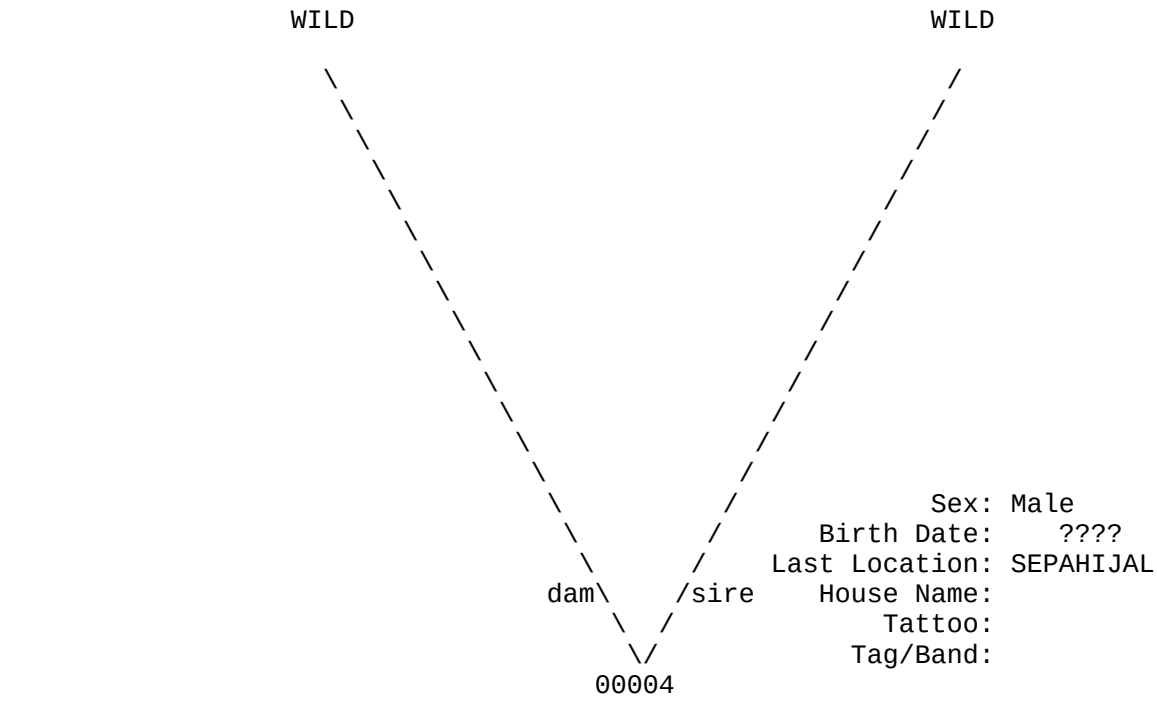
Studbook Number: 00002



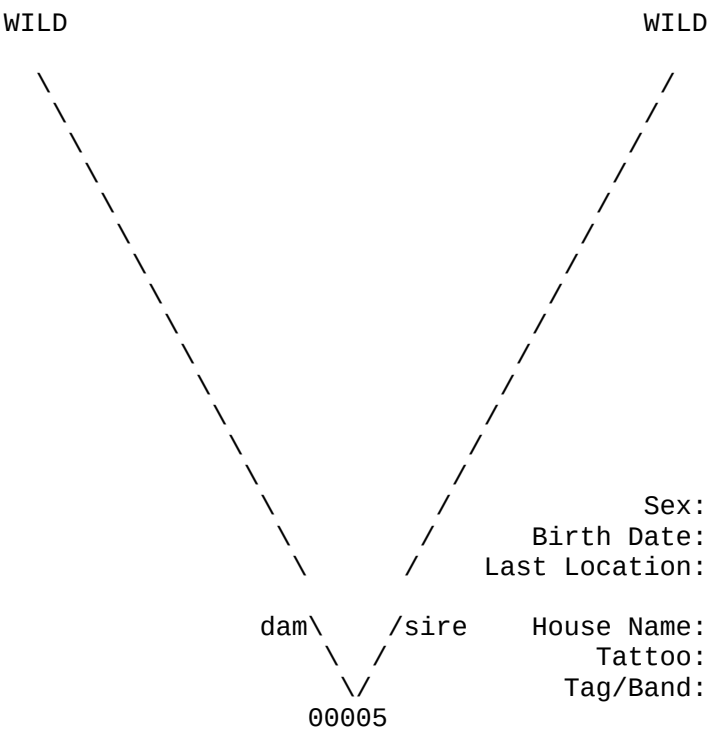
Studbook Number: 00003



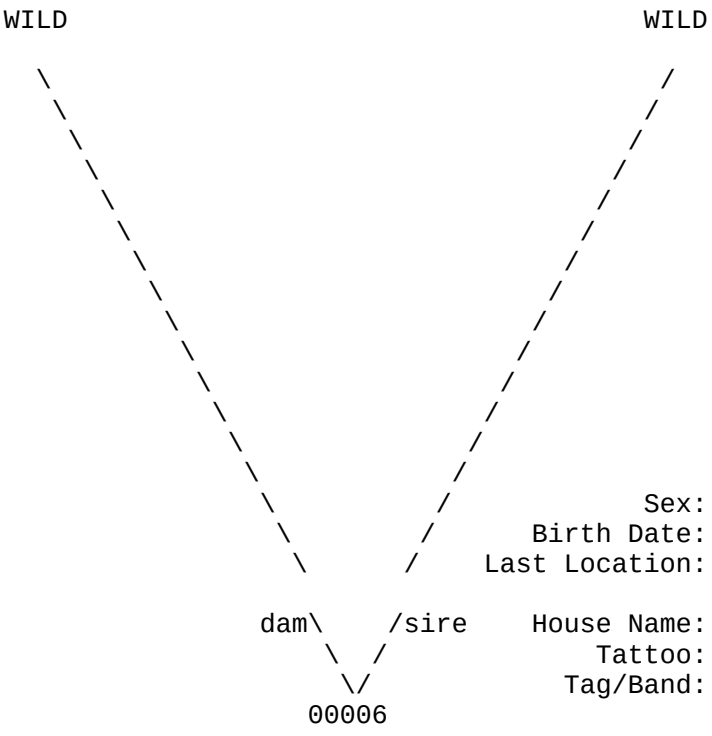
Studbook Number: 00004



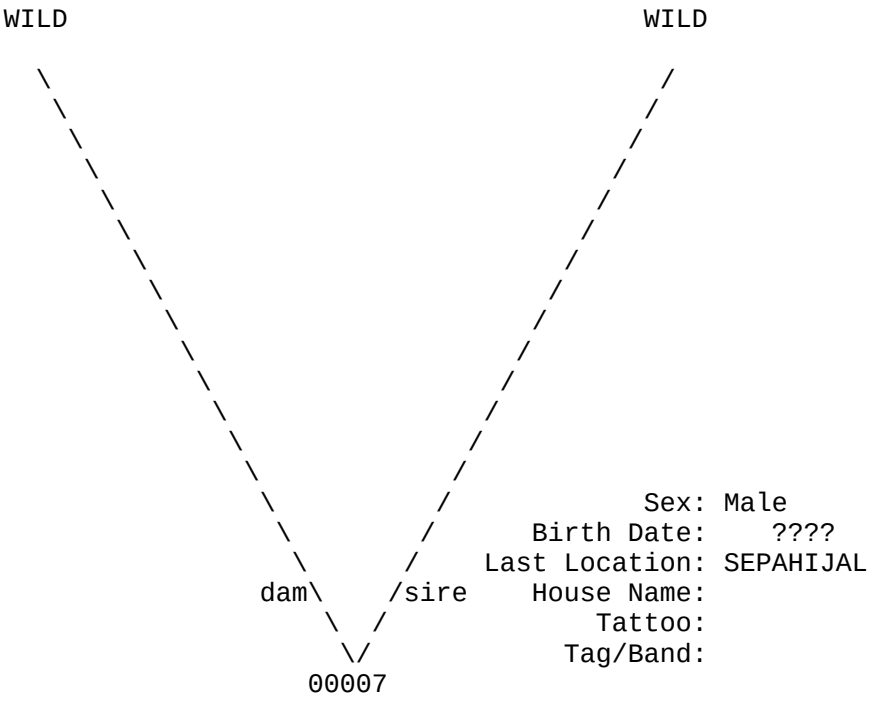
Studbook Number: 00005



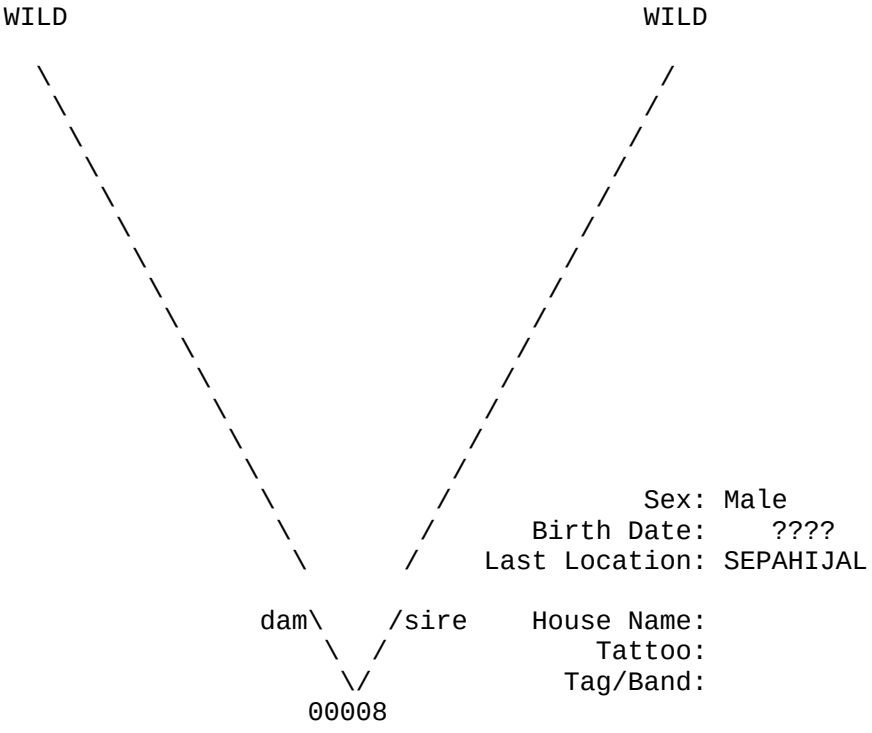
Studbook Number: 00006



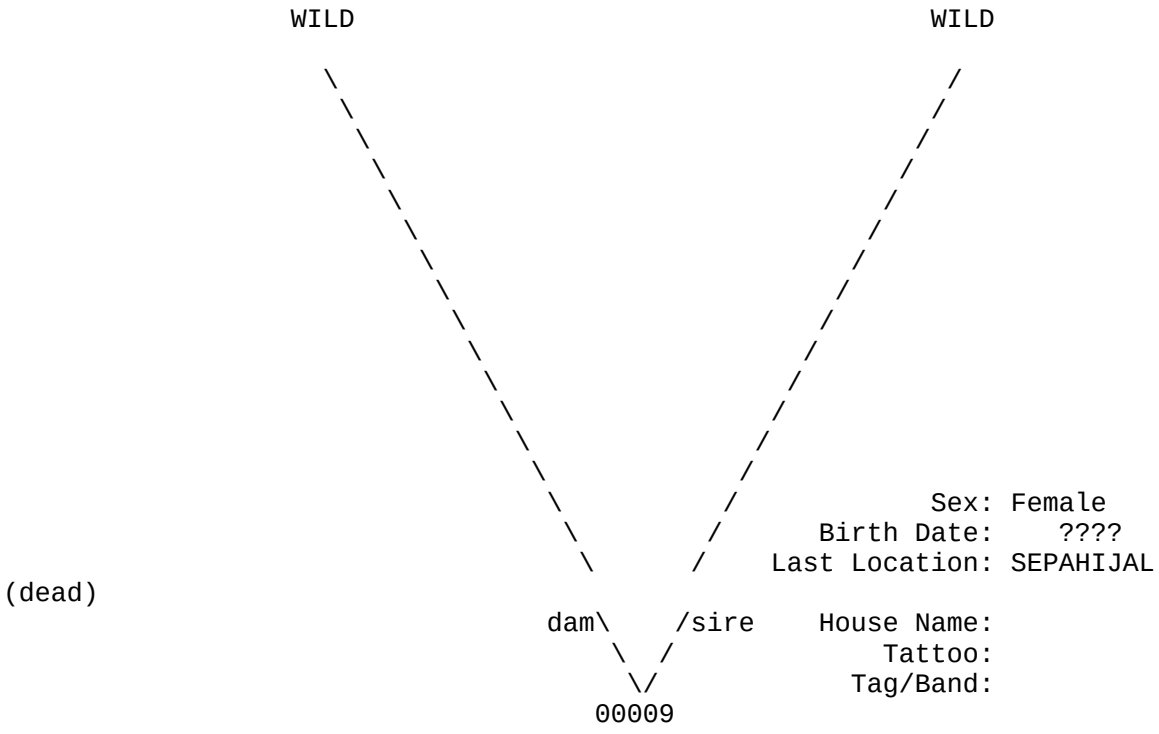
Studbook Number: 00007



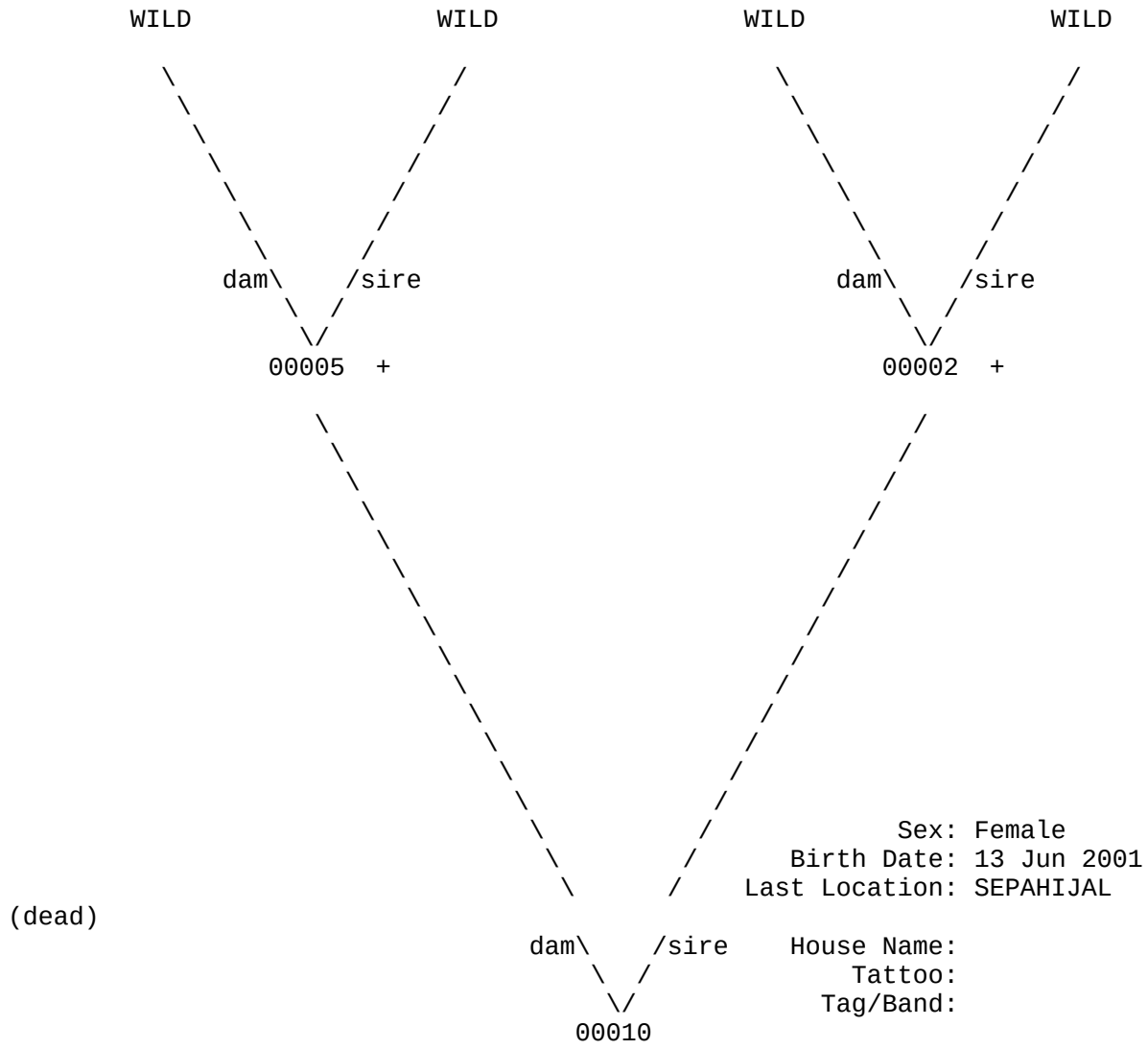
