National Studbook of Asiatic Wild Dog (*Cuon alpinus*)

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority

June, 2010

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Studbook compiled and analyzed by

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Cover Photo: Kalyan Varma

Srivastav, A. and Nigam. P. 2010. National Studbook of Asiatic wild dog (*Cuon alpinus*). 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 *Cuon alpinus* .(Asiatic wild dog)

We are thankful to Shri B. S. Bonal, 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 Asiatic wild dog is gratefully acknowledged in compilation of the studbook data.

Nehru Zoological Park, Hyderabad
Arignar Anna Zool. Park, Chennai
Sri Chamarajendra Zoological Garden, Mysore
Sri Venkateswara Zoological Park, Tirupati
Indira Gandhi Zoological Park, Visakapatnam

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

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

Authors

Contents

Wild Dog: Biology and status

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Carnivore
Family	Canidae
Scientific Name	***Cuon alpinus***
Species Authority	***(Pallas,1811)***
Common Names	Dhole, Asiatic wild dog, Indian wild dog, Red dog, Ban kutta ,

Taxonomy of wild dog

Simpson (1945) placed the dhole in the subfamily Simocyoninae of the family Canidae, together with the African wild dog (*Lycaon pictus*) and the bush dog (*Speothos venaticus*) of South America on the basis of shared anatomical features. However, Simpson's classification has been widely debated as similarities in anatomical features considered may be attributed to convergent evolution. The genus Cuon is, more closely related to the extant jackals than to wolves (Thenius 1954). Clutton-Brock et al. (1976) further strengthened Thenius's view by analysing morphological, ecological and behavioural characteristics across 39 canid species. They found that *Cuon* was more similar to *Canis*, *Dusicyon* and even *Alopex*, than to *Speothos* or *Lycaon*. However, Cuon resembles *Speothos* and *Lycaon* only when skull and dental characters were considered. Further evidence of the taxonomic distinctiveness between *Speothos*, *Cuon* and *Lycaon* comes from analysis of sequences from mitochondrial genes (Wayne et al. 1997); both *Lycaon* and *Cuon* were classified as Canis-like canids and *Speothos* within a clade with another South American canid, the maned wolf (*Chrysocyon brachyrus*). According to Ginsberg and Macdonald (1990), there are 11 subspecies of wild dogs however, the validity of many of these forms is doubtful (L.S. Durbin, *et.al.* 2008)

Habitat

The dhole inhabits a wide variety of vegetation types, including: primary, secondary and degraded forms of tropical dry and moist deciduous forest; evergreen and semi-evergreen forests; dry thorn forests; grassland–scrub– forest mosaics; and alpine

steppe (above 3,000m a.s.l.). In India, tropical dry and moist deciduous forest are considered to represent optimal habitats and believed to hold the largest dhole populations. Ungulate biomass particularly that of cervid species, is also highest in these vegetation types. Important factors that are thought to regulate habitat selection are; the availability of prey species, water, the presence of other large carnivore species, human population levels, and suitability of breeding sites.

Dholes prefer open patches surrounded by forests. They mainly hunt vertebrate prey, preferring medium to large ungulates. Dholes occasionally eat carrion and scavenge. Their diet consists of goat, sheep, monkey, deer, rodents, wild berries, wild pigs, lizards, and insects.

Biology

The maximum life span of a dhole is approximately 16 years. The adult dhole has a rusty red coat with a pale underside depending upon the region; colour may vary from light brownish grey to red uniform coat. The bushy tails are darker or black in colour. The body weight of adults ranges from 17 to 21 Kg. Each litter comprises of 2 – 6 pups with 2 being the average. The males and females reach sexual maturity by one and a half years. However, because of behavioural reasons 3 years is the minimum age of reproduction for females and for males it can be much higher or never depending on the individuals position in the social hierarchy. Females are polyestrous with a cycle of 4 – 6 weeks. Mating activity is initiated in November and continues till April with a peak during December and January. Pups are born after a gestation period of 60 – 62 days.

Behaviour

Dholes usually live in packs of 5–10 individuals, but packs of 30 or even more animals have been recorded. The pack or some members (usually 10 or less) associate to hunt. When prey availability is scarce, dholes may also hunt alone or in pairs, taking smaller prey. Observations by Johnsingh (1983) and Venkataraman *et al.* (1995), suggest that packs contained significantly more males than females, perhaps a reflection of female-biased dispersal (Venkataraman 1998). Pack members regularly play together,

engaging in mock-fights, rolling, and allo-grooming. Social rank is established by pushing and holding, but rarely by aggressive biting. Groups have a strong hierarchical structure, with a dominant male and female who are the main, or sole, breeders. Pack members over-mark each other's faeces and urine, producing latrines throughout the group's range. Latrines may serve intra-group communicative functions (e.g., relaying information about hierarchical or sexual status) as well as territorial ones. The ranges (or at least core areas) of neighbouring packs are often quite separate (Johnsingh 1982; Venkataraman *et al.* 1995; L. Durbin unpubl.), though interactions between groups can be either friendly or hostile.

Dholes have a broad and unusual vocal repertoire that includes whines, mews, and squeaks (Fox 1984). Growls, growl-barks, chattering calls, and screams are used as alarms to alert other pack-mates to danger (Johnsingh 1982).

Reproduction and denning behaviour

The dominant pair engages in vigorous play and marking, culminating in a copulatory tie (Davidar 1973; Paulraj *et al.* 1992). Usually only the dominant female breeds, but exceptions have also been recorded. Lone females breeding outside the group have been recorded by Johnsingh (1979); however, the success in extra pack rearing is poor. Sneak copulations by subordinate males have also been observed. Pups are dependent on their mothers for the first three weeks thereafter the pack members start feeding them regurgitated meat. Weaning takes place by 6 – 7 weeks of age with a switch to a fully solid diet. All the pack members take part in guarding, feeding and grooming the pups. The pups start accompanying the pack in hunts by 3 months of age. Dens range from earthen burrows to rocky caverns.

Distribution

Formerly the species was present across most of South, East, and Southeast Asia. Extending from the Tian-Shan and Altai mountains and the Maritime Province of the former USSR southwards through Mongolia, Korea, China, Tibet, Nepal, India, and south-eastwards into Myanmar, Cambodia, Vietnam, Laos, Thailand, the Malaysian peninsula, and the Indonesian islands of Sumatra and Java.

In recent times their range has been restricted; they are now found in parts of south China, Tibet, Ladakh in India, throughout most of India south of the Gangetic river basin, north-east India, Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Kazakhstan; Kyrgyzstan; Malaysia; Mongolia; Myanmar; Nepal; Russian Federation; Tajikistan; Thailand; Vietnam.

The distribution range of the species is presented in figure 1.

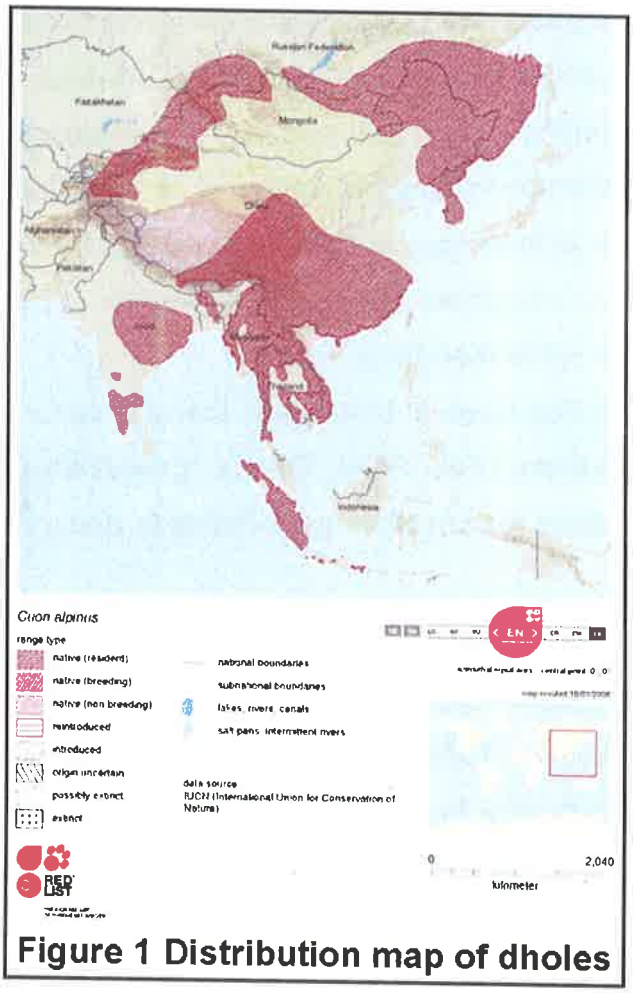

Figure 1 Distribution map of dholes

Threats

The species is threatened by habitat loss and degradation of forest tracts resulting in loss of cover for dholes and disappearance of their prey species. Besides this, disease and pathogens of canids are the other major threats to dholes because of their susceptibility to diseases like mange, canine distemper, parvovirus, rabies, which have a negative impact on dhole populations.

Status

Due to various threats to the *Cuon alpinus* in wild, the species has been ranked as endangered [criterion (C2a(i))] in IUCN Red list of Threatened species, version 2010.1 and Schedule I of the Wild Life Protection Act; Govt. of India and also included in CITES Appendix II. They are also protected by legislation in most of its range countries.

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). The data collected was entered in SPARKS 1.5 and analyzed using SPARKS 1.5 and PM 2000.

Status in captivity in Indian zoos

The dhole population in Indian zoos owes its origin to wild caught founders. The present population of thirty-eight specimens consists of ten wild caught individuals and twenty-eight captive born individuals the census of the living population is summarized in table 1. Arignar Anna Zoological Park, Chennai has been successful in breeding the species in captive conditions. The location-wise listing of living dholes in captivity in Indian zoos is summarized in table 2, while table 3 summarizes the historical listing.

Table 1 Status of dholes in Indian zoos

Sl.No.	Zoo Name	Males	Females	Total
1.	Arignar Anna Zoological Park, Chennai	9	10	19
2.	Sri Chamarajendra Zoological Park, Mysore	2	2	4
3.	Sri. Venkateswara Zoological Park, Tirupati	2	2	4
4.	Indira Gandhi Zoological Park, Vishakapatnam	5	4	9
5.	Nehru Zoological Park, Hyderabad	0	2	2
	Total	18	20	38

Table 2 Location wise listing of live dhole in Indian zoos

Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
Arignar Anna Zoological Park, Chennai											
1.	Dhiviya	00012		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
2.	Vasantha	00013		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
3.	Gomathi	00014		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
4.	Sheela	00015		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
5.	Praveen	00016		Male	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
6.	Paulraj	00017		Male	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
7.	ZSB40	00021		Male	00016	00014	19-Aug-2006	Chennai	19-Aug-2006	Birth	
8.	ZSB41	00030		Male	00016	00014	22-Dec-2006	Chennai	22-Dec-2006	Birth	
9.	Kannan	00031		Male	00016	00015	22-Dec-2006	Chennai	22-Dec-2006	Birth	
10.	AAZP47	00032		Male	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
11.	AAZP48	00033		Male	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
12.	AAZP49	00034		Female	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
13.	AAZP50	00035		Female	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
14.	AAZP53	00036		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
15.	AAZP51	00037		Male	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
16.	AA;ZP52	00038		Male	00016	00014	6-Jan-	Chennai	6-Jan-2008	Birth	

Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
							2008				
17.	AAZP54	00039		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
18.	AAZP55	00040		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
19.	AAZP56	00041		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
9.10.0(19)											
Nehru Zoological Park, Hyderabad											
20.	Anju 0006B725C4	00011		Female	00002	00003	28-Dec-2003	Chennai Hyderabad	28-Dec-2003 11-Sep-2007	Birth Transfer	
21.	Akita 0006B715F0	00019		Female	Unk	Unk	????	Tirupati Hyderabad	???? 22-Jul-2007	Birth Transfer	
0.2.0(2)											
Sri Chamarajendra Zoological Park, Mysore											
22.	Unamed	00001		Female	Unk	Unk	2-Dec-1999	Chennai Mysore	2-Dec-1999 19-Dec-2003	Birth Transfer	
23.	Valli	00020		Female	Unk	Unk	????	Chennai Mysore	???? ????	Birth Transfer	
24.	Uname1	00009		Male	Unk	Unk	18-Oct-2002	Chennai Mysore	18-Oct-2002 19-Dec-2003	Birth Transfer	
25.	Mani	00022		Male	Unk	Unk	????	Chennai Mysore	???? ????	Birth Transfer	
2.2.0(4)											
Sri. Venkateswara Zoological Park, Tirupati											
26.	Radha 0006B7287C	00004		Female	Unk	Unk	????	Vishakhapatnam Tirupati	???? ????	Birth Transfer	
27.	Chanti 0006B71632	00005		Male	Wild	Wild	????	India Tirupati	???? ????	Capture Transfer	
28.	Buji	00007		Female	Unk	Unk	????	Vishakhapatnam Tirupati	???? 11-Nov-2003	Birth Transfer	

Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
29.	Krishna	00008		Male	Unk	Unk	????	Vishakhapatnam Tirupati	???? 11-Nov-2003	Birth Transfer	
2.2.0(4)											
Indira Gandhi Zoological Park, Vishakapatnam											
30.	WDM1	00006		Male	Wild	Wild	????	India Vishakhapatnam	8-Jan-2002 8-Jan-2002	Capture Transfer	
31.	WDF2	00010		Female	Wild	Wild	????	India Vishakhapatnam	21-Dec-2003 21-Dec-2003	Capture Transfer	
32.	WDF5	00023		Female	Wild	Wild	????	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
33.	WDF4 WDF4	00024		Female	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
34.	WDM2	00025		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
35.	WDM3	00026		Male	Wild	Wild	????	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
36.	WDM4	00027		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
37.	WDM5	00028		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
38.	WDF3	00029		Female	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
5.4.0(9)											

Table 3 Historical Listing of Dhole in Indian zoos

Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
1.	Unamed	00001		Female	Unk	Unk	2-Dec-1999	Chennai Mysore	2-Dec-1999 19-Dec-2003	Birth Transfer	
2.	Mohan	00002		Male	Unk	Unk	????	Chennai	???? ????	Birth Death	
3.	Viji	00003		Female	Unk	Unk	????	Chennai	???? ????	Birth Death	
4.	Radha 0006B7287C	00004		Female	Unk	Unk	????	Vishakhapatnam Tirupati	???? ????	Birth Transfer	
5.	Chanti 0006B71632	00005		Male	Wild	Wild	????	India Tirupati	???? ????	Capture Transfer	
6.	WDM1	00006		Male	Wild	Wild	????	India Vishakhapatnam	8-Jan-2002 8-Jan-2002	Capture Transfer	
7.	Buji	00007		Female	Unk	Unk	????	Vishakhapatnam Tirupati	???? 11-Nov-2003	Birth Transfer	
8.	Krishna	00008		Male	Unk	Unk	????	Vishakhapatnam Tirupati	???? 11-Nov-2003	Birth Transfer	
9.	Uname1	00009		Male	Unk	Unk	18-Oct-2002	Chennai Mysore	18-Oct-2002 19-Dec-2003	Birth Transfer	
10.	WDF2	00010		Female	Wild	Wild	????	India Vishakhapatnam	21-Dec-2003 21-Dec-2003	Capture Transfer	
11.	Anju 0006B725C4	00011		Female	00002	00003	28-Dec-2003	Chennai Hyderabad	28-Dec-2003 11-Sep-2007	Birth Transfer	
12.	Dhiviya	00012		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
13.	Vasantha	00013		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
14.	Gomathi	00014		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
15.	Sheela	00015		Female	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
16.	Praveen	00016		Male	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	

Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
17.	Paulraj	00017		Male	00002	00003	28-Dec-2003	Chennai	28-Dec-2003	Birth	
18.	Asha 0006B746B9	00018		Female	Unk	Unk	????	Tirupati Hyderabad Hyderabad	???? 22-Jul-2005 17-Feb-2008	Birth Transfer Death	
19.	Akita 0006B715F0	00019		Female	Unk	Unk	????	Tirupati Hyderabad	???? 22-Jul-2007	Birth Transfer	
20.	Valli	00020		Female	Unk	Unk	????	Chennai Mysore	???? ????	Birth Transfer	
21.	ZSB40	00021		Male	16	14	19-Aug-2006	Chennai	19-Aug-2006	Birth	
22.	Mani	00022		Male	Unk	Unk	????	Chennai Mysore	???? ????	Birth Transfer	
23.	WDF5	00023		Female	Wild	Wild	????	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
24.	WDF4 WDF4	00024		Female	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
25.	WDM2	00025		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
26.	WDM3	00026		Male	Wild	Wild	????	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
27.	WDM4	00027		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
28.	WDM5	00028		Male	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
29.	WDF3	00029		Female	Wild	Wild	~ 2006	India Vishakhapatnam	4-Dec-2006 4-Dec-2006	Capture Transfer	
30.	ZSB41	00030		Male	00016	00014	22-Dec-2006	Chennai	22-Dec-2006	Birth	
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Sl. No.	Home name and Transponder No.	National Studbook No.	International Studbook No.	Sex	Sire	Dam	Birth Date	Location	Date	Event	Remarks
33.	AAZP48	00033		Male	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
34.	AAZP49	00034		Female	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
35.	AAZP50	00035		Female	00017	00012	14-Nov-2007	Chennai	14-Nov-2007	Birth	
36.	AAZP53	00036		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
37.	AAZP51	00037		Male	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
38.	AA;ZP52	00038		Male	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
39.	AAZP54	00039		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
40.	AAZP55	00040		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	
41.	AAZP56	00041		Female	00016	00014	6-Jan-2008	Chennai	6-Jan-2008	Birth	

Location Glossary

Sl. No.	Location	Zoo / Establishment name
1.	Chennai	Arignar Anna Zoological Park, Vandalur, Chennai
2.	Hyderabad	Nehru Zoological Park, Hyderabad
3.	Mysore	Sri. Chamarajendra Zoological Garden, Mysore
4.	Tirupati	Sri. Venkateswara Zoological Park, Tirupati
5.	Vishakhapatnam	Indira Gandhi Zoological Park, Vishakapatnam

Population planning and recommendations

The species faces various threats in the free ranging condition and has been listed in Schedule I of the Wildlife Protection Act (1972) and as endangered in the IUCN Red list of threatened species. The captive management of this species therefore assumes importance for maintenance of an insurance population as well as for possible reintroduction of surpluses in suitable habitats.

The captive population in Indian zoos presently is 38 distributed across 5 zoos. The population was analysed for demographic parameters and attempts were made to carry out genetic analysis using PM 2000. However the presence of a large number of individuals of unknown ancestry and dates of birth were limitations to analysis.

Demographic analysis revealed males to have a positive growth rate compared to females that showed a decline. However to have a demographically stable and genetically viable population of dholes in captivity in India it is necessary that the population shows a positive growth trend.

The species is vulnerable to almost all infectious diseases that can affect canids. It is important that necessary preventive measures be taken to avoid diseases both parasitic and infectious.

It is suggested that a molecular genetic analysis to ascertain the parentage/ relatedness of individuals be carried out and based on this analysis the pairings of individuals can be decided upon.

Demographic analysis

Census

The annual census trend of dholes in captivity in Indian zoos is presented in table 4 and figure 2 respectively. A total of 10 wild origin founders were brought into captivity the other 31 specimens are the offspring of these founder animals.

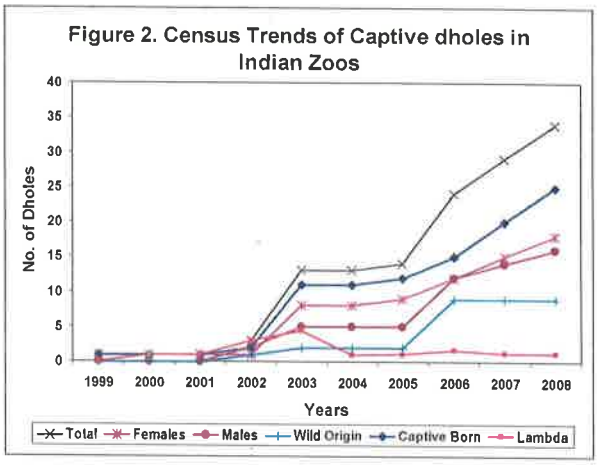

Table 4 Census trends of dholes in Indian zoos

Year	Total	Females	Males	Unsexed	Wild origin	Captive born	Lambda
1999	1	1	0	0	0	1	0
2000	1	1	0	0	0	1	1
2001	1	1	0	0	0	1	1
2002	3	1	2	0	1	2	3
2003	13	8	5	0	2	11	4.33
2004	13	8	5	0	2	11	1
2005	14	9	5	0	2	12	1.08
2006	24	12	12	0	9	15	1.71
2007	29	15	14	0	9	20	1.21
2008	34	18	16	0	9	25	1.17

Age structure

The age structure of the captive dhole population was modelled using PM 2000. The results suggest that the recruitment rate in the population is too low to maintain a demographically stable population (table 5 and figure 2). No individuals are present in the 0-1 and 1-2 year age classes, whereas it is desirable to have a larger number of individuals in the lower age classes relative to the reproductive and post reproductive age classes. This is to achieve a population growth as the individuals in these age classes are potential breeders that can contribute maximum to the gene pool of the population.

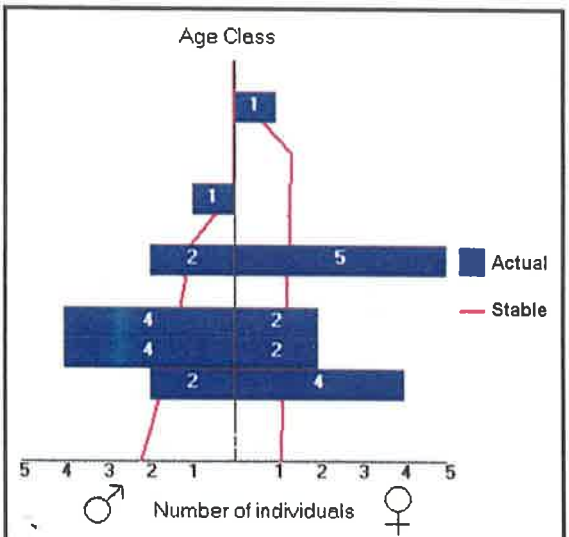

Figure 2 Age structure of known age dholes

Table 5 Age structure of the Indian captive dhole population

Age (x)	Actual	Stable	Actual	Stable
0	0	2.2	0	1.07
1	0	1.98	0	1.09
2	2	1.78	4	1.12
3	4	1.6	2	1.15
4	4	1.44	2	1.18
5	0	1.3	0	1.21
6	2	1.17	5	1.24
7	0	1.05	0	1.27
8	1	0.47	0	1.3
9	0	0	0	1.33
10	0	0	0	1.36
11	0	0	1	0.7
12	0	0	0	0

Life table

Life table for the Indian captive dhole population was obtained using SPARKS 1.5 and is presented in table 6. Fecundity (Mx) the indicator of reproductive activity for males is extremely low and has a small peak in the 4^{th} – 5^{th} year, while for females the onset of reproductive activity is in the 2^{nd} – 3^{rd} year peaks at 4^{th} – 5^{th} year of life and then abruptly ceases. The value of mortality (Qx) for both males and females is zero as all known age individuals in the captive population are still alive.

Table 6 Life table of the Indian captive dhole population

Class	Mx Male	NmXm	Mx Female	NmXf	Qx Male	NqXm	Qx Female	NqXf	Lx Male	Lx Female
1	0	13	0	14	0	13	0	14	1	1
2	0	13	0	14	0	13	0	14	1	1
3	0.14	10.99	0.14	10.85	0	10.99	0	10.85	1	1
4	0.32	6.29	0.28	7.03	0	6.29	0	7.03	1	1
5	1	3	0.5	6	0	3	0	6	1	1
6	0	3	0	6	0	3	0	6	1	1
7	0	1.9	0	3.25	0	1.9	0	3.25	1	1
8	0	0.64	0	1	0	0.64	0	1	1	1
9	0	0	0	1	0	0	0	1	1	1
10	0	0	0	1	0	0	0	1	1	1
11	0	0	0	0.52	0	0	0	0.52	1	1
12	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	1	1

Generation length (T); It is the average time elapsing from reproduction in one generation of females or males to the reproduction in the next generation. Net reproductive rate (R_0), population growth rate (λ) and the intrinsic rate of increase for

males and females is presented in table 7. Males exhibit a positive growth trend whereas females show a decline at the population level.

Table 7 Projected population growth rates

	Males	Females
T	3.589	3.391
Ro	1.460	0.920
lambda	1.11	0.98
r	0.105	-0.025

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")
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.
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.
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.
Intrinsic Rate of Increase [r] the exponential rate at which a population with a stable age distribution grows.
Population Growth Rate (Lambda, λ) – 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.
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.
Generation Time (T) – The average time elapsing from reproduction in one generation to the time the next generation reproduces.

Population projections

Population projections for the captive dhole population were obtained using PM2000 for the next 20 years. Due to the presence of a large number of specimens of unknown ancestry, it is not possible to run genetic analysis and analyse the population goals for the captive dhole population at present. . Consequently it is also not possible to determine the minimum number of specimens that would be required to maintain a genetically viable and demographically stable population. It is therefore assumed that a population of 150 individuals to be achieved over span of 10 years in captivity would retain an adequate sample of the original gene pool and at the same time be demographically stable. Population targeted growth was accordingly analysed and the calculations were used to generate population projections.

The number of births and pairs required each year to achieve the target population size is presented in table 8. Details of recruitment each year in each age class is presented in table 9, while figure 4 represents the trends for the next 50 years for the stable and actual populations.

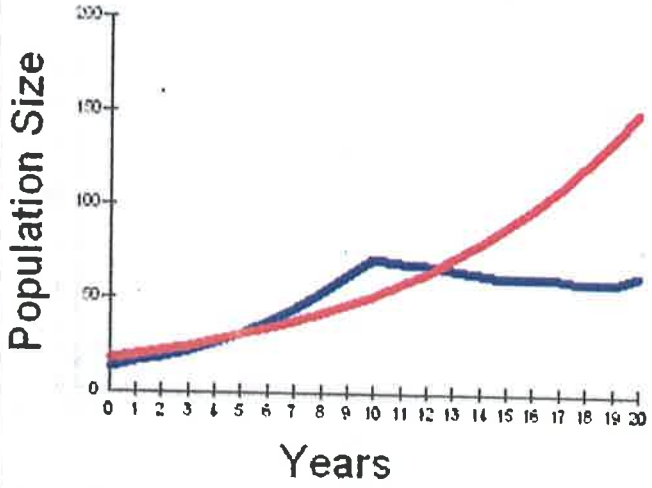

Figure 3 Population projections for the Indian captive dhole population

Table 8 Reproductive needs for achieving a demographically stable population

Year	# Births	# Pairs
0	8.407577	16.8
1	7.823301	15.6
2	8.76758	17.5
3	11.25824	22.5
4	18.83426	37.7
5	18.85244	37.7
6	15.56191	31.1
7	17.438	34.9
8	23.09951	46.2
9	26.1168	52.2
10	4.14772	8.3

Table 9 Population projections for the Indian captive dhole population for the next 20 years

		Years																			
		0	1	2	3	4	5	6	7	8	9	10	11	12	12	14	15	16	17	18	18	20
Age Class	# Born	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89	9.78	10.45	7.91	6.47
	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89	9.78	10.45	7.91	6.47
	1.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89	9.78	10.45	7.91
	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89	9.78	10.45
	3.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89	9.78
	4.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81	7.89
	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78	6.81
	6.00	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79	6.78
	7.00	0.00	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55	5.79
	8.00	0.00	0.00	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07	3.55
	9.00	0.00	0.00	0.00	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06	2.07
	10.00	0.00	0.00	0.00	0.00	5.00	0.00	2.00	2.00	4.00	0.00	0.00	4.20	3.91	4.38	5.63	9.42	9.43	7.78	8.72	11.55	13.06
	11.00	1.00	0.00	0.00	0.00	0.00	2.50	0.00	1.00	1.00	2.00	0.00	0.00	2.10	1.96	2.19	2.81	4.71	4.71	3.89	4.36	5.77
	12.00	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	14.00	17.20	21.12	25.50	31.13	38.05	44.97	51.75	58.47	67.02	78.08	80.15	81.61	83.34	85.98	87.77	88.14	88.49	90.34	90.00	86.34

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Appendix 1

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.

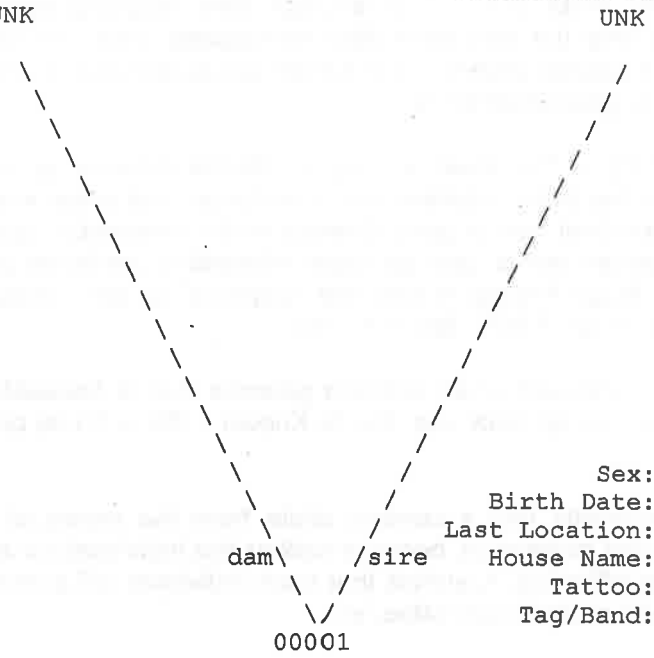
Percent Known -- Percent of an animal's genome that is traceable to known Founders. Thus, if an animal has an UNK sire, the % Known = 50. If it has an UNK grandparent, % Known = 75.