Studbook Number: 00008



Studbook Number: 00009



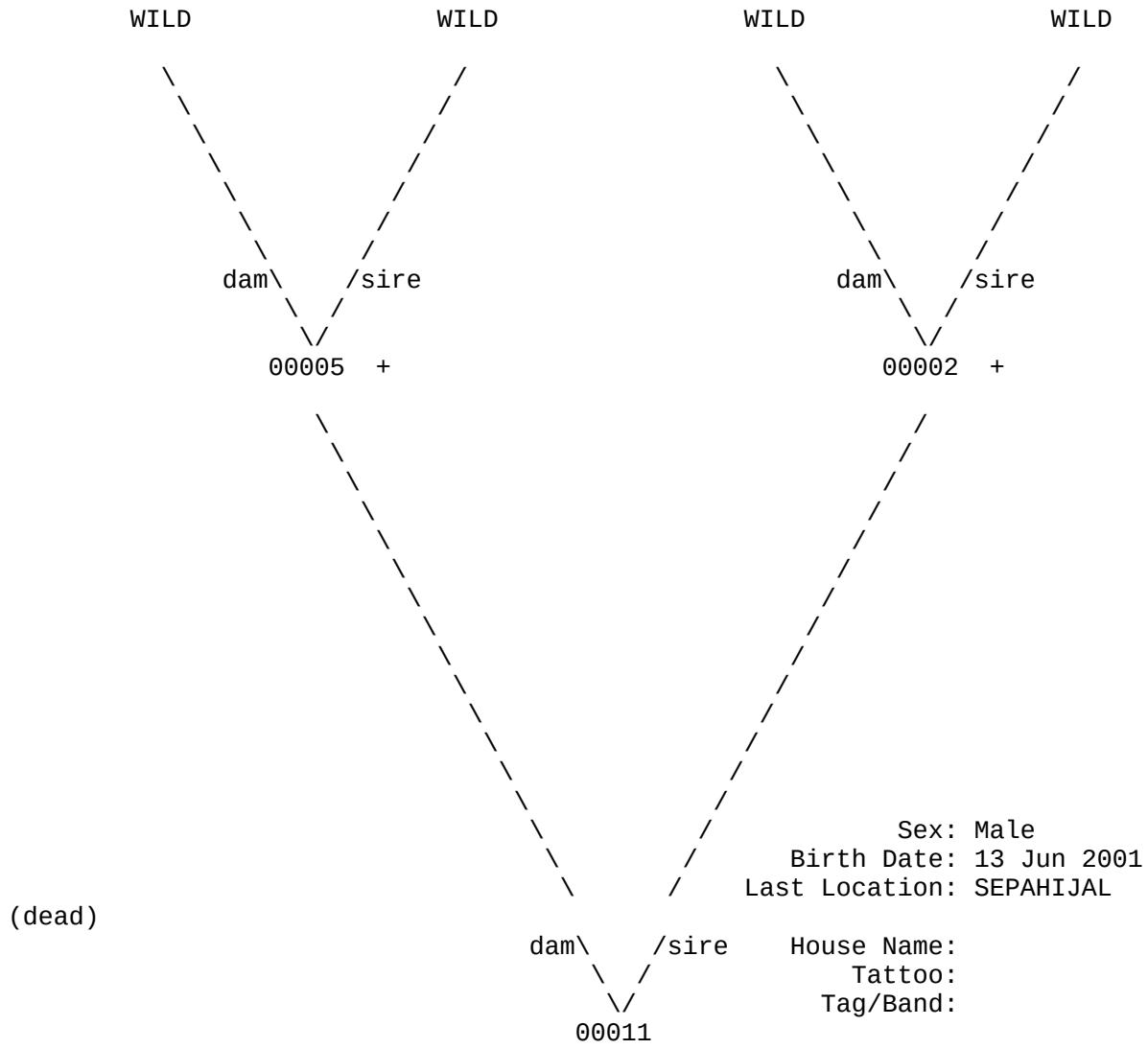
Studbook Number: 00010



Sex: Female
Birth Date: 13 Jun 2001
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

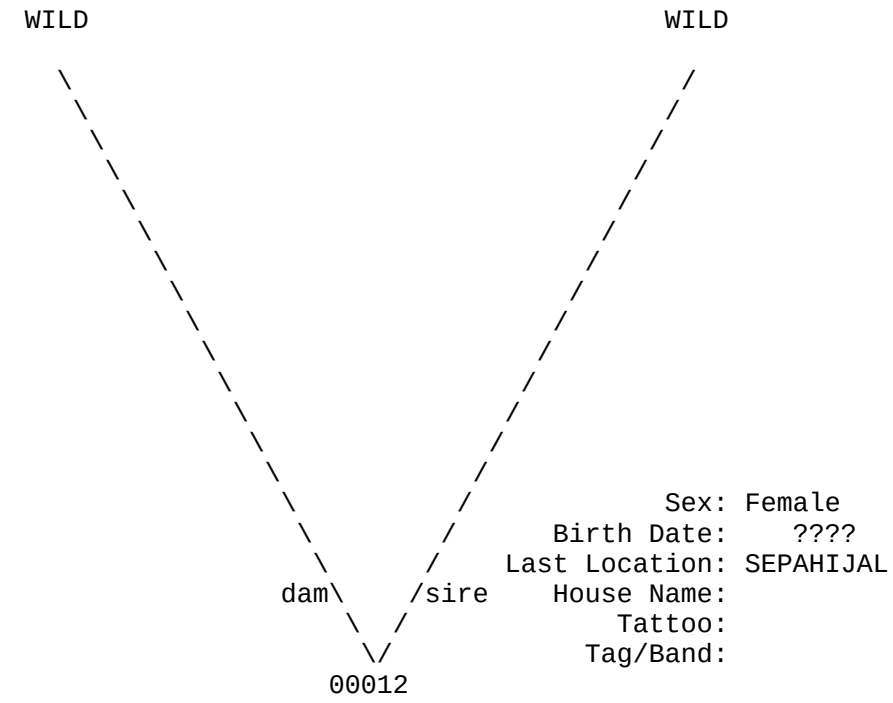
Studbook Number: 00011



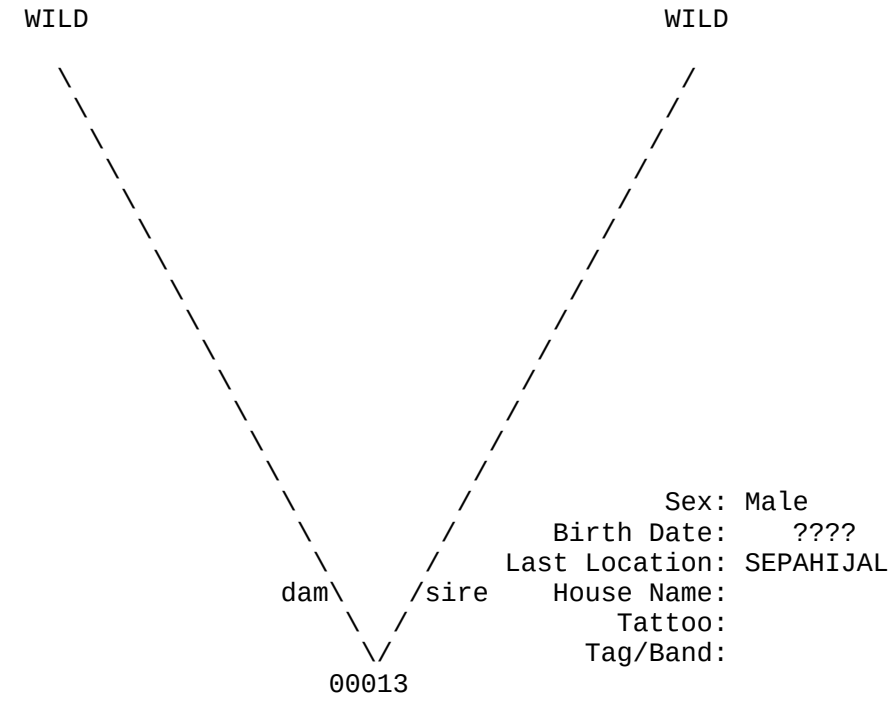
Sex: Male
Birth Date: 13 Jun 2001
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