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 2

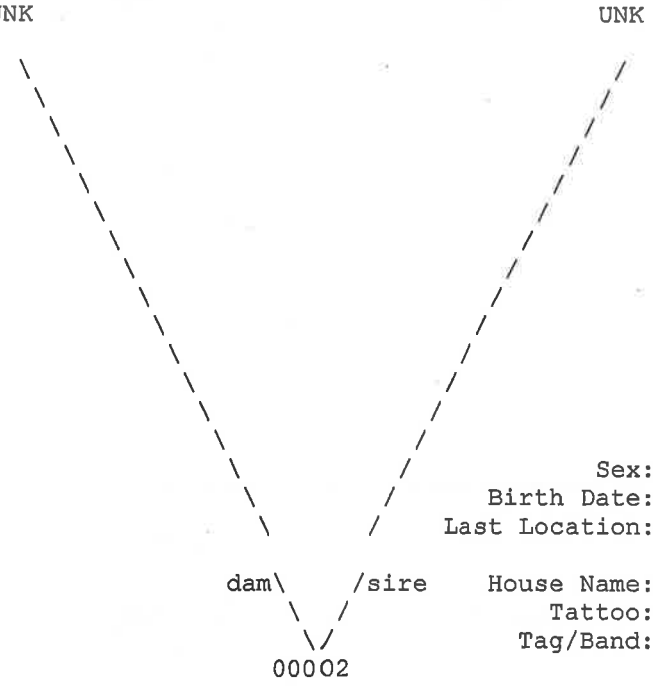
Pedigree Chart Report DHOLE

Taxon Name: CUON ALPINUS Studbook Number: 00001



Sex: Female
Birth Date: 2 Dec 1999
Last Location: MYSORE
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00002



Sex: Male
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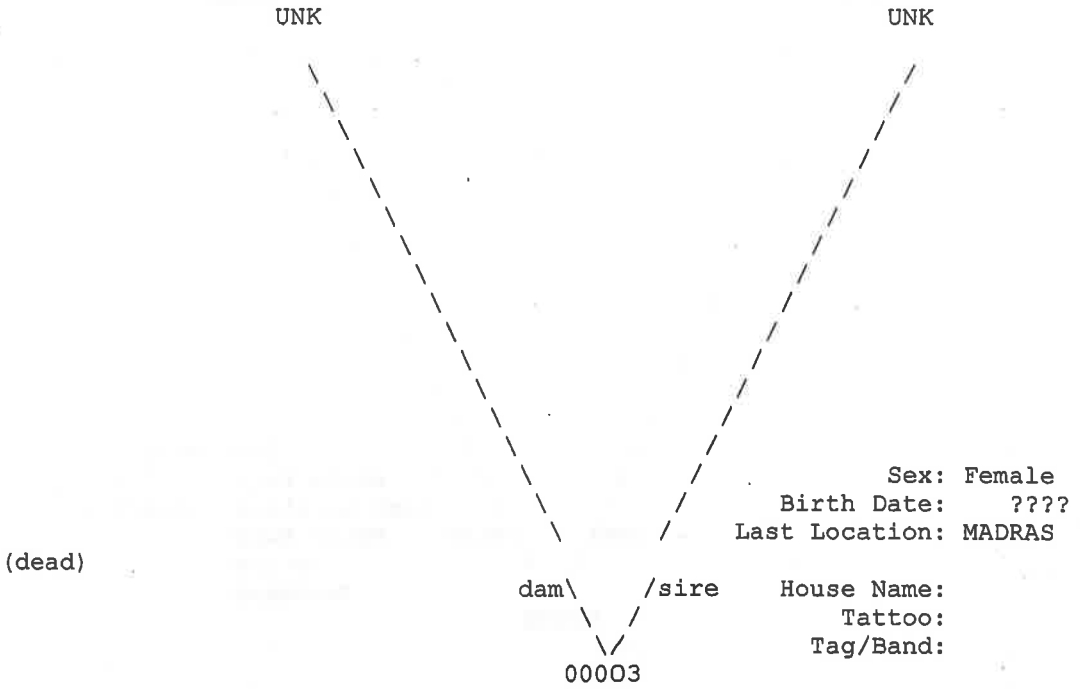
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

(dead)

Taxon Name: CUON ALPINUS Studbook Number: 00003



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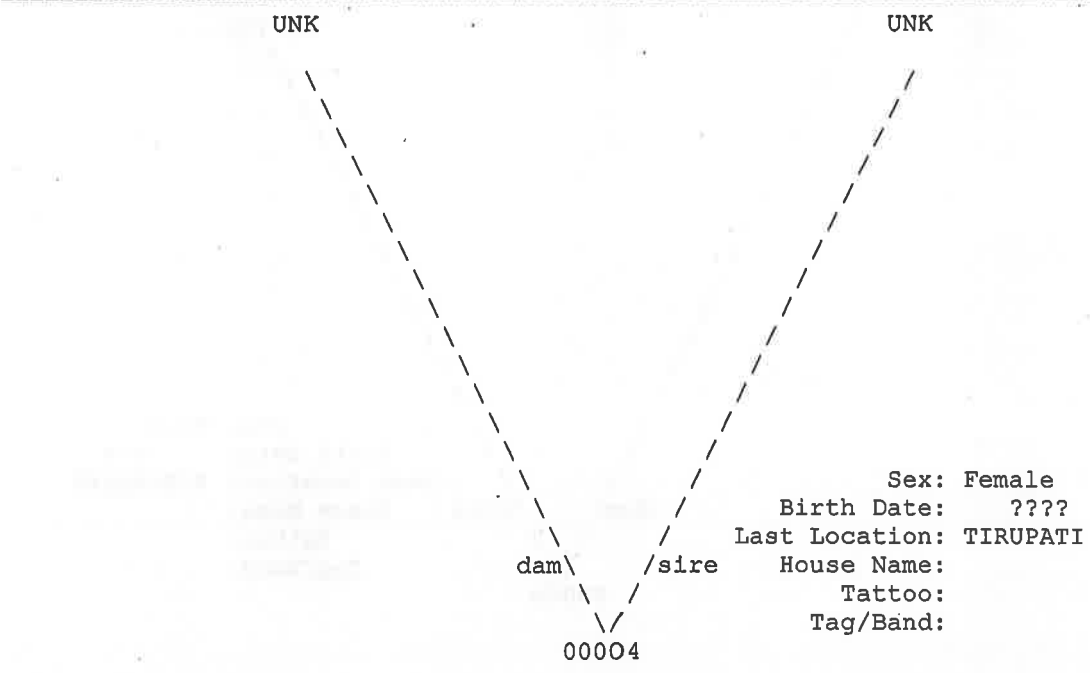

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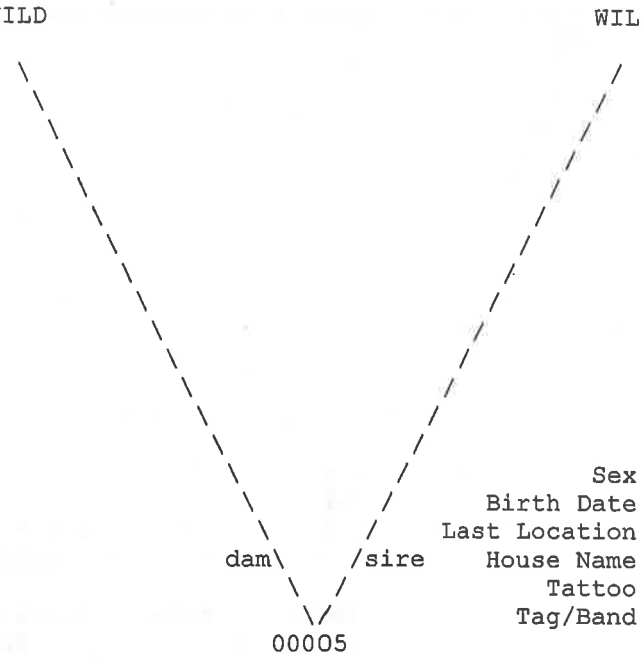
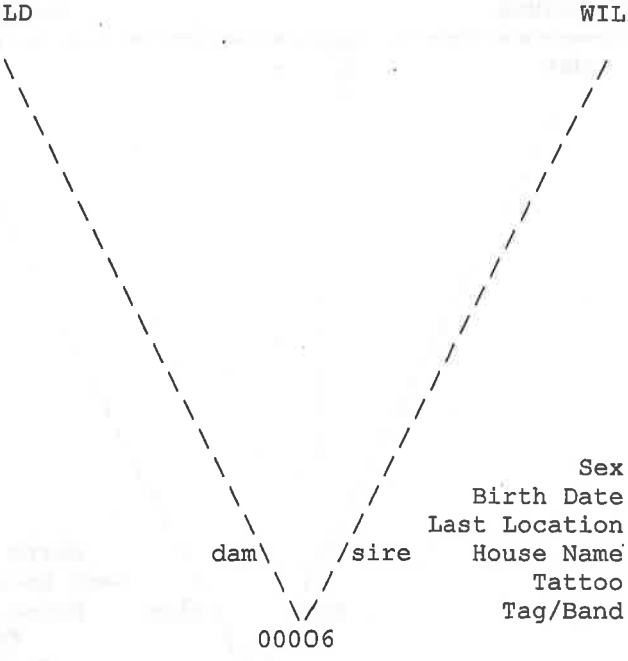


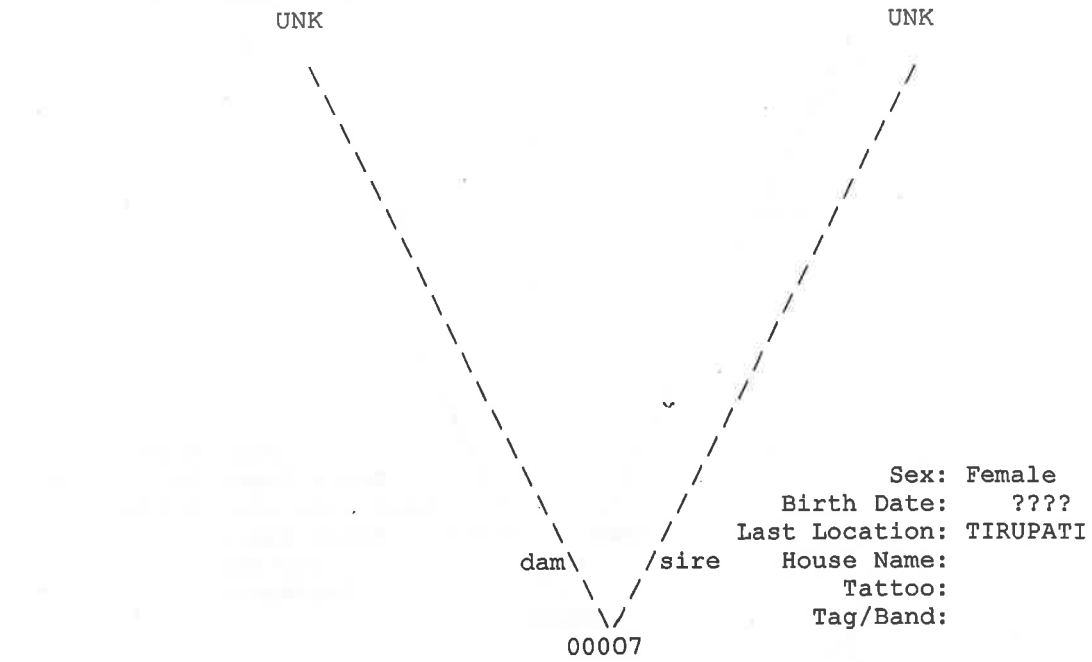
Sex: Male
Birth Date: ????
Last Location: TIRUPATI
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00006



Sex: Male
Birth Date: ????
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00007



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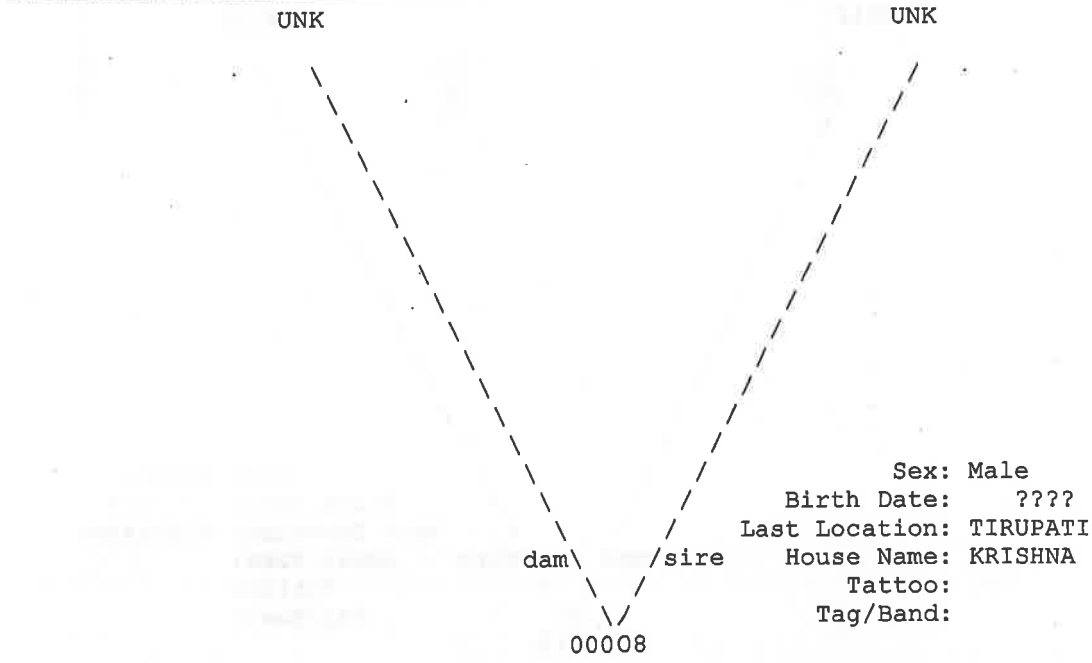

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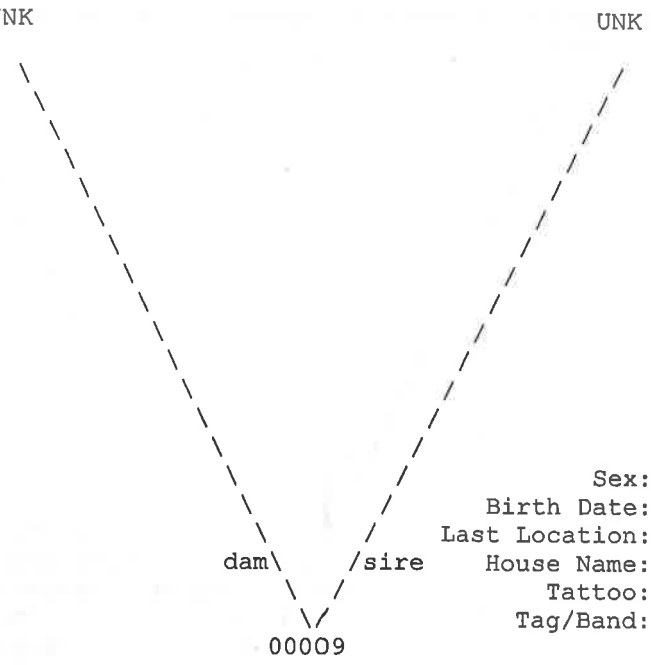

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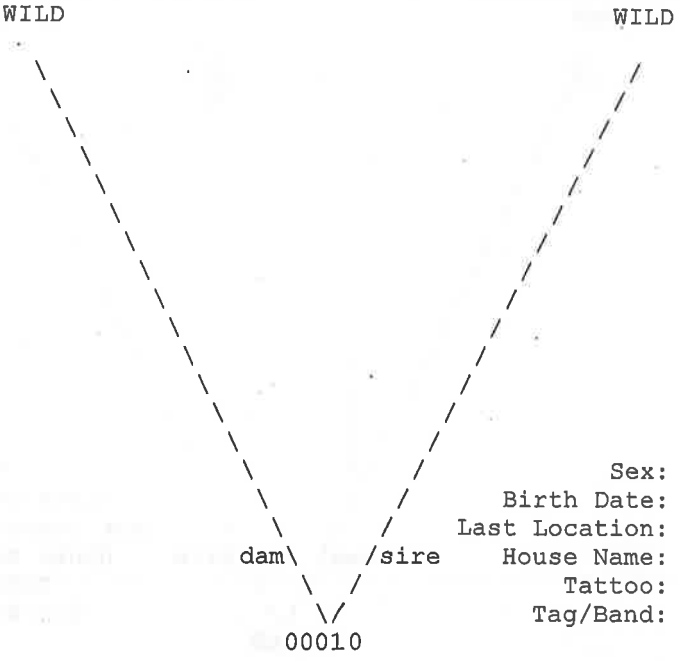
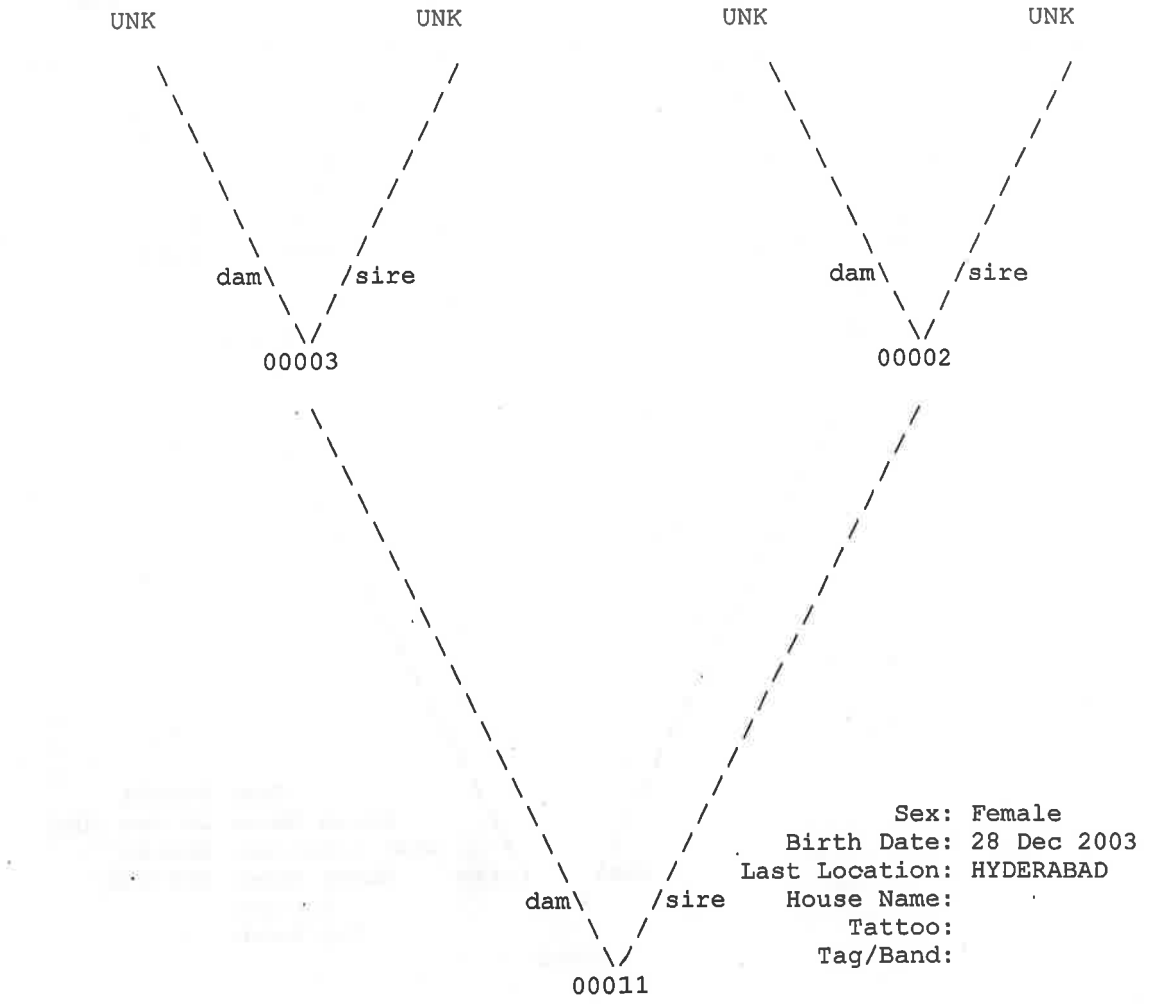
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00010



Sex: Female
Birth Date: ????
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00011



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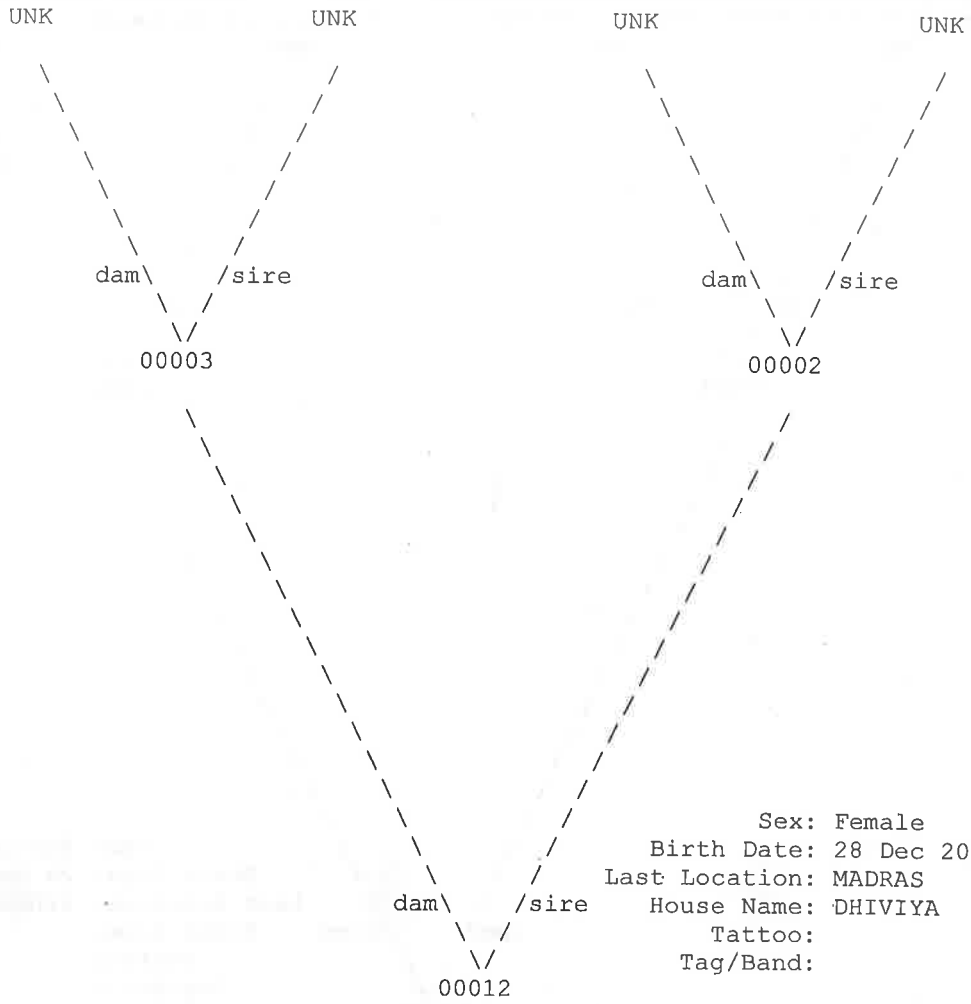

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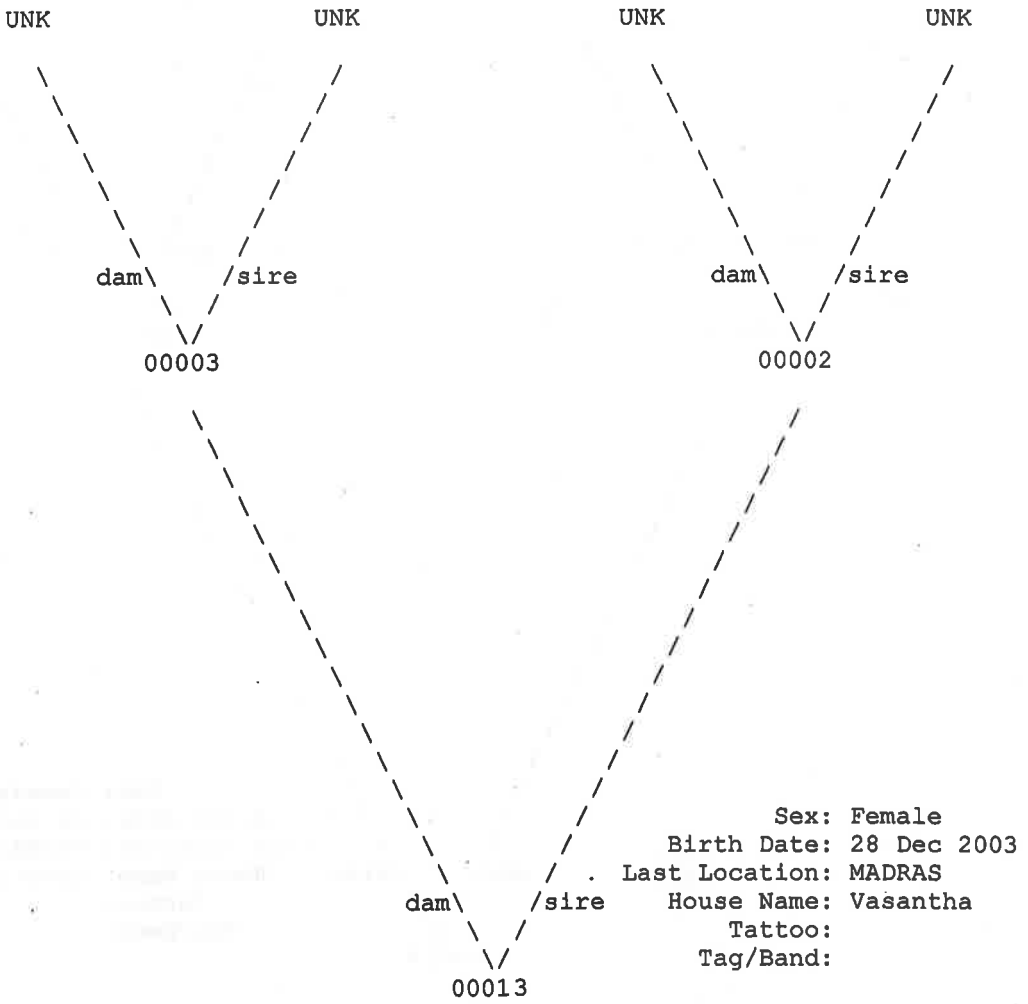
Last Location: MADRAS
House Name: DHIVIYA
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00013



Sex: Female
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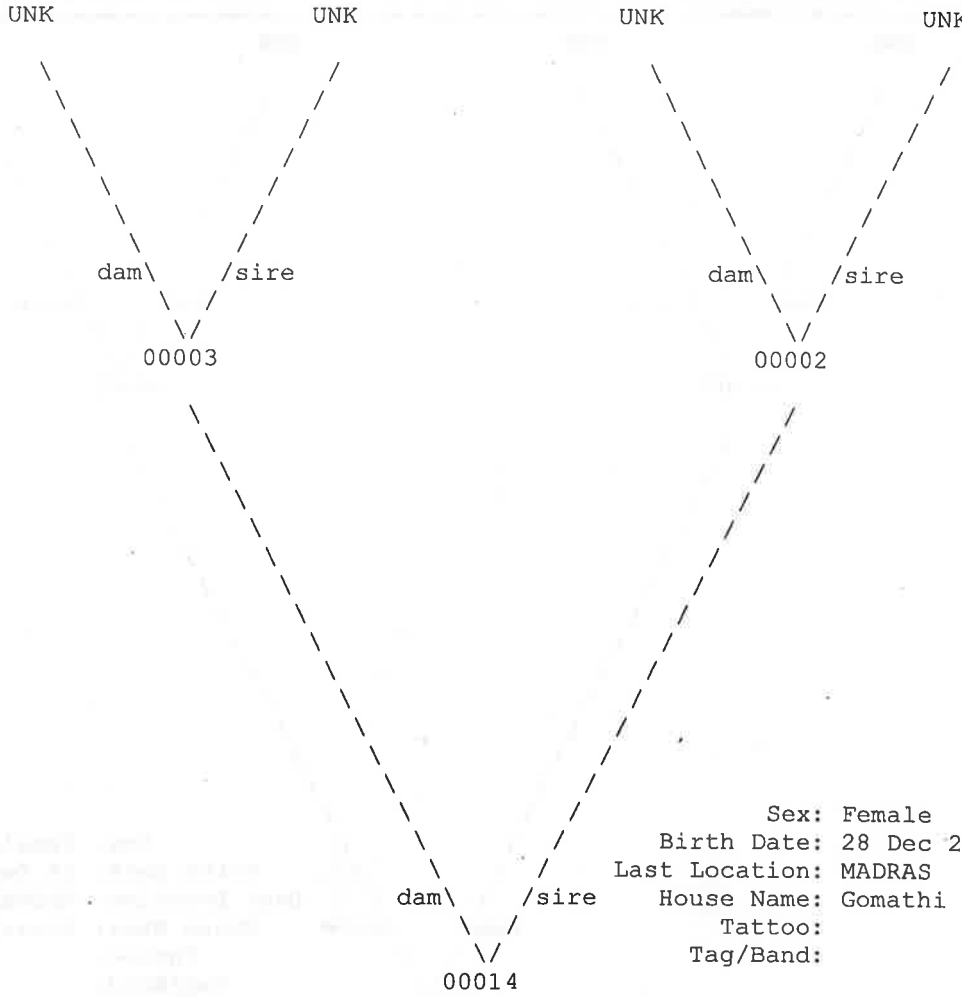
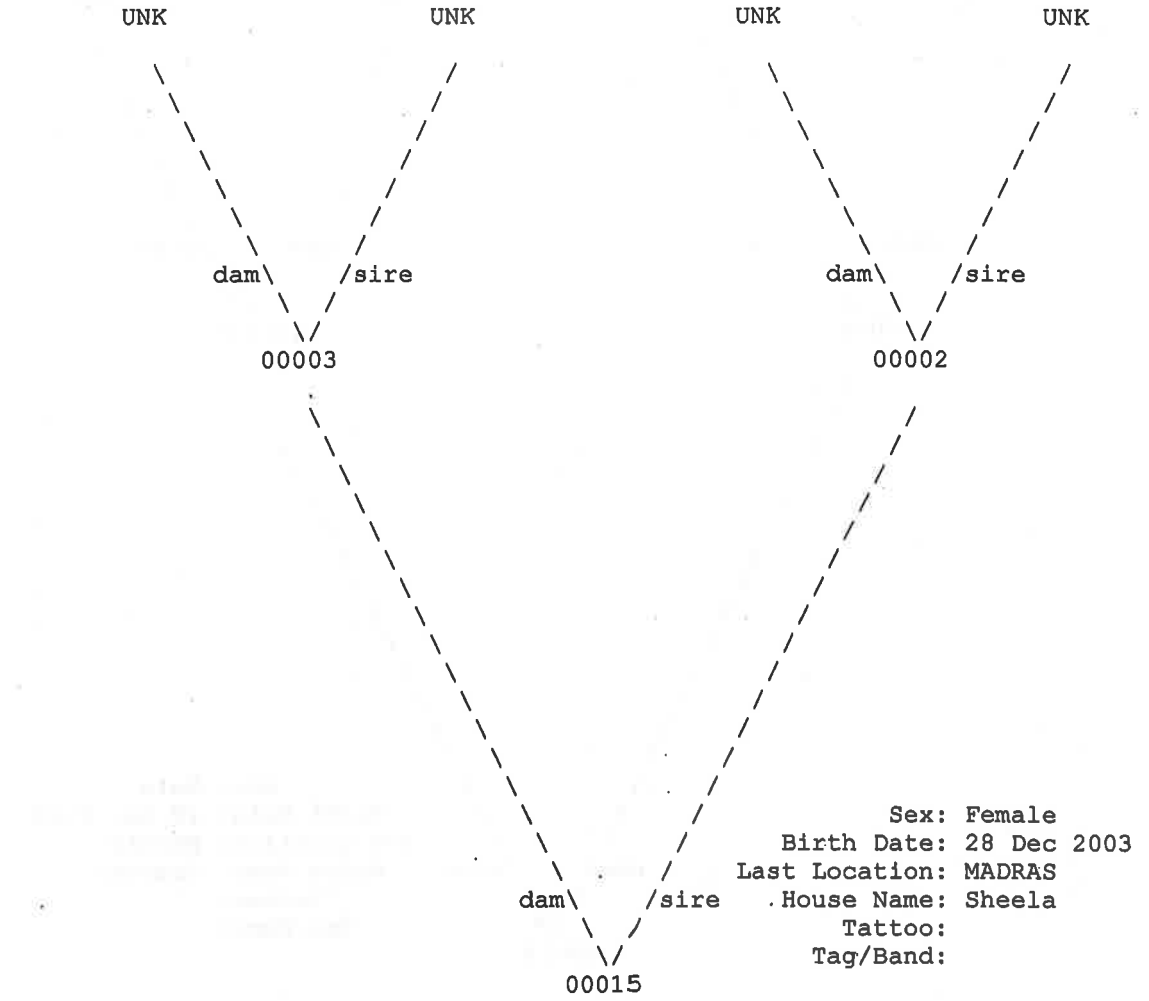
Last Location: MADRAS
House Name: Vasantha
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00014