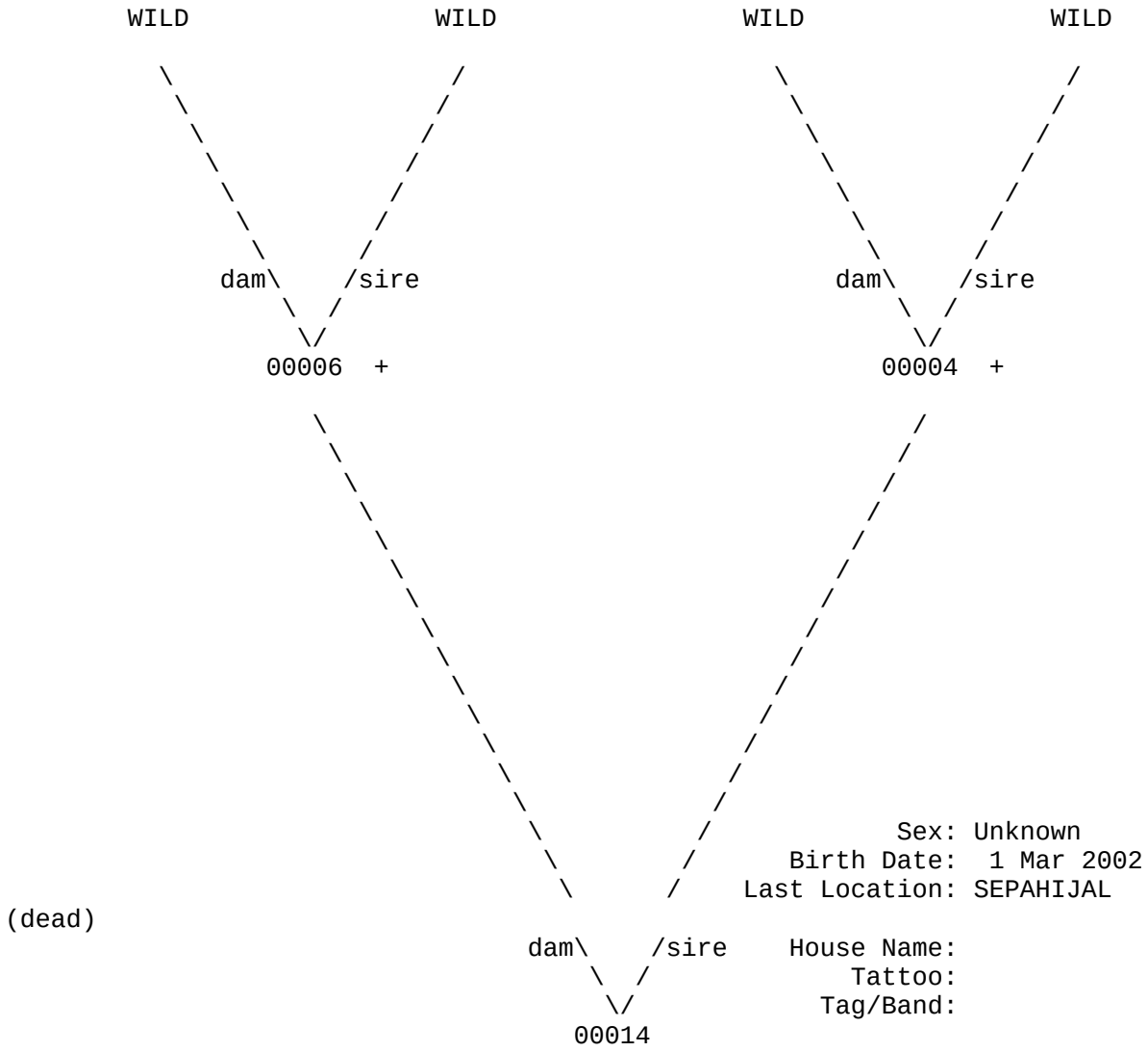
Studbook Number: 00012



Studbook Number: 00013



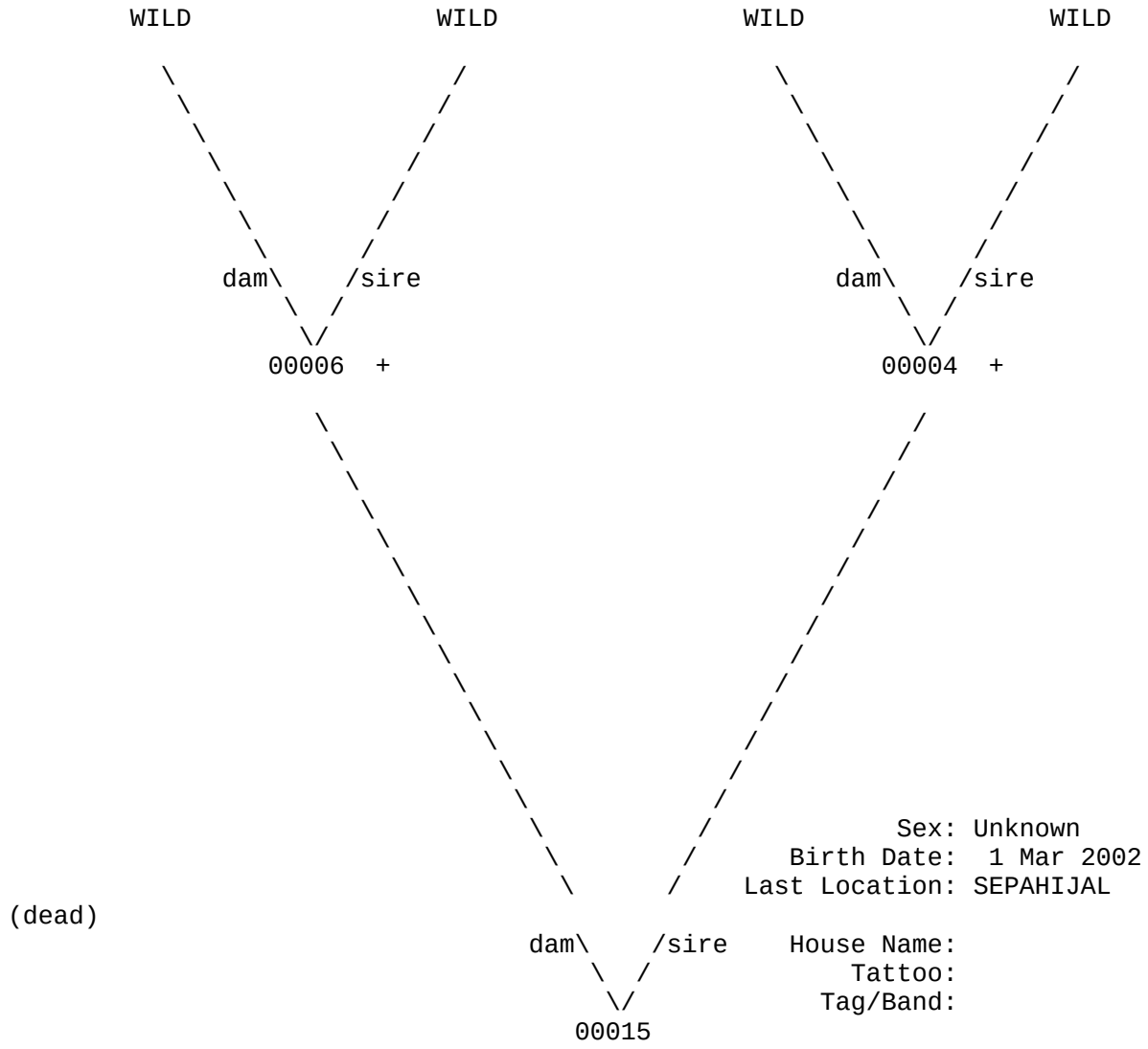
Studbook Number: 00014



Sex: Unknown
Birth Date: 1 Mar 2002
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

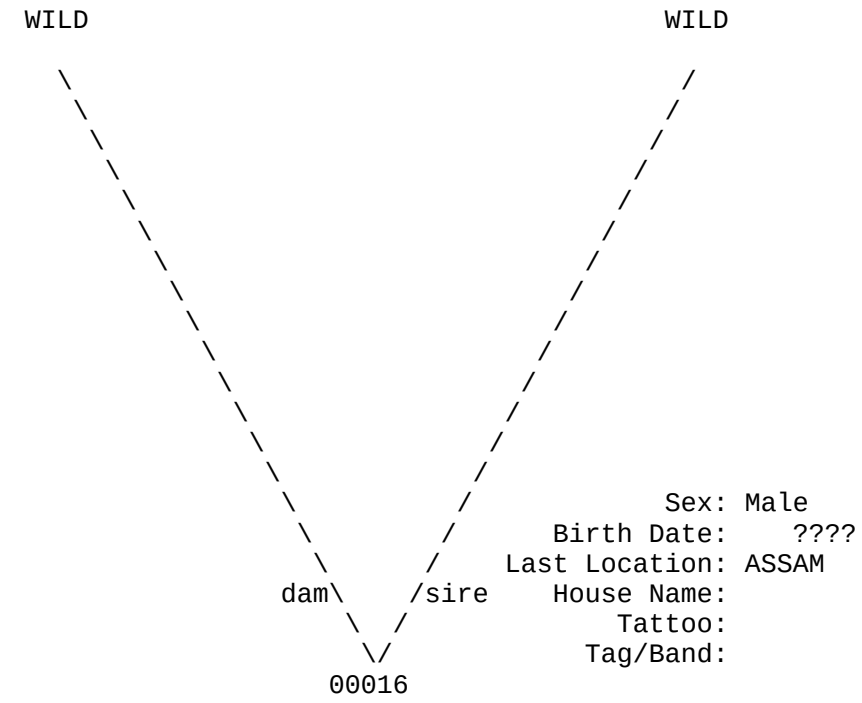
Studbook Number: 00015



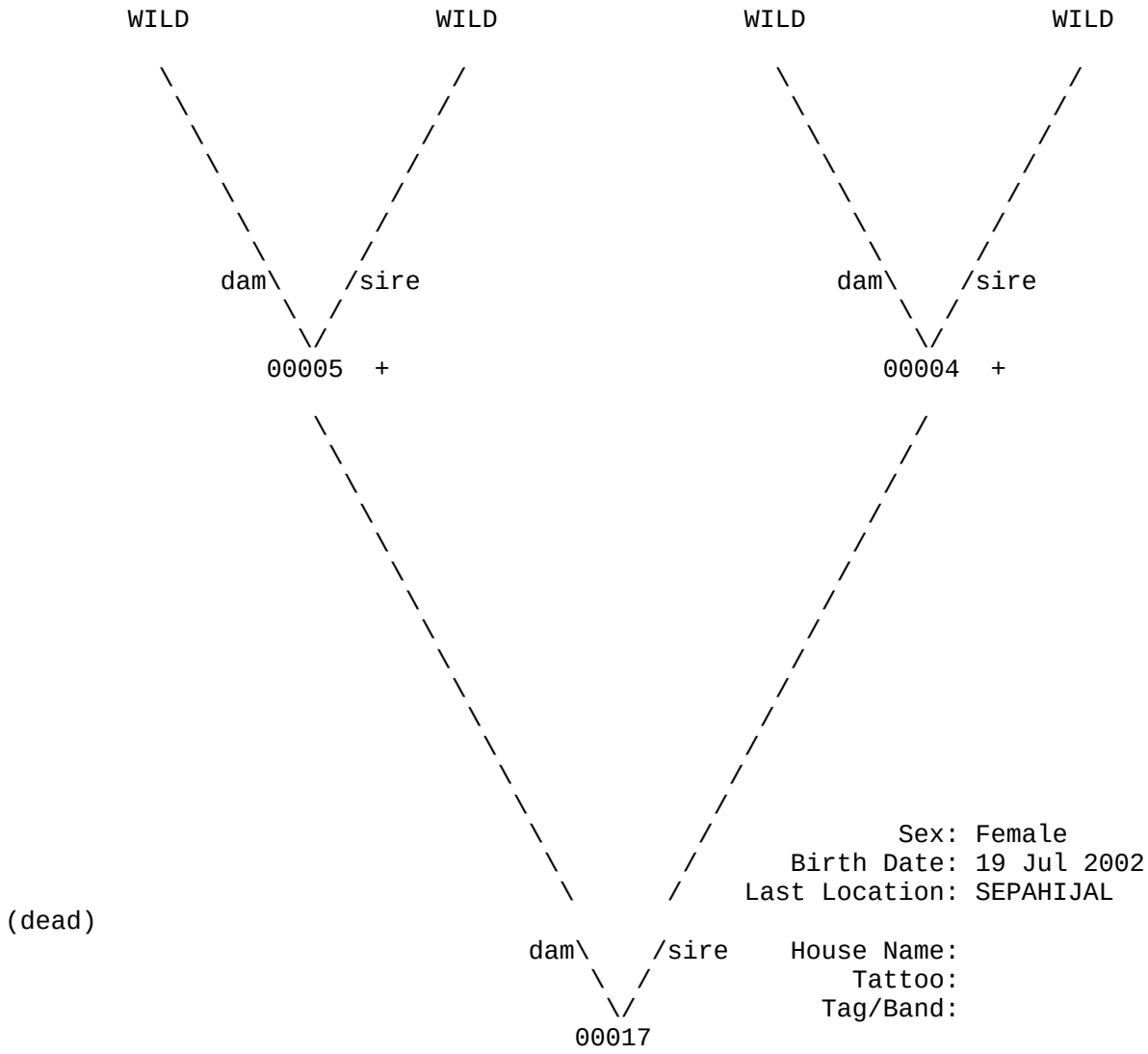
Sex: Unknown
Birth Date: 1 Mar 2002
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