Sex: Female
Birth Date: 28 Dec 2003
Last Location: MADRAS
House Name: Gomathi
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00015



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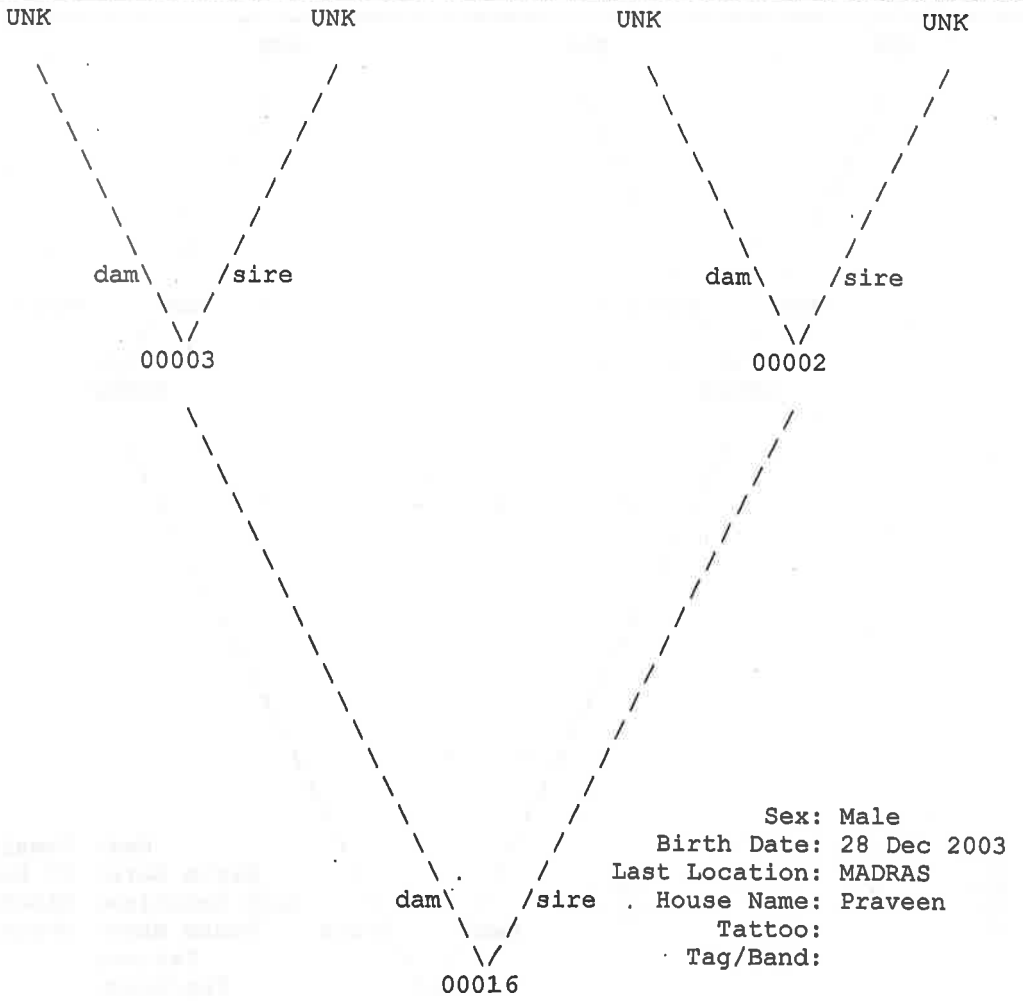

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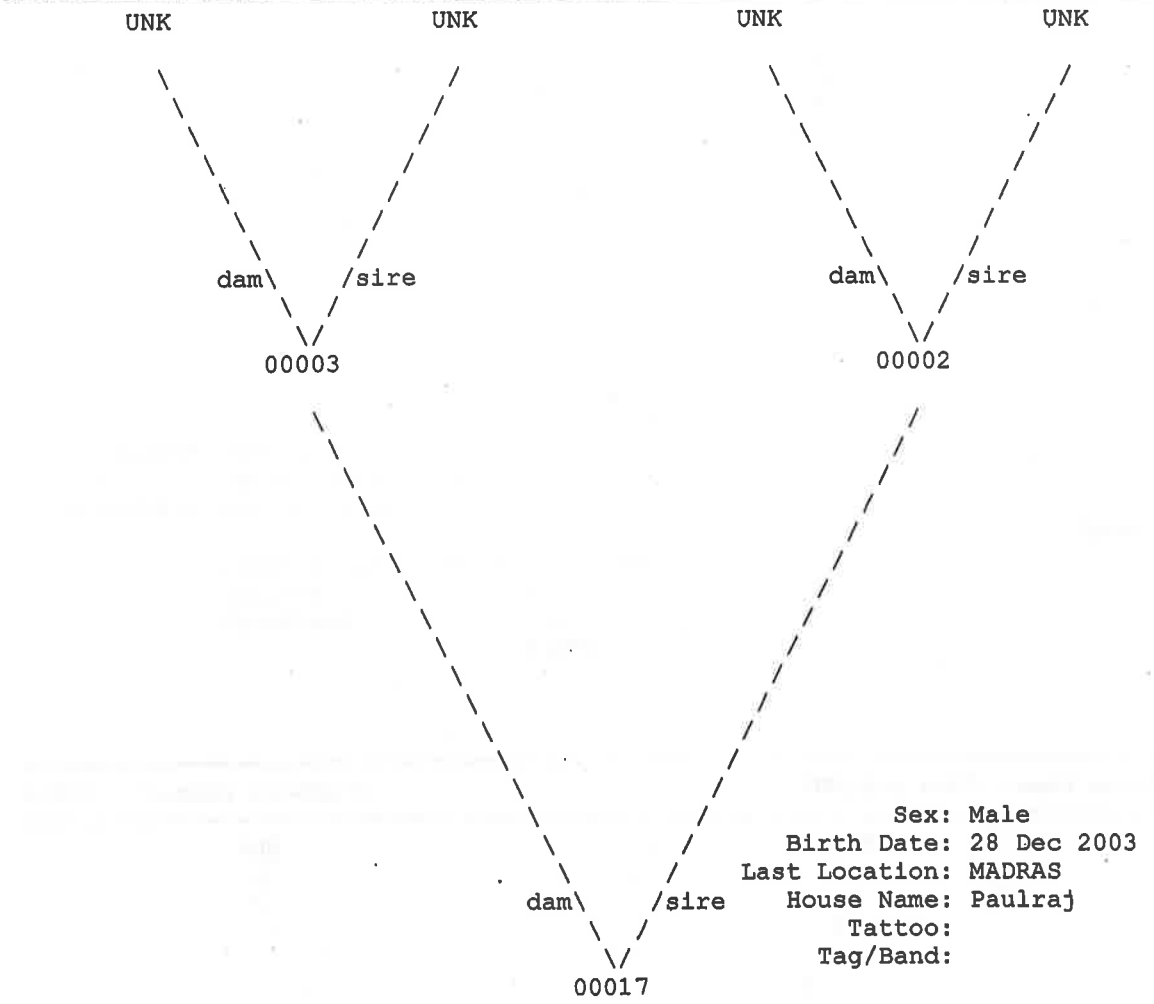

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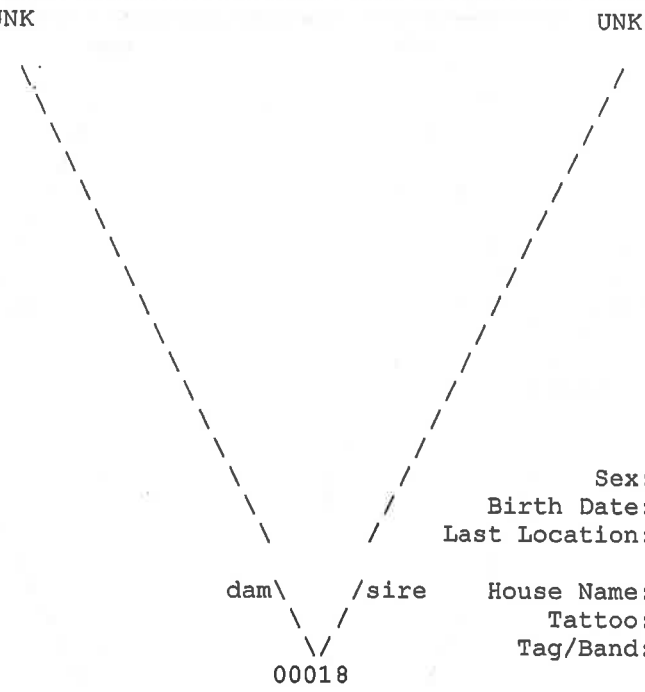
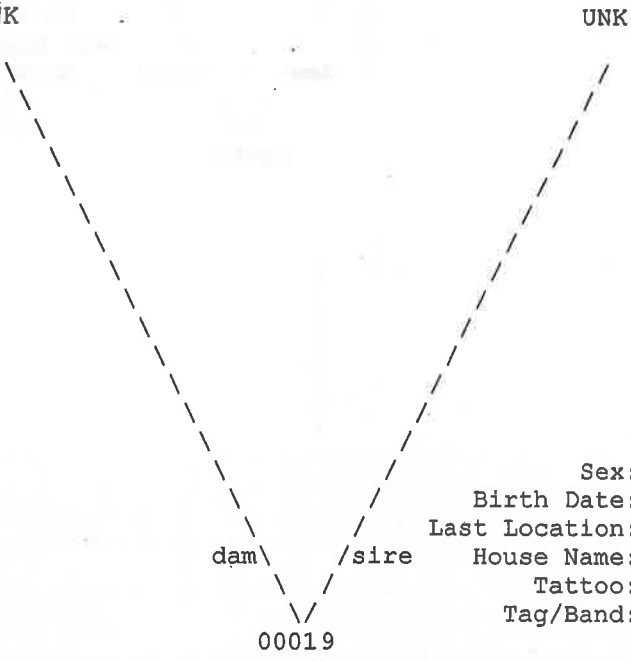


Sex: Female
Birth Date: ????
Last Location: HYDERABAD
House Name:
Tattoo:
Tag/Band:

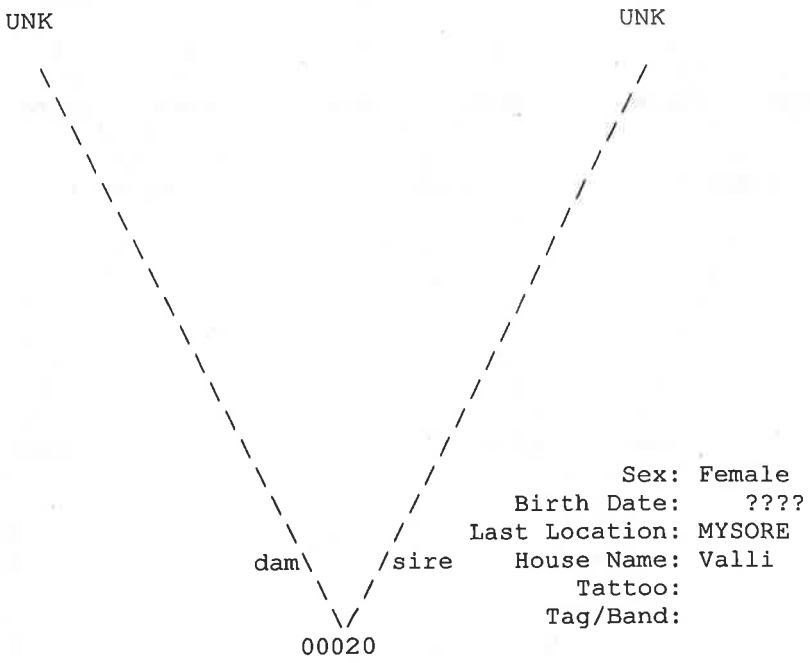
(dead)