Studbook Number: 00016



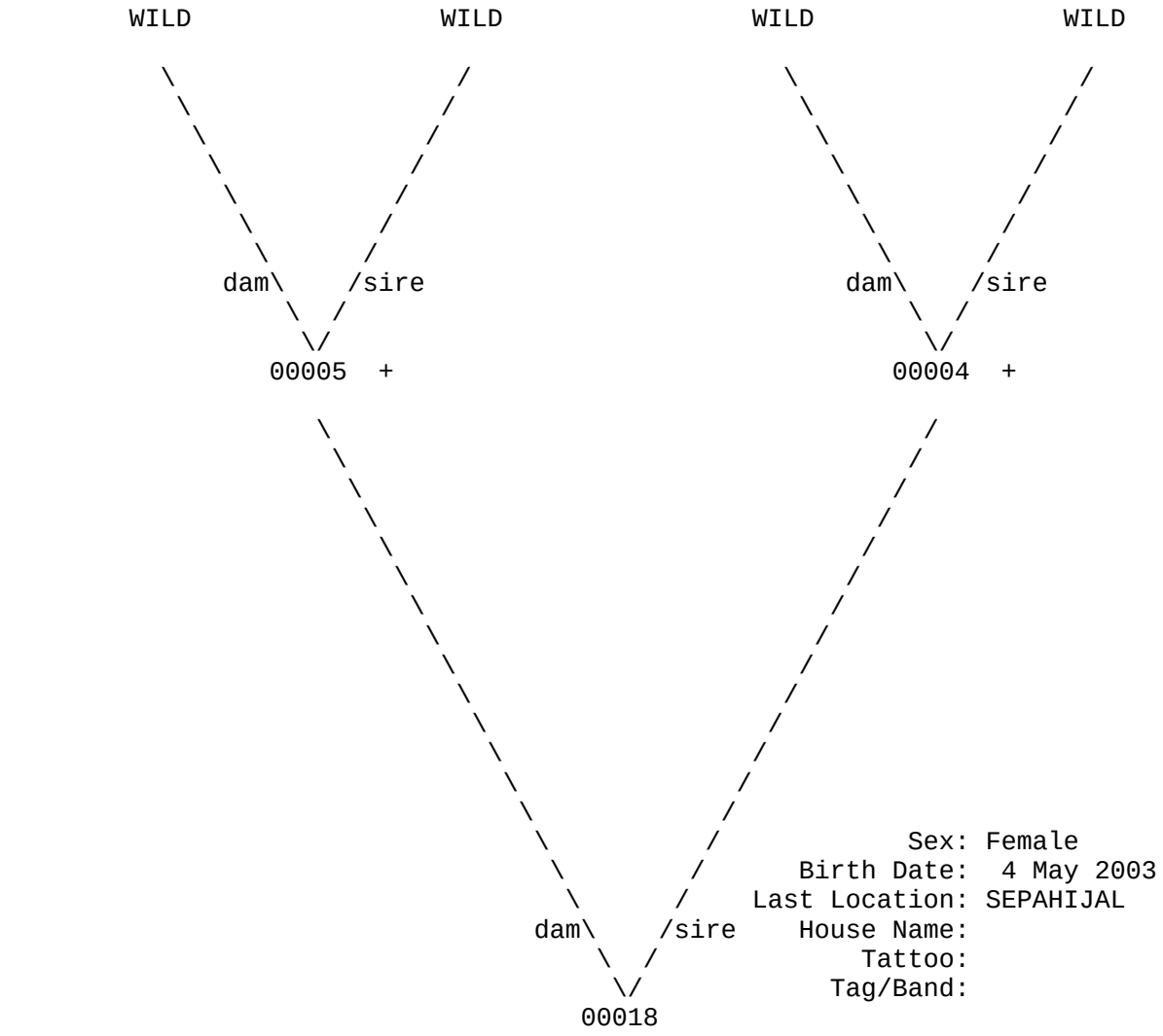
Studbook Number: 00017



Sex: Female
Birth Date: 19 Jul 2002
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

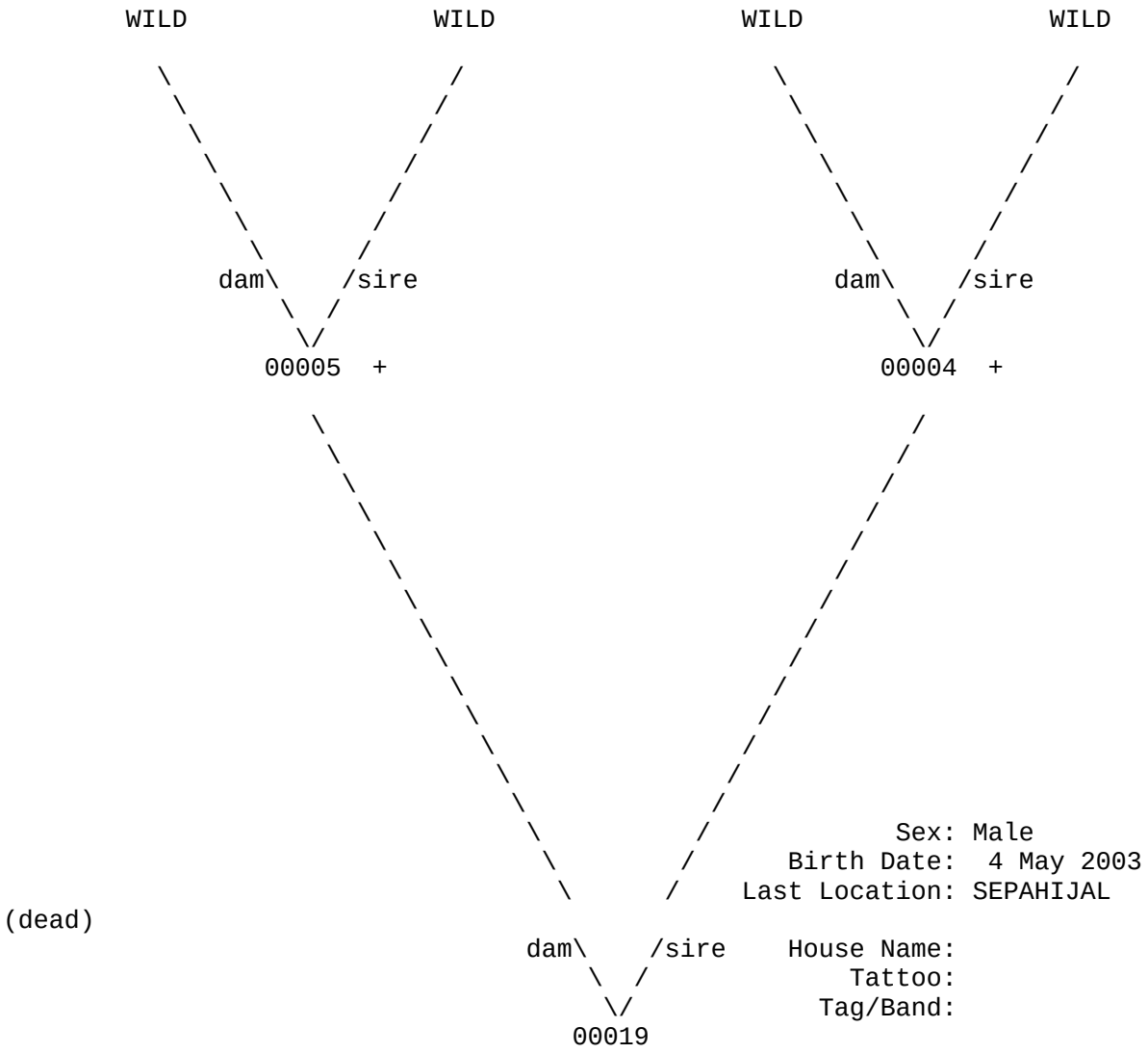
+ Wild-caught...

Studbook Number: 00018



+ Wild-caught...

Studbook Number: 00019

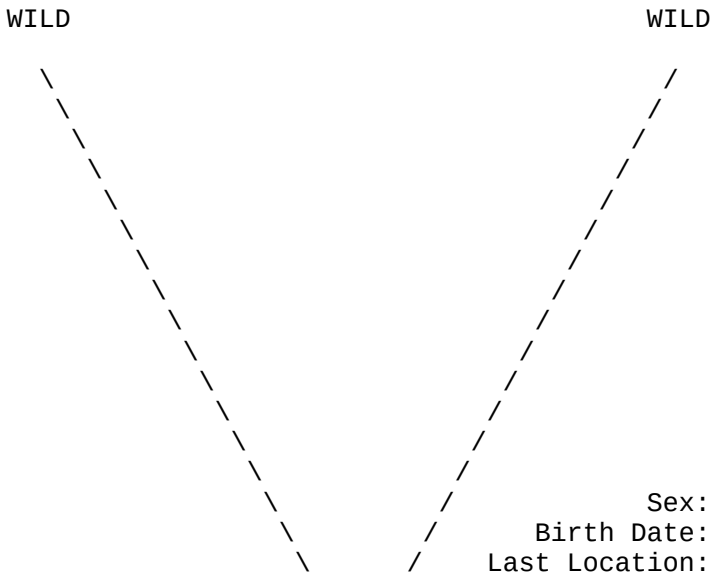


+ Wild-caught...

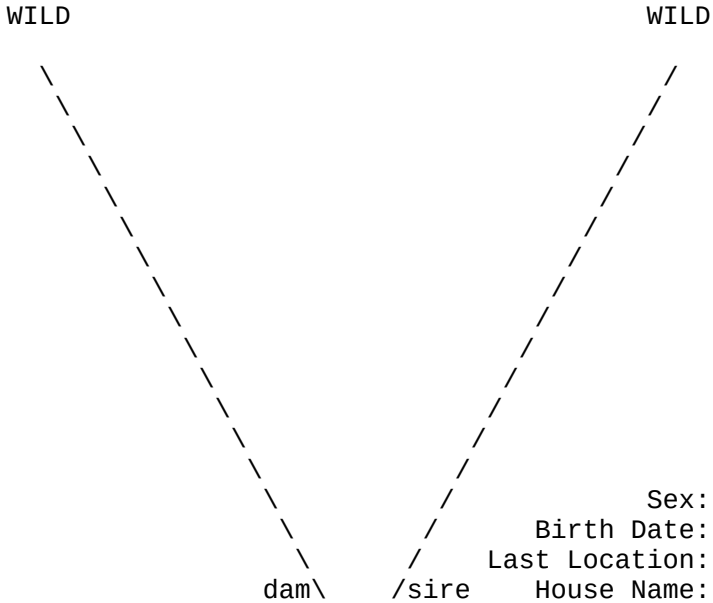
Studbook Number: 00020

+ Wild-caught...