Taxon Name: CUON ALPINUS Studbook Number: 00019

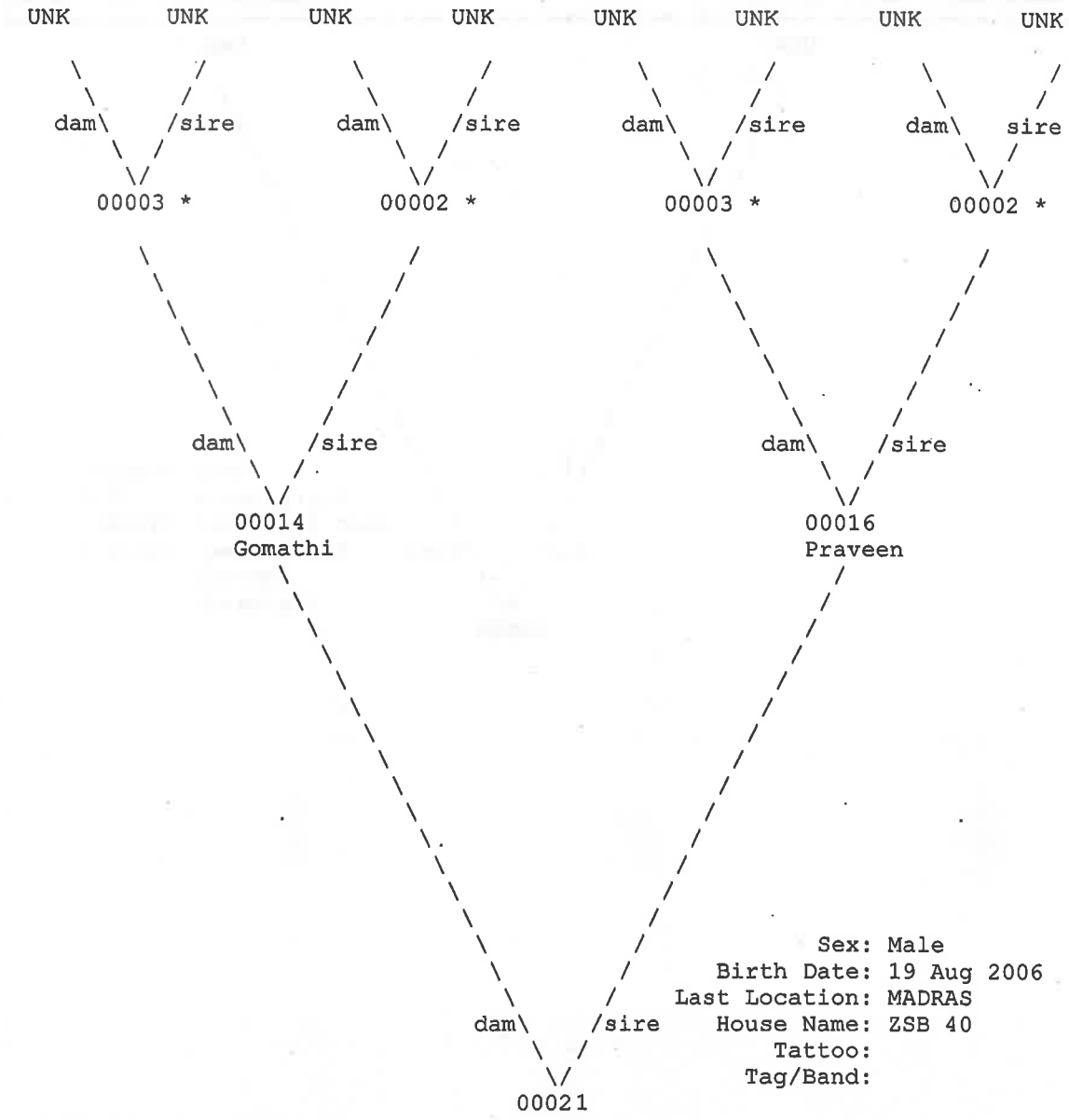


Sex: Female
Birth Date: ????
Last Location: HYDERABAD
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00020



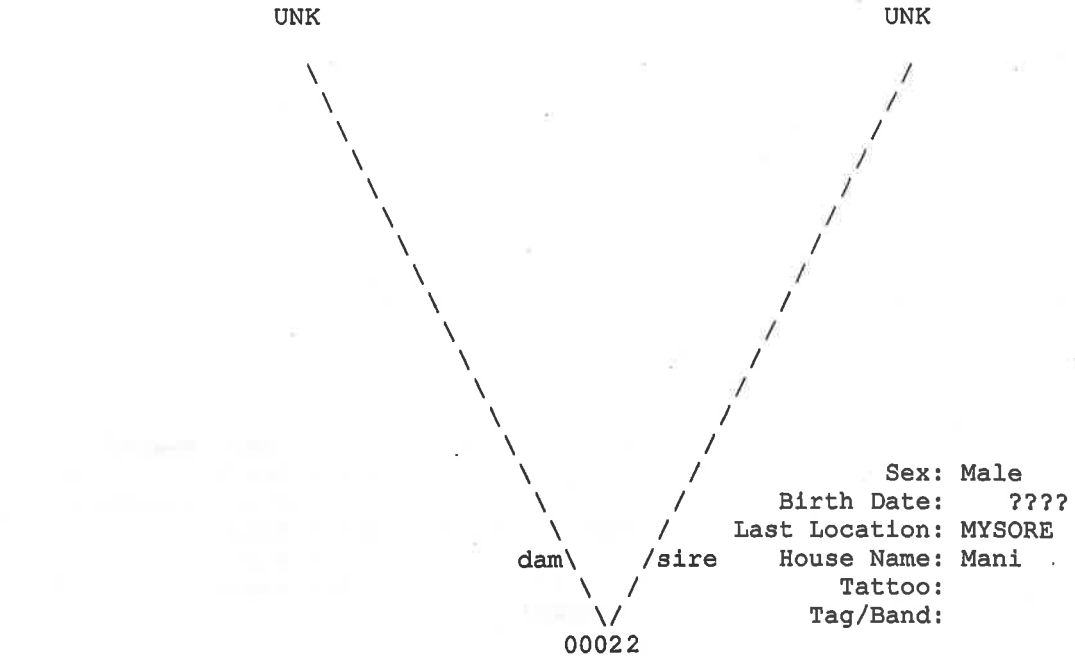
Taxon Name: CUON ALPINUS Studbook Number: 00021



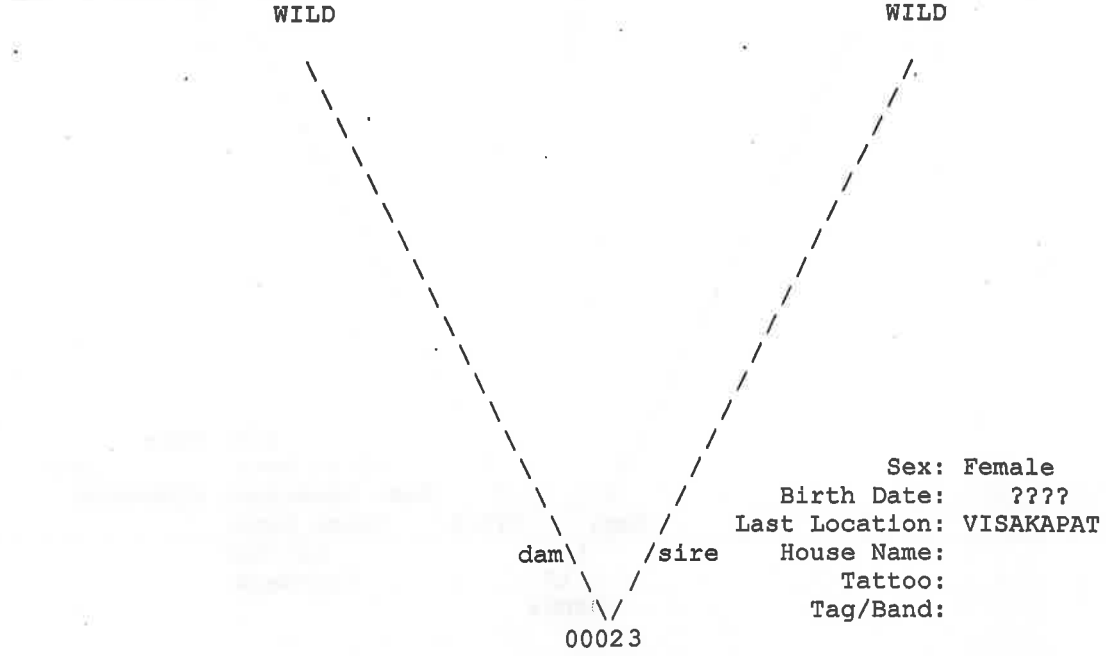
Sex: Male
Birth Date: 19 Aug 2006
Last Location: MADRAS
House Name: ZSB 40
Tattoo:
Tag/Band:

* Appear more than once...

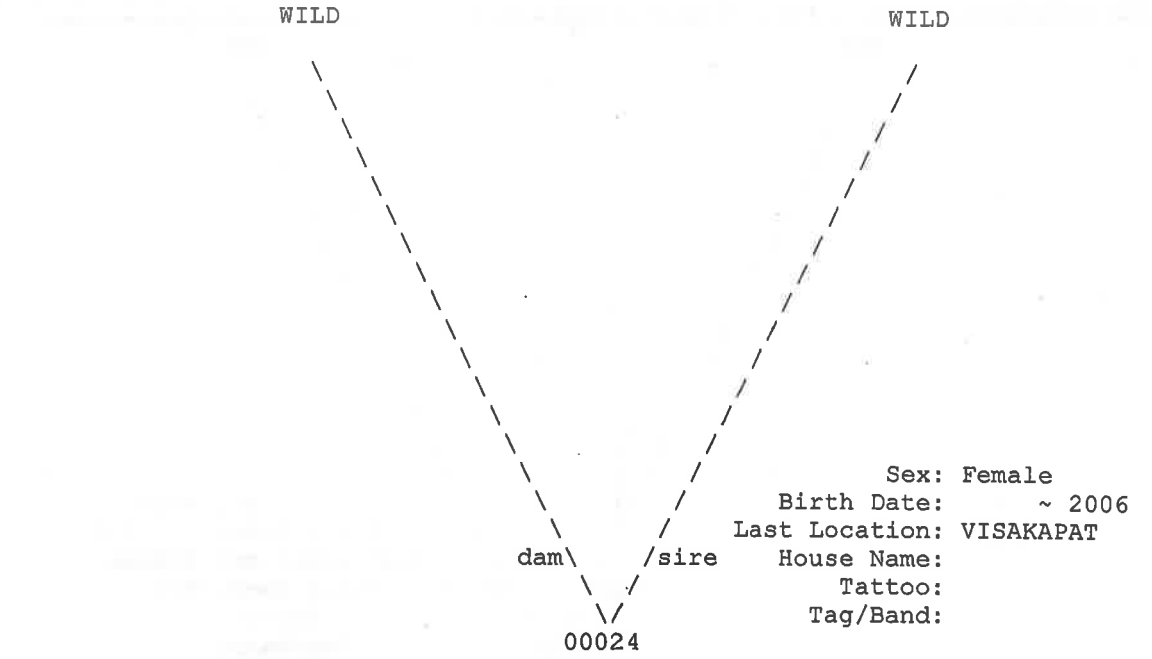
Taxon Name: CUON ALPINUS Studbook Number: 00022



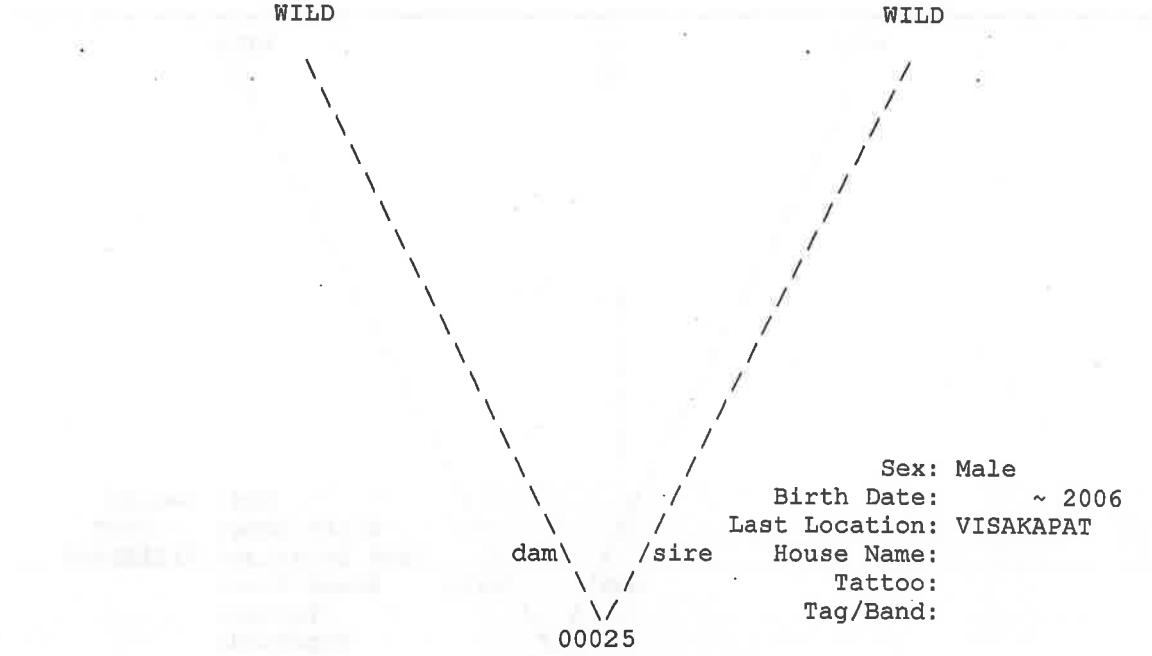
Taxon Name: CUON ALPINUS Studbook Number: 00023



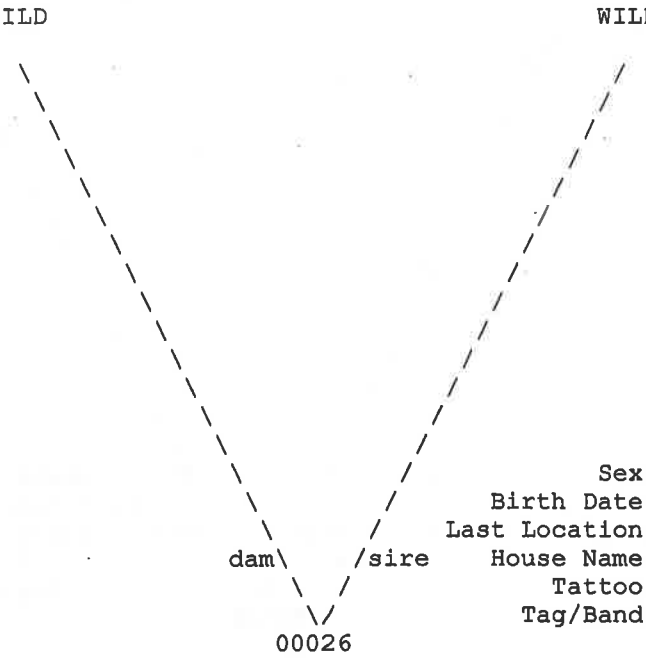
Taxon Name: CUON ALPINUS Studbook Number: 00024