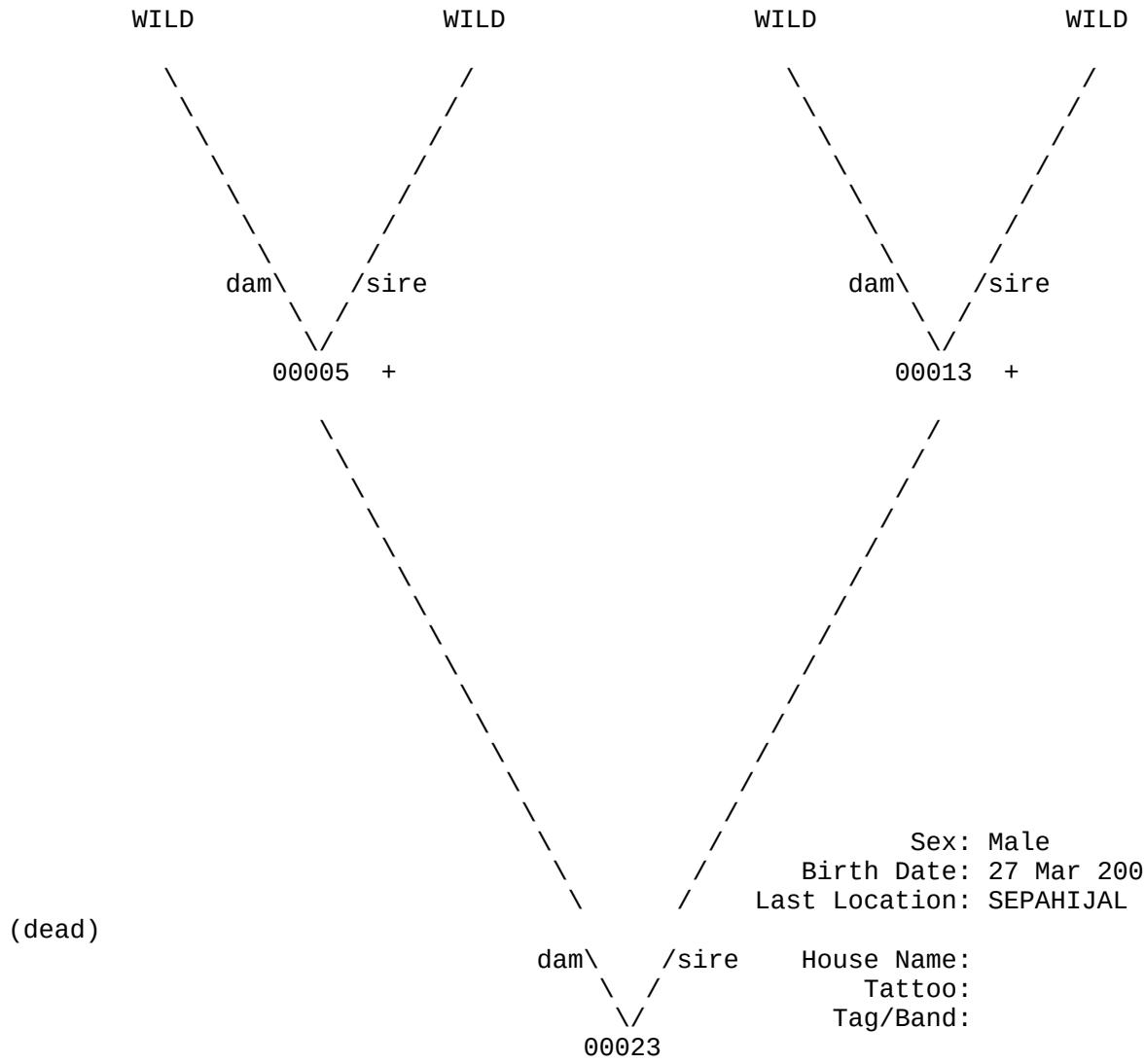
Studbook Number: 00021



Studbook Number: 00022



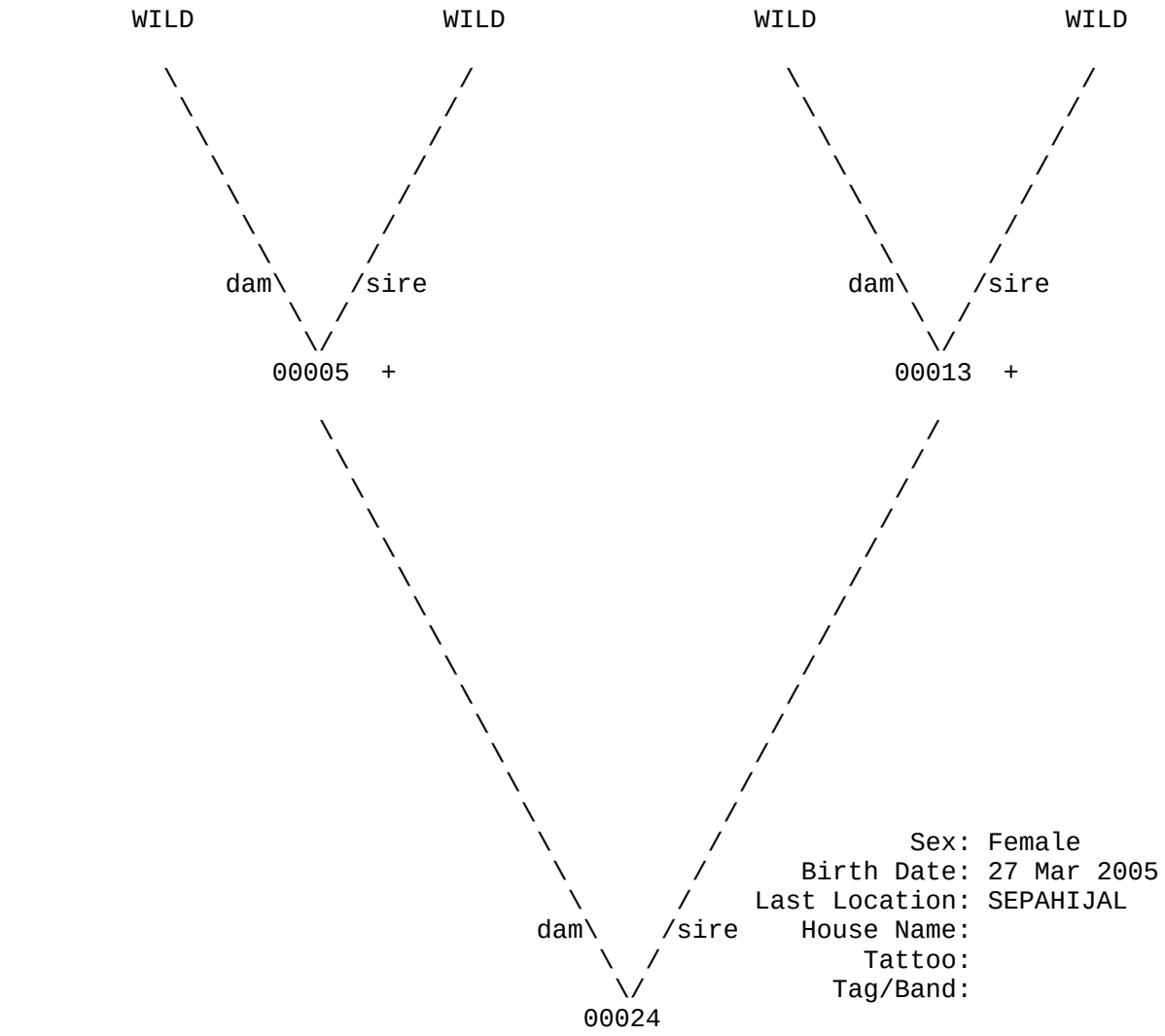
Studbook Number: 00023



Sex: Male
Birth Date: 27 Mar 2005
Last Location: SEPAHIJAL
(dead)
House Name:
Tattoo:
Tag/Band:

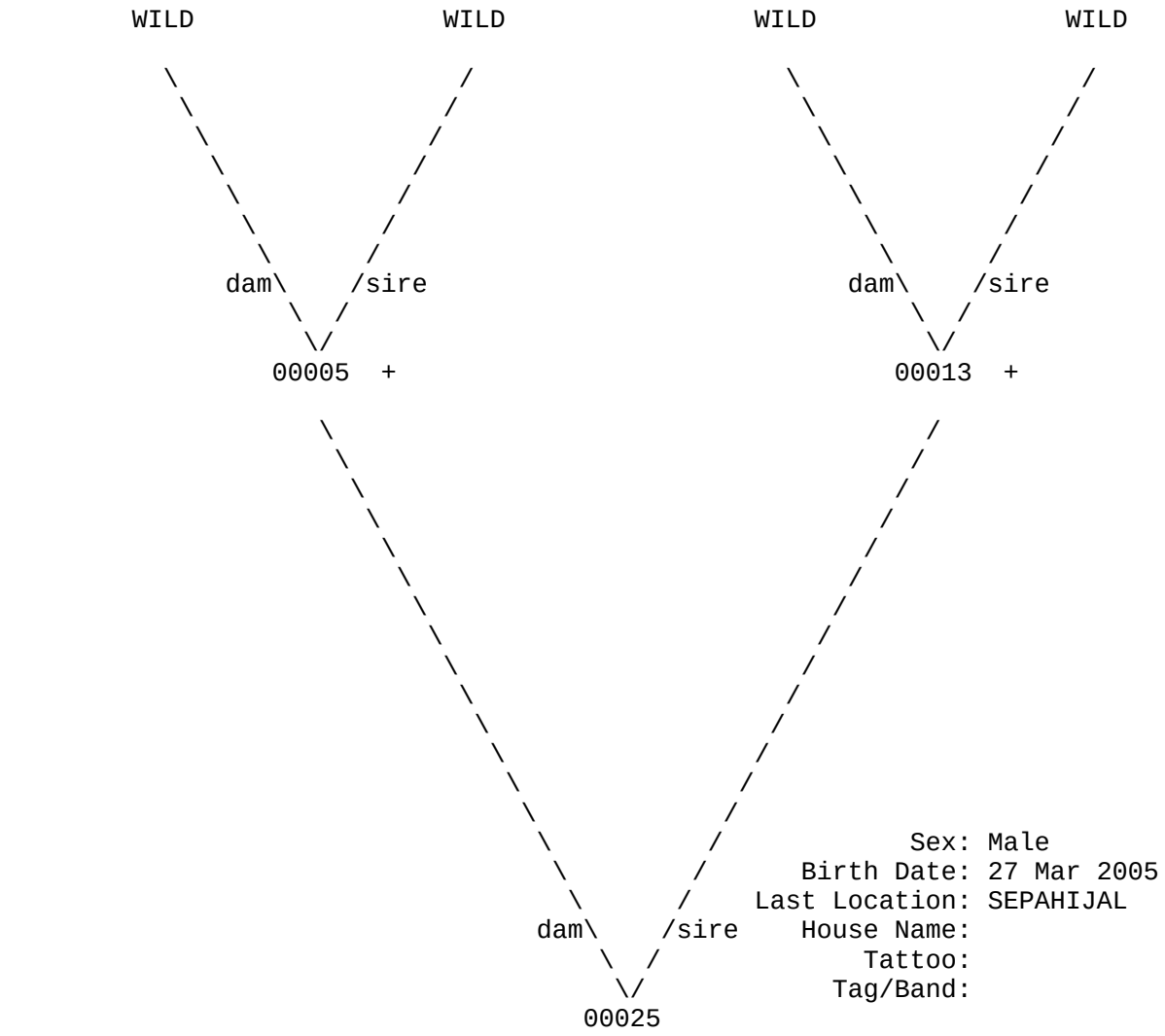
+ Wild-caught...

Studbook Number: 00024



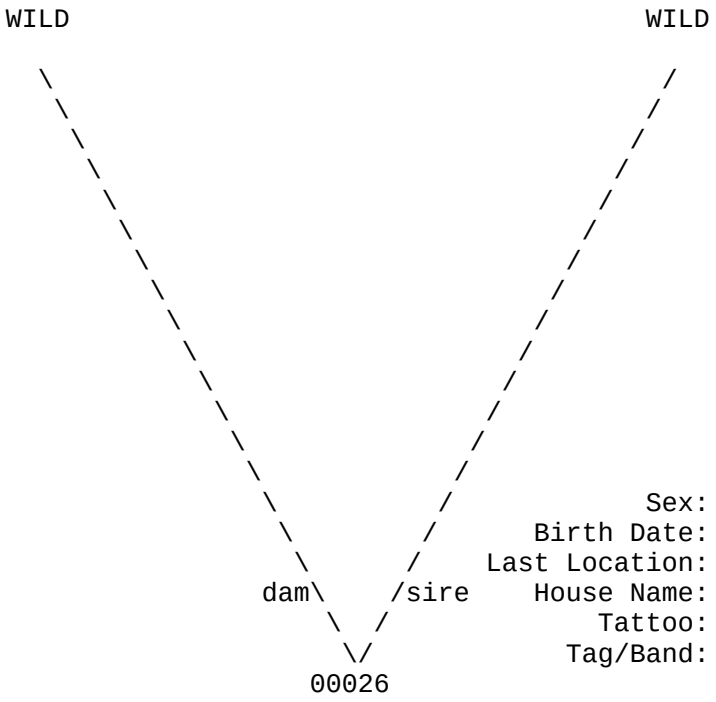
+ Wild-caught...

Studbook Number: 00025

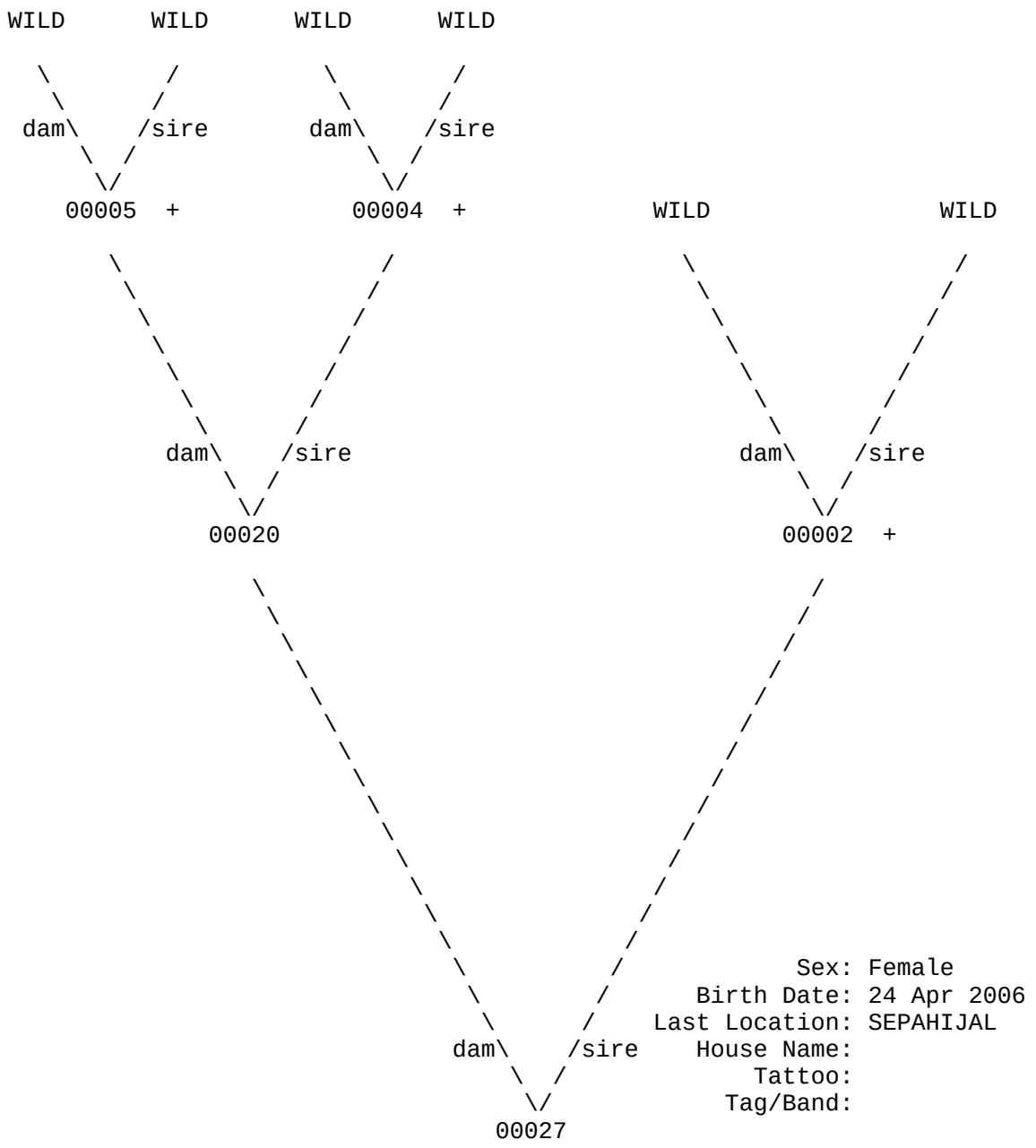


+ Wild-caught...

Taxon Name: NEOFELIS NEBULOSA Studbook Number: 00026

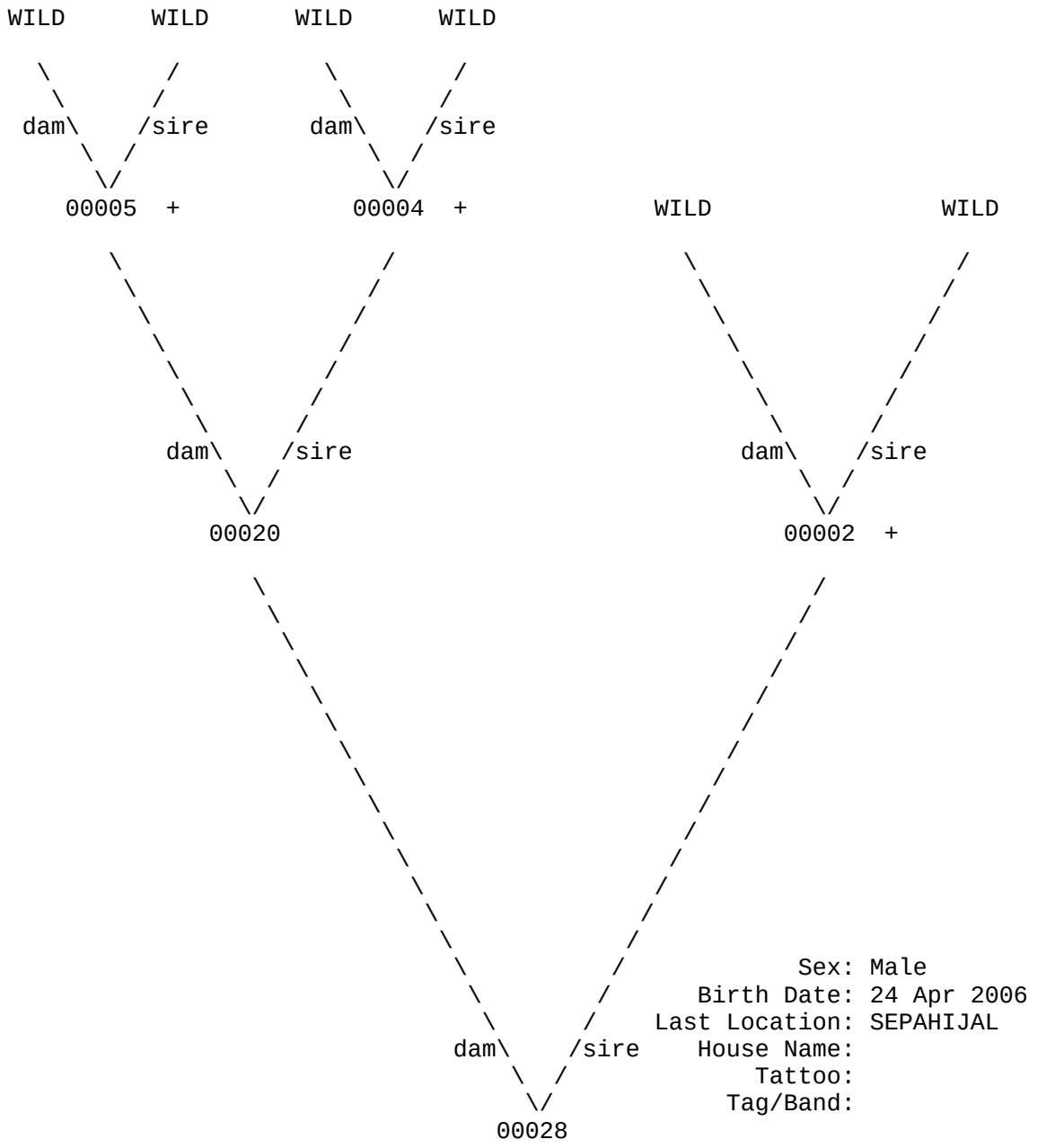


Studbook Number: 00027



\+ Wild-caught...

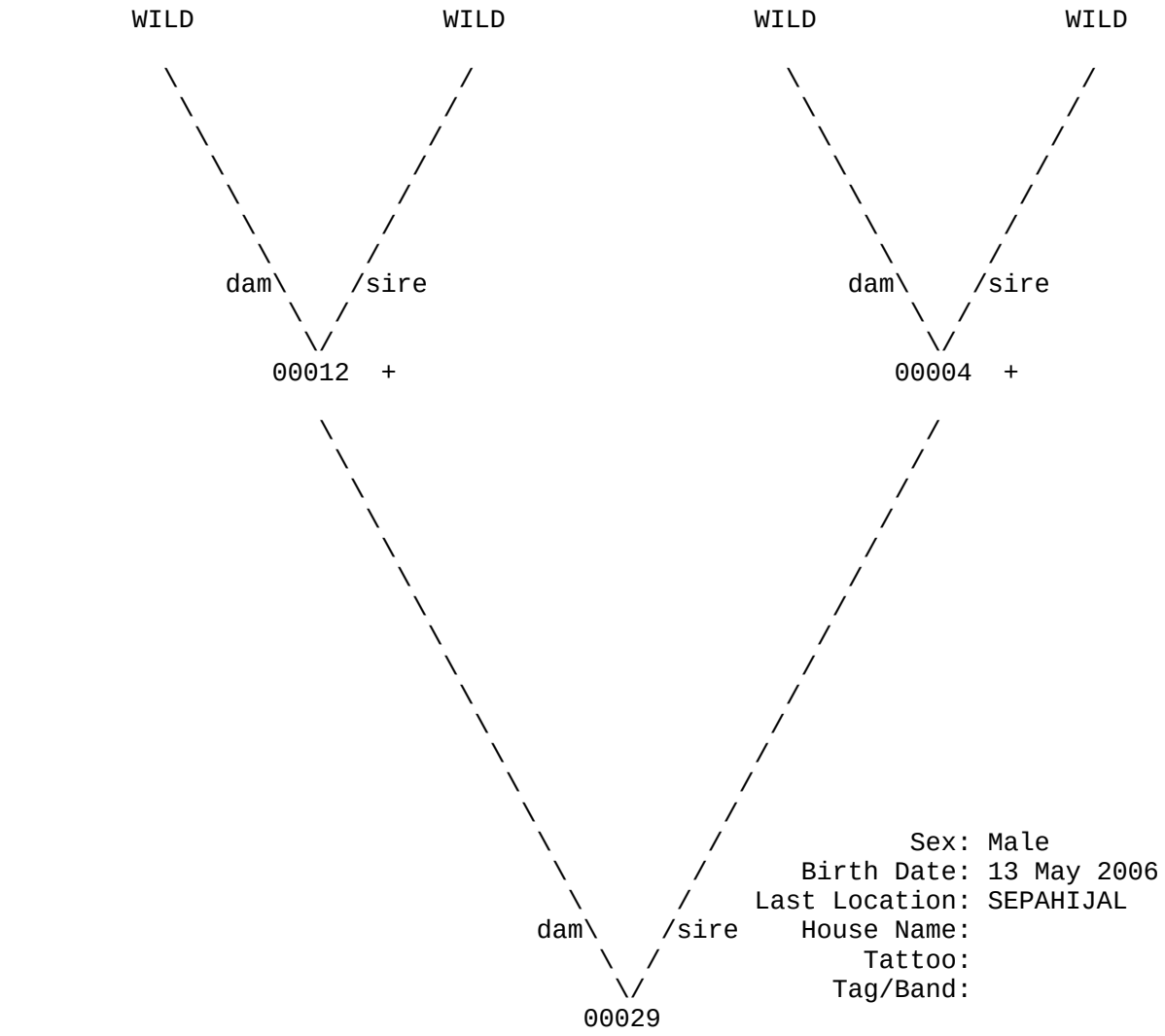
Studbook Number: 00028



Sex: Male
Birth Date: 24 Apr 2006
Last Location: SEPAHIJAL
House Name:
Tattoo:
Tag/Band:

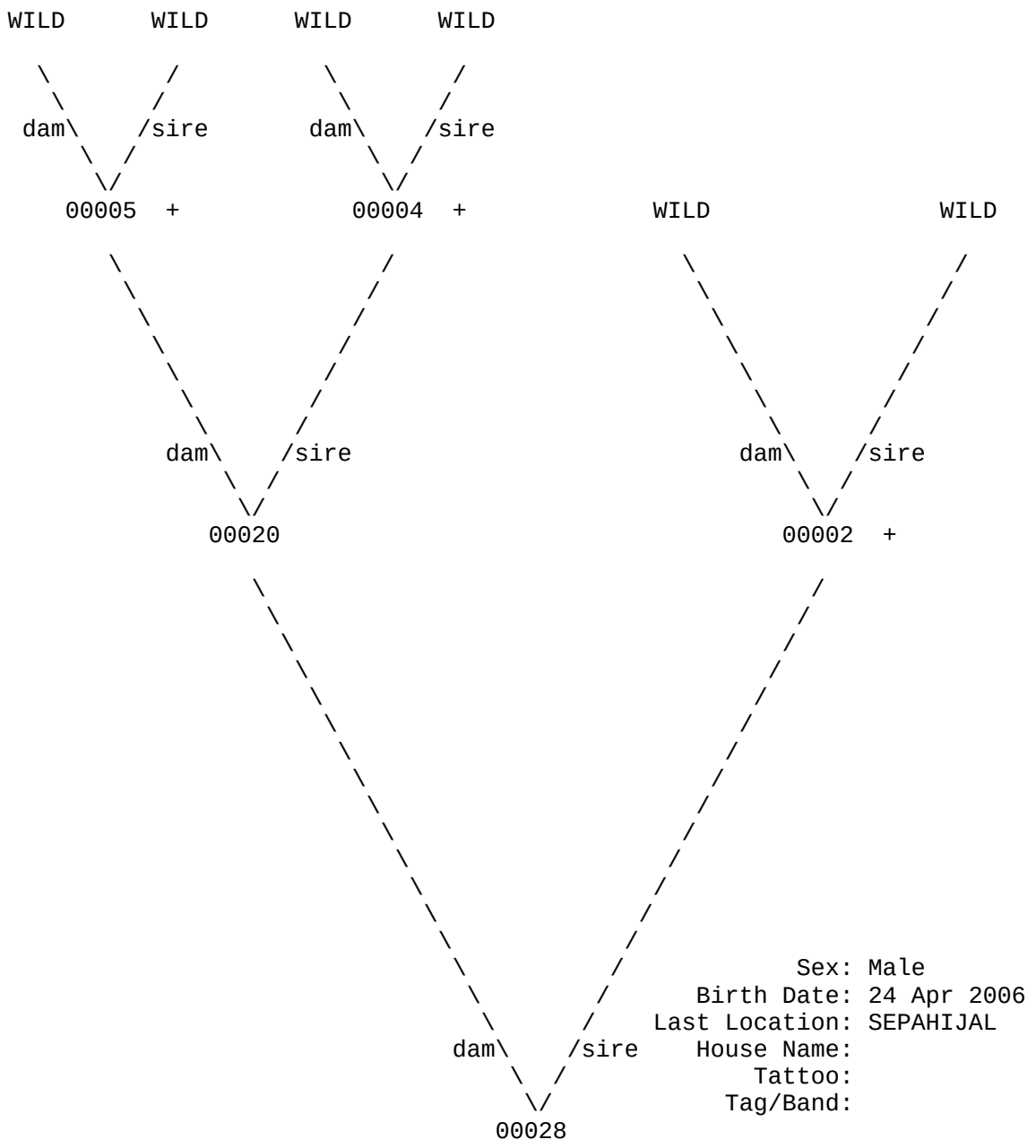
+ Wild-caught...