Taxon Name: CUON ALPINUS Studbook Number: 00025

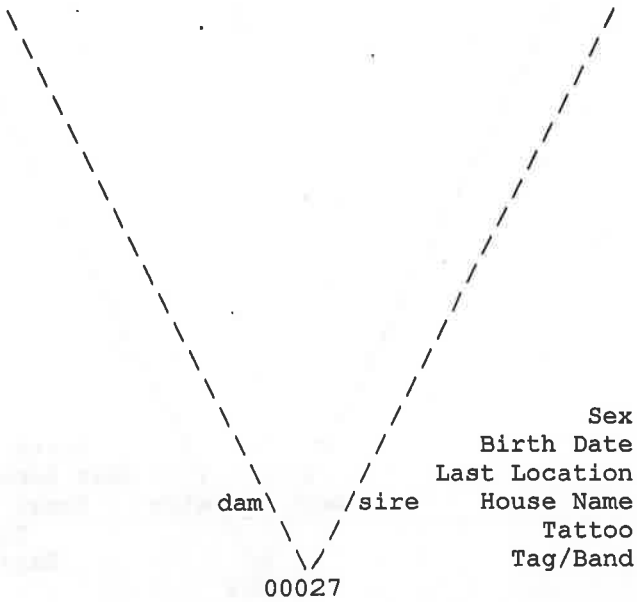


Taxon Name: CUON ALPINUS Studbook Number: 00026



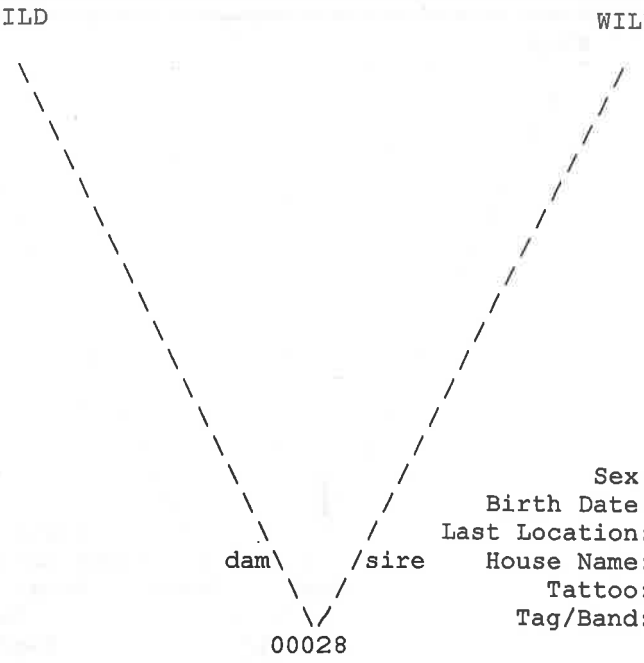
Sex: Male
Birth Date: ????
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00027



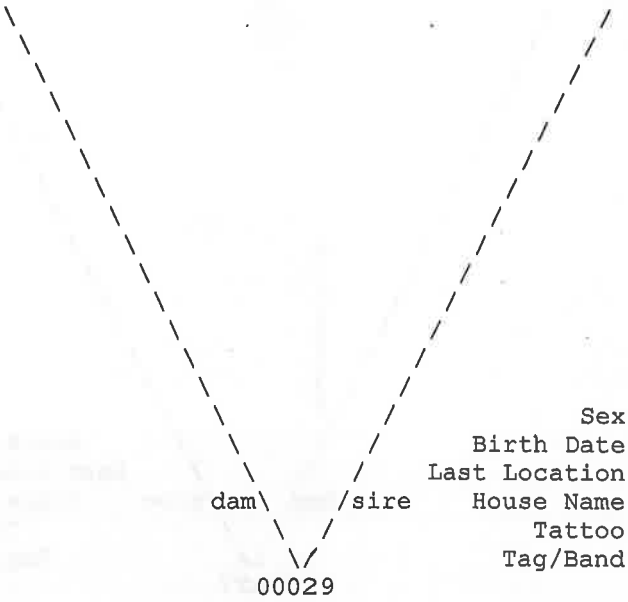
Sex: Male
Birth Date: ~ 2006
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00028



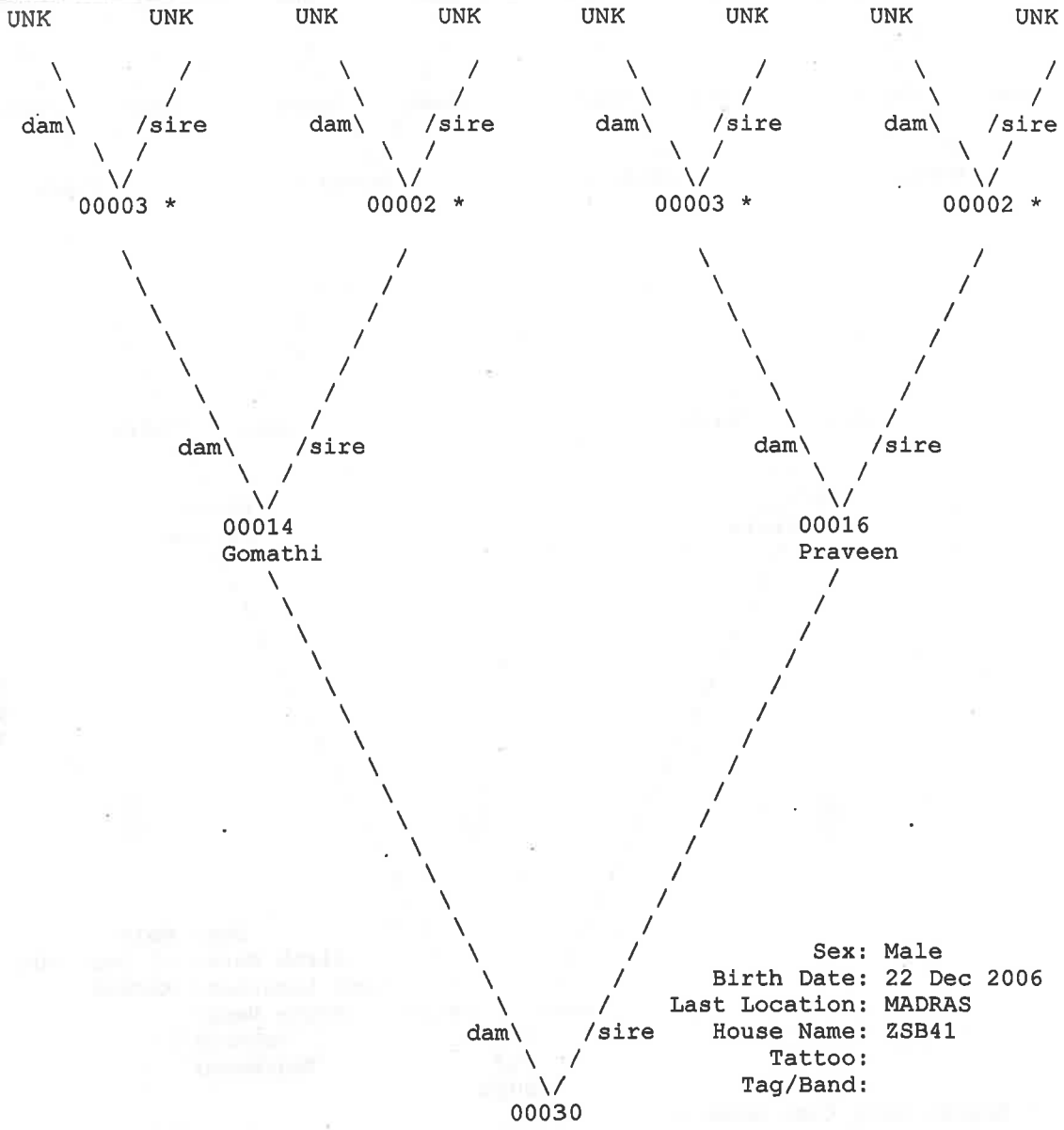
Sex: Male
Birth Date: ~ 2006
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

Taxon Name: CUON ALPINUS Studbook Number: 00029



Sex: Female
Birth Date: ~ 2006
Last Location: VISAKAPAT
House Name:
Tattoo:
Tag/Band:

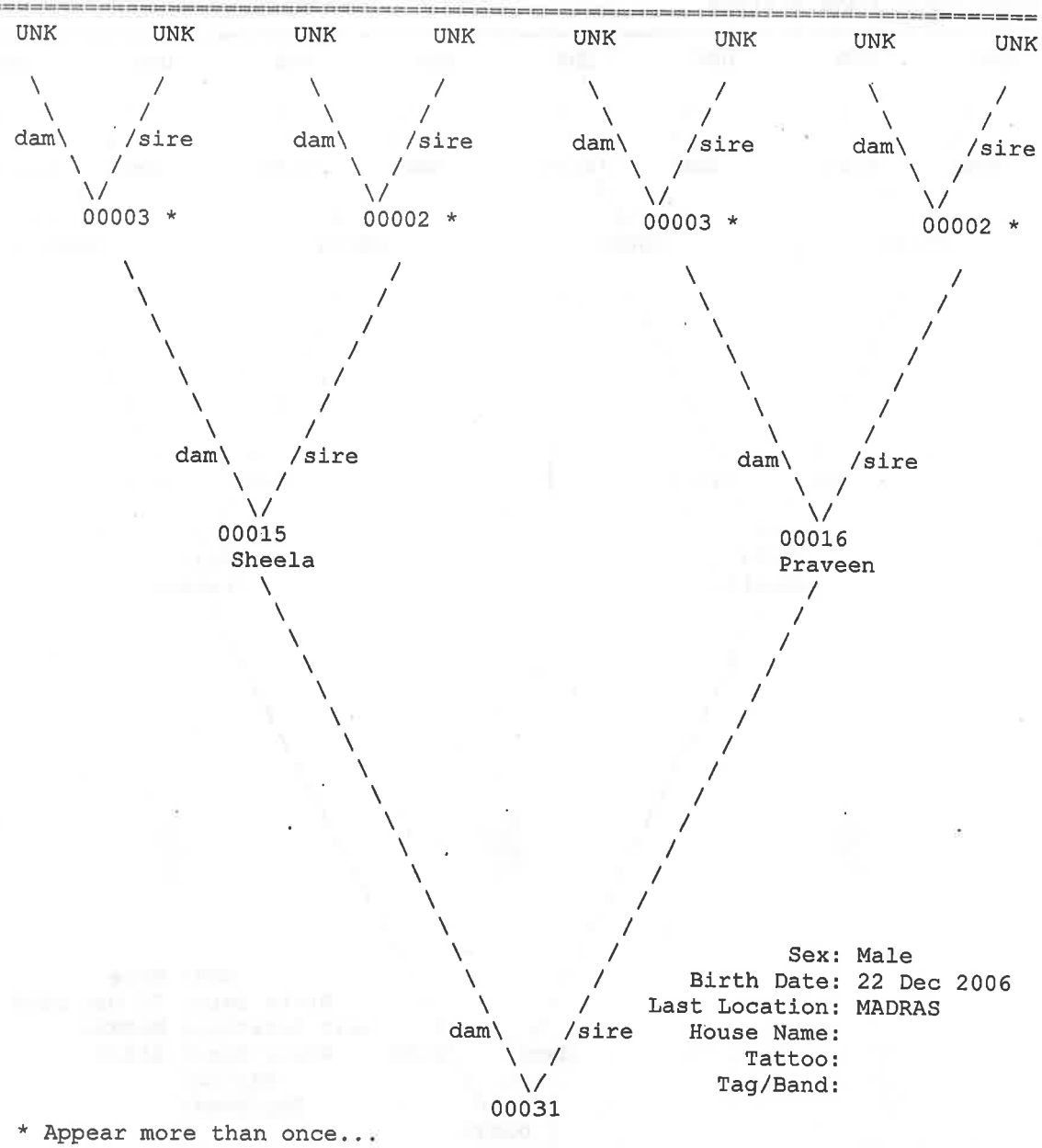
Taxon Name: CUON ALPINUS Studbook Number: 00030



Sex: Male
Birth Date: 22 Dec 2006
Last Location: MADRAS
House Name: ZSB41
Tattoo:
Tag/Band:

* Appear more than once...

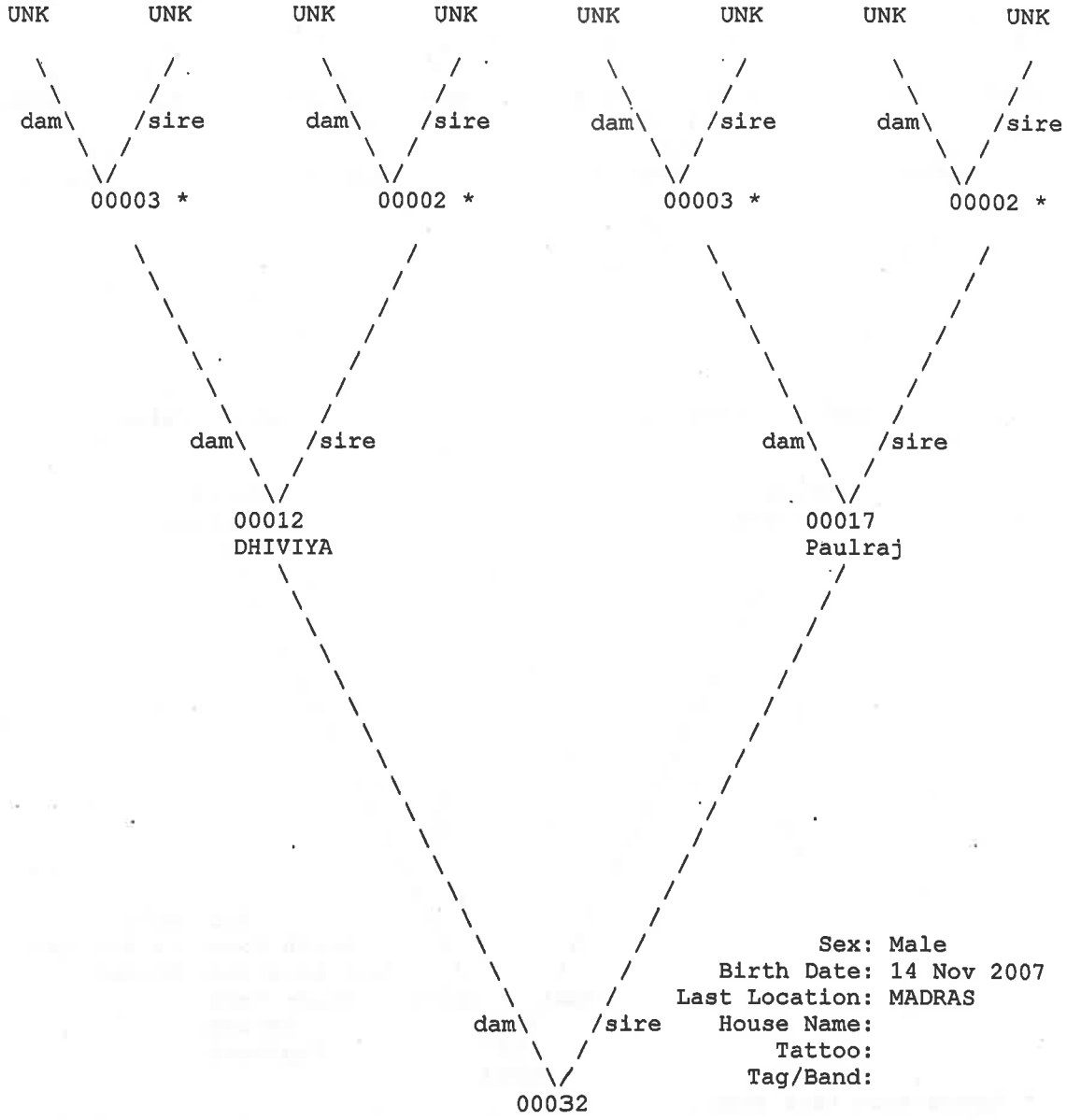
Taxon Name: CUON ALPINUS Studbook Number: 00031



Sex: Male
Birth Date: 22 Dec 2006
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

* Appear more than once...