Studbook Number: 00029



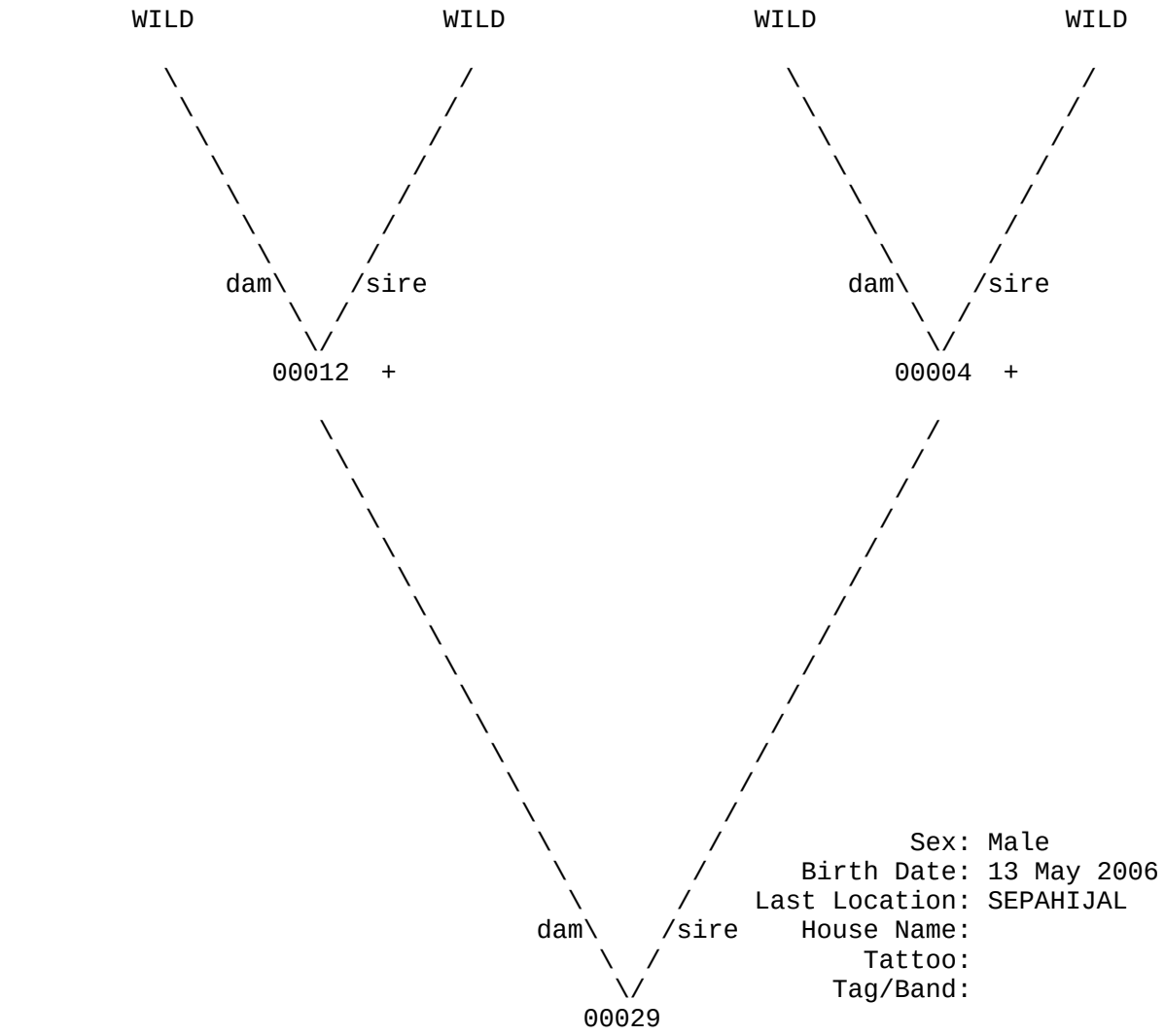
+ Wild-caught...

Studbook Number: 00028



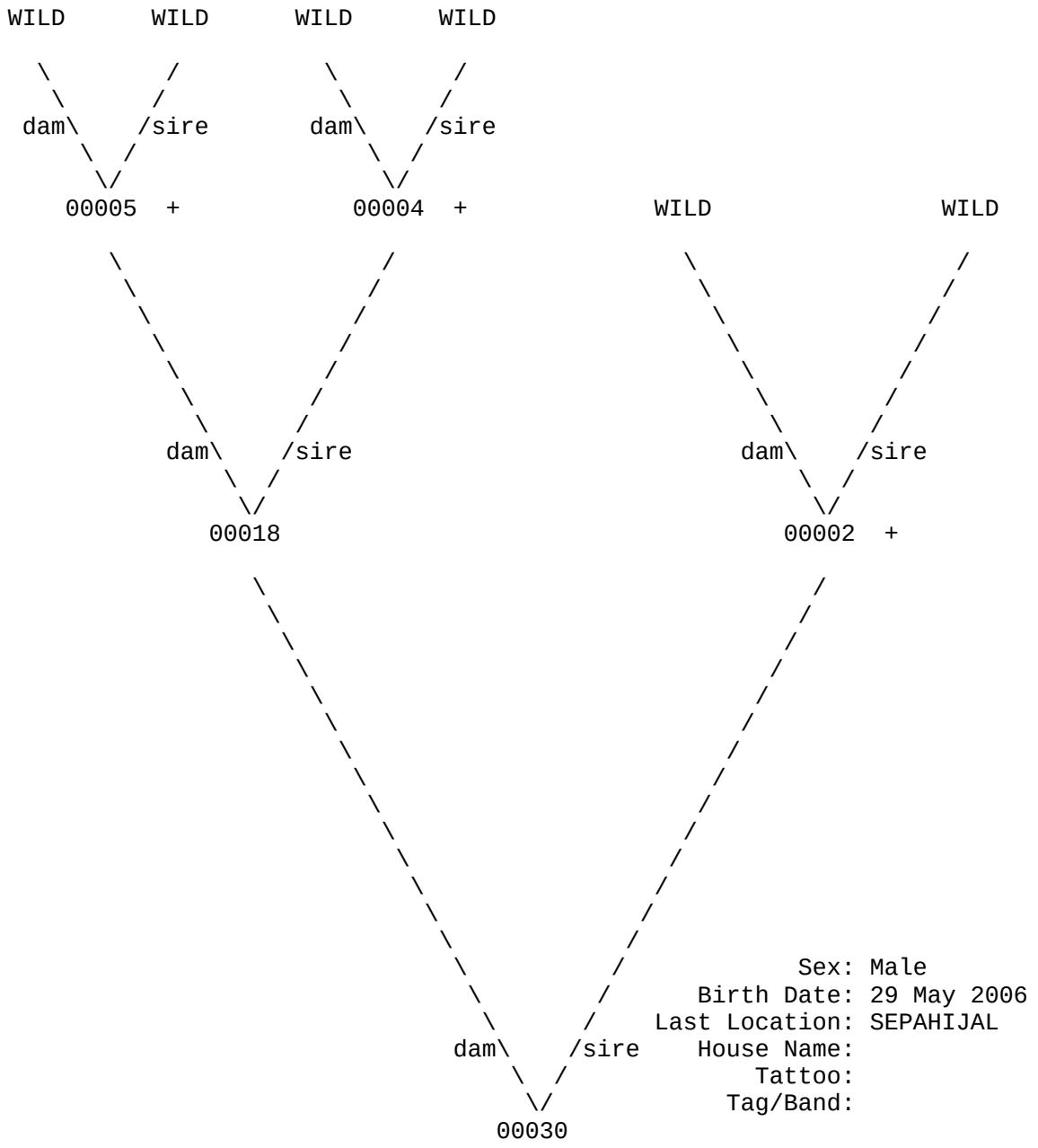
\+ Wild-caught...

Studbook Number: 00029



+ Wild-caught...

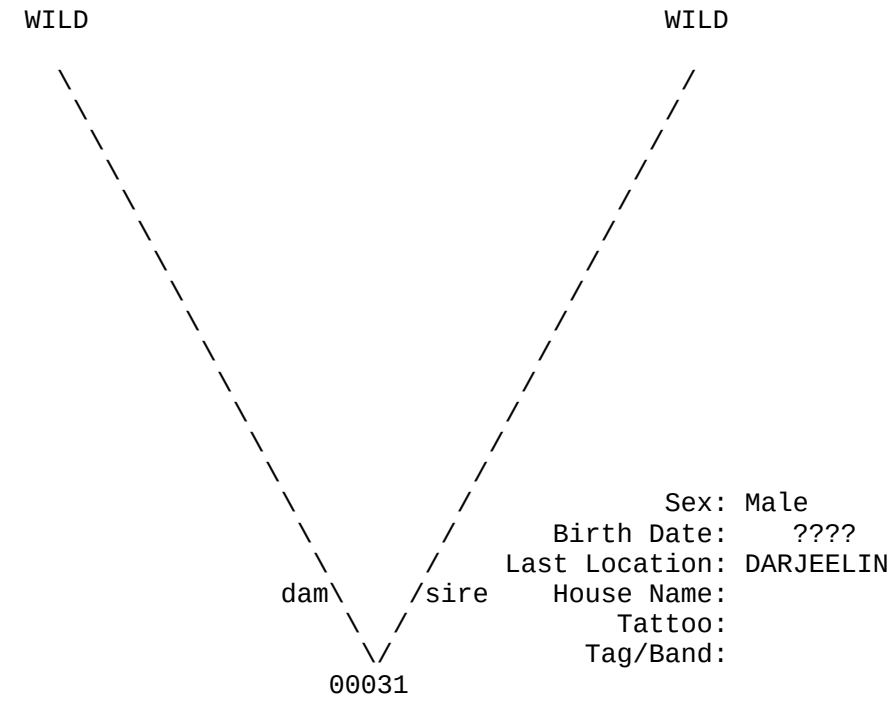
Studbook Number: 00030



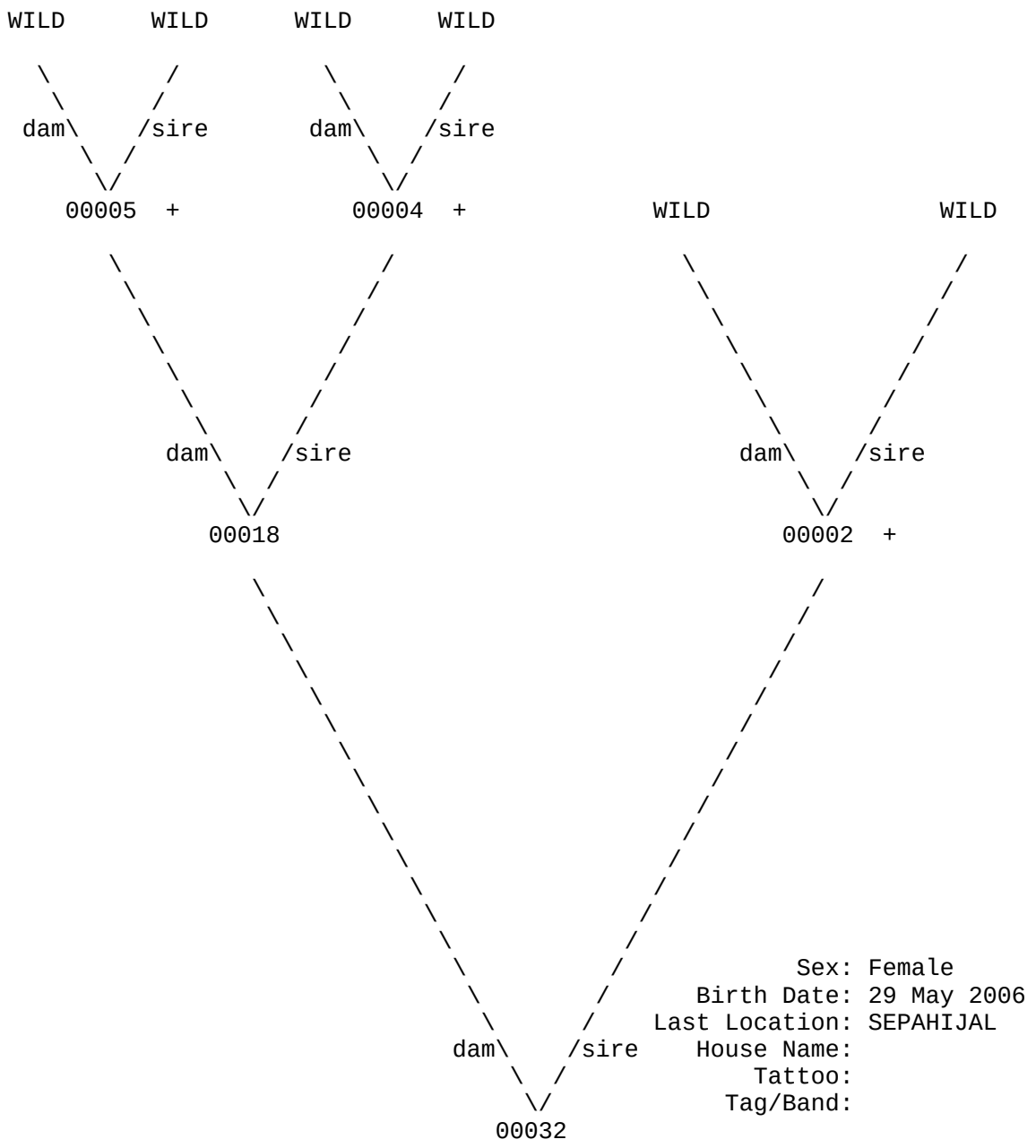
Sex: Male
Birth Date: 29 May 2006
Last Location: SEPAHIJAL
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

Studbook Number: 00031



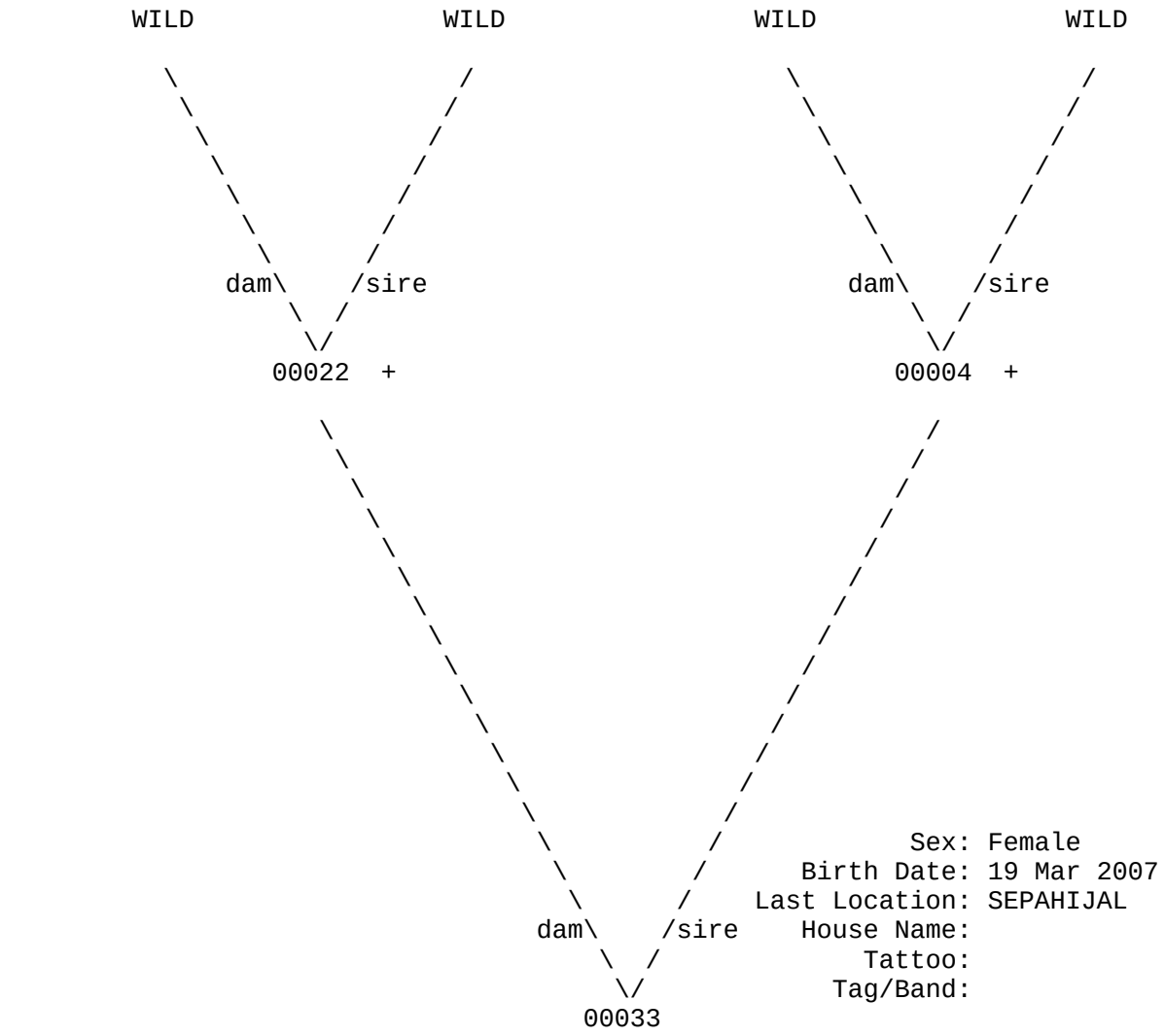
Studbook Number: 00032



Sex: Female
Birth Date: 29 May 2006
Last Location: SEPAHIJAL
House Name:
Tattoo:
Tag/Band:

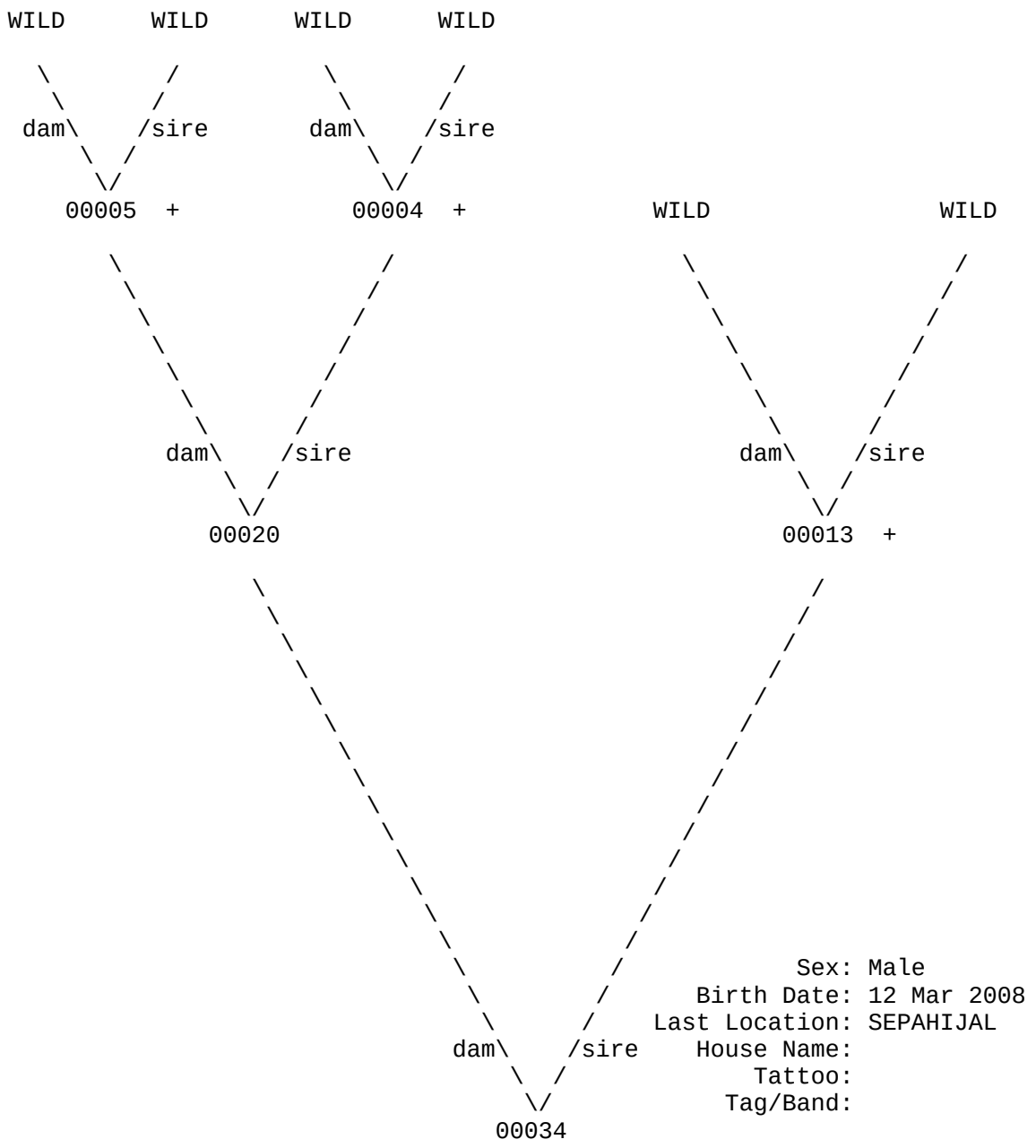
+ Wild-caught...

Studbook Number: 00033



+ Wild-caught...

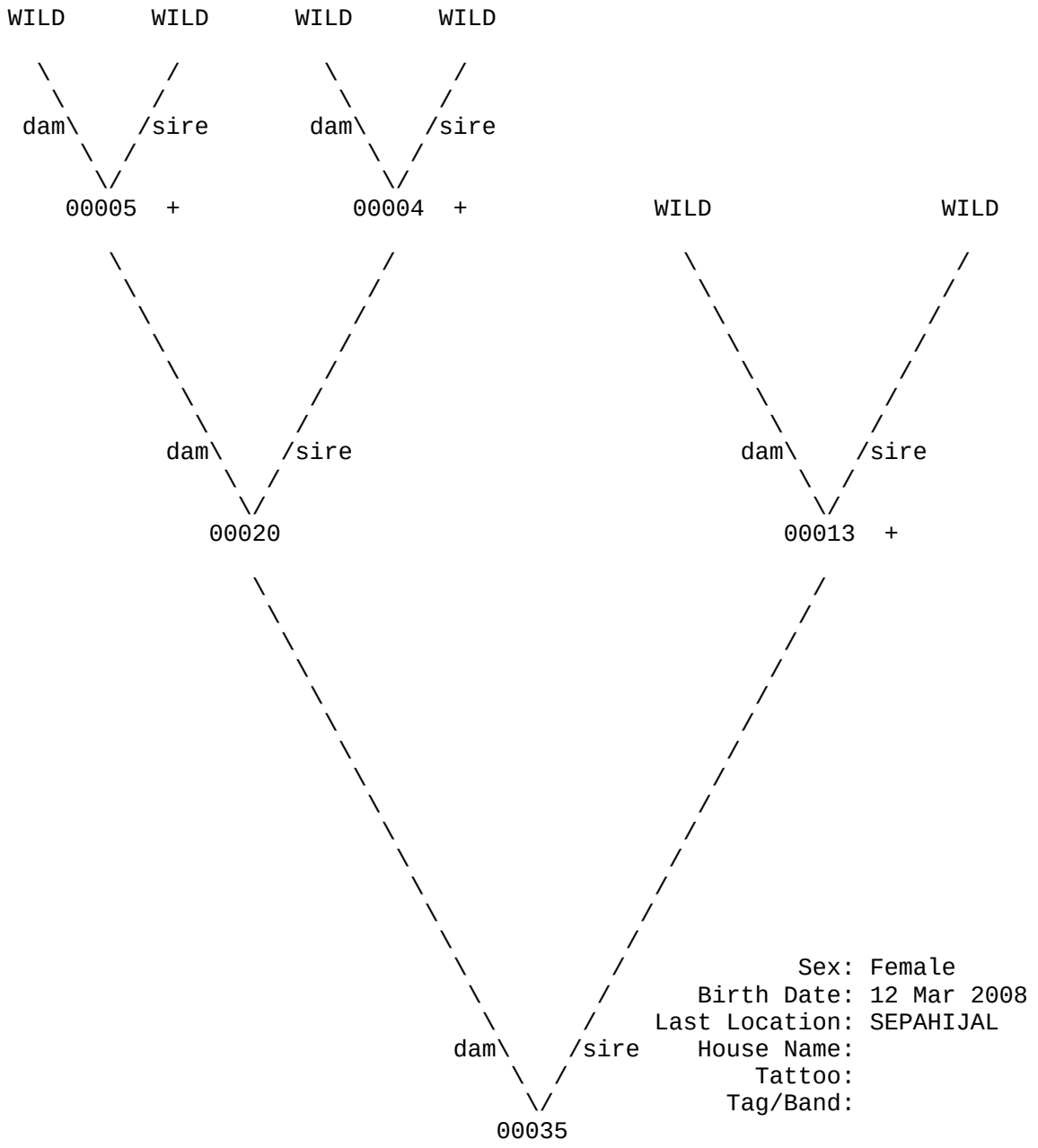
Studbook Number: 00034



Sex: Male
Birth Date: 12 Mar 2008
Last Location: SEPAHIJAL
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

Studbook Number: 00035



Sex: Female
Birth Date: 12 Mar 2008
Last Location: SEPAHIJAL
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

Studbook Number: 00036