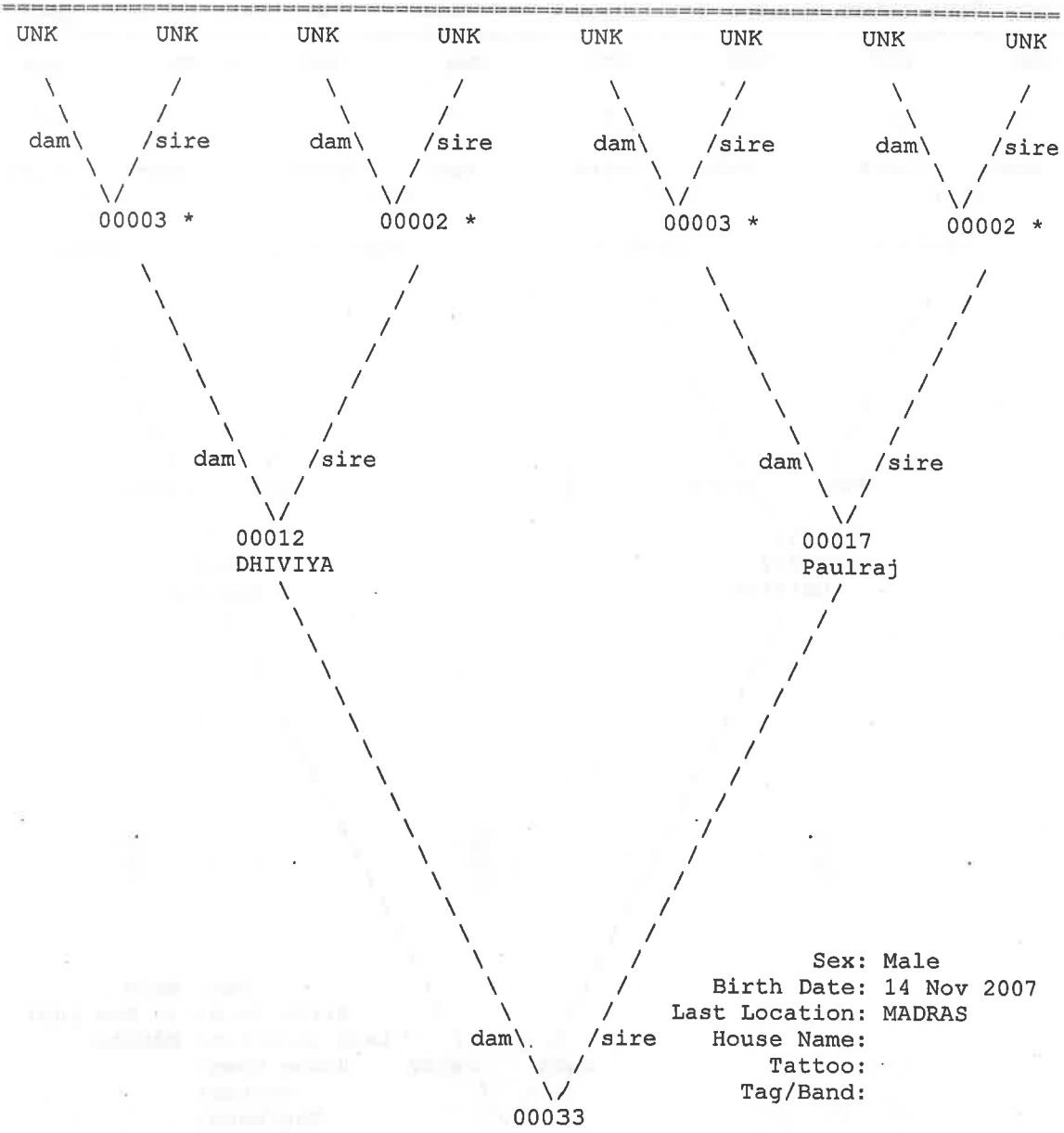
Taxon Name: CUON ALPINUS Studbook Number: 00032



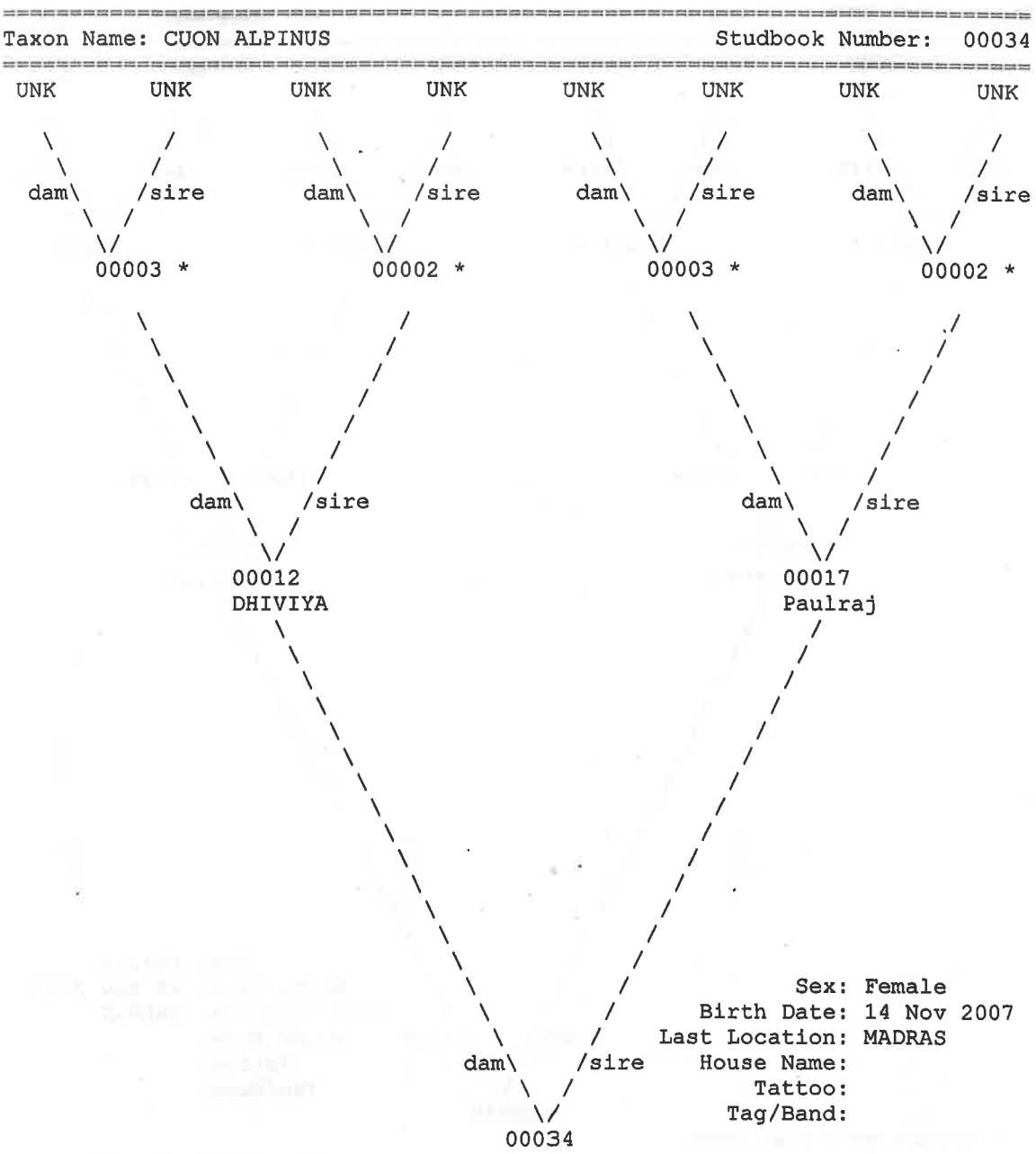
Sex: Male
Birth Date: 14 Nov 2007
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

* Appear more than once...

Taxon Name: CUON ALPINUS Studbook Number: 00033

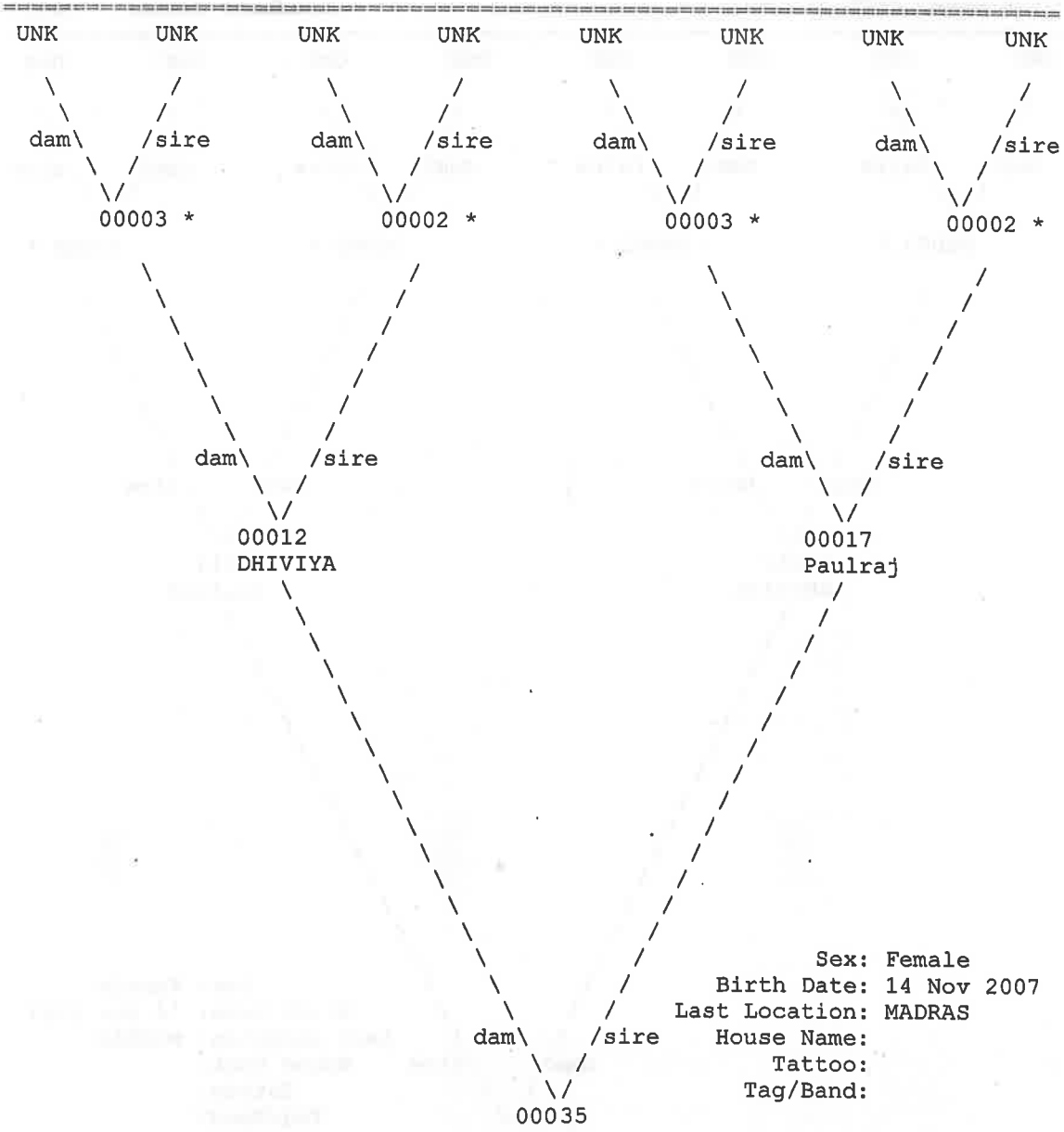


* Appear more than once...



* Appear more than once...

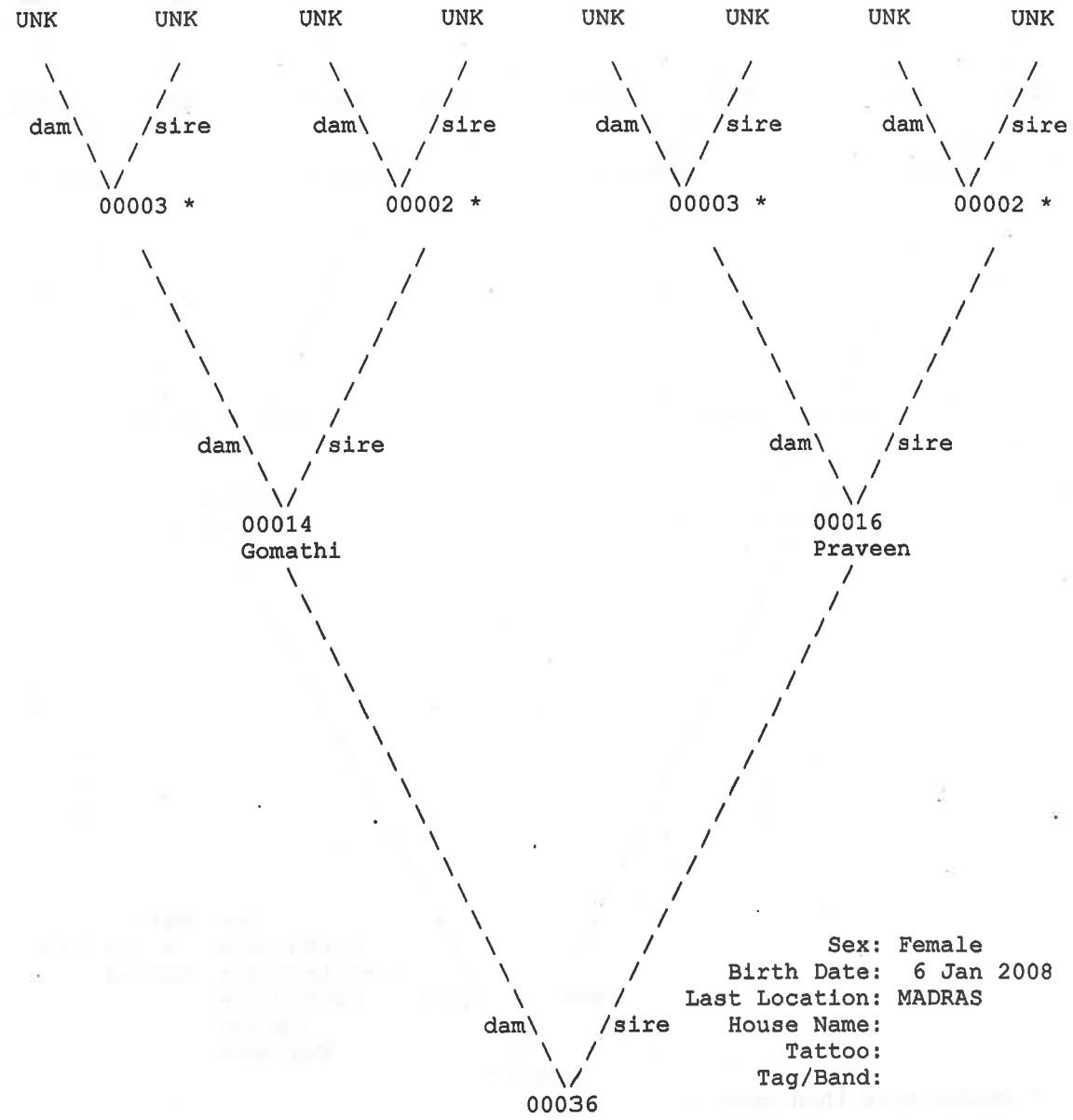
Taxon Name: CUON ALPINUS Studbook Number: 00035



Sex: Female
Birth Date: 14 Nov 2007
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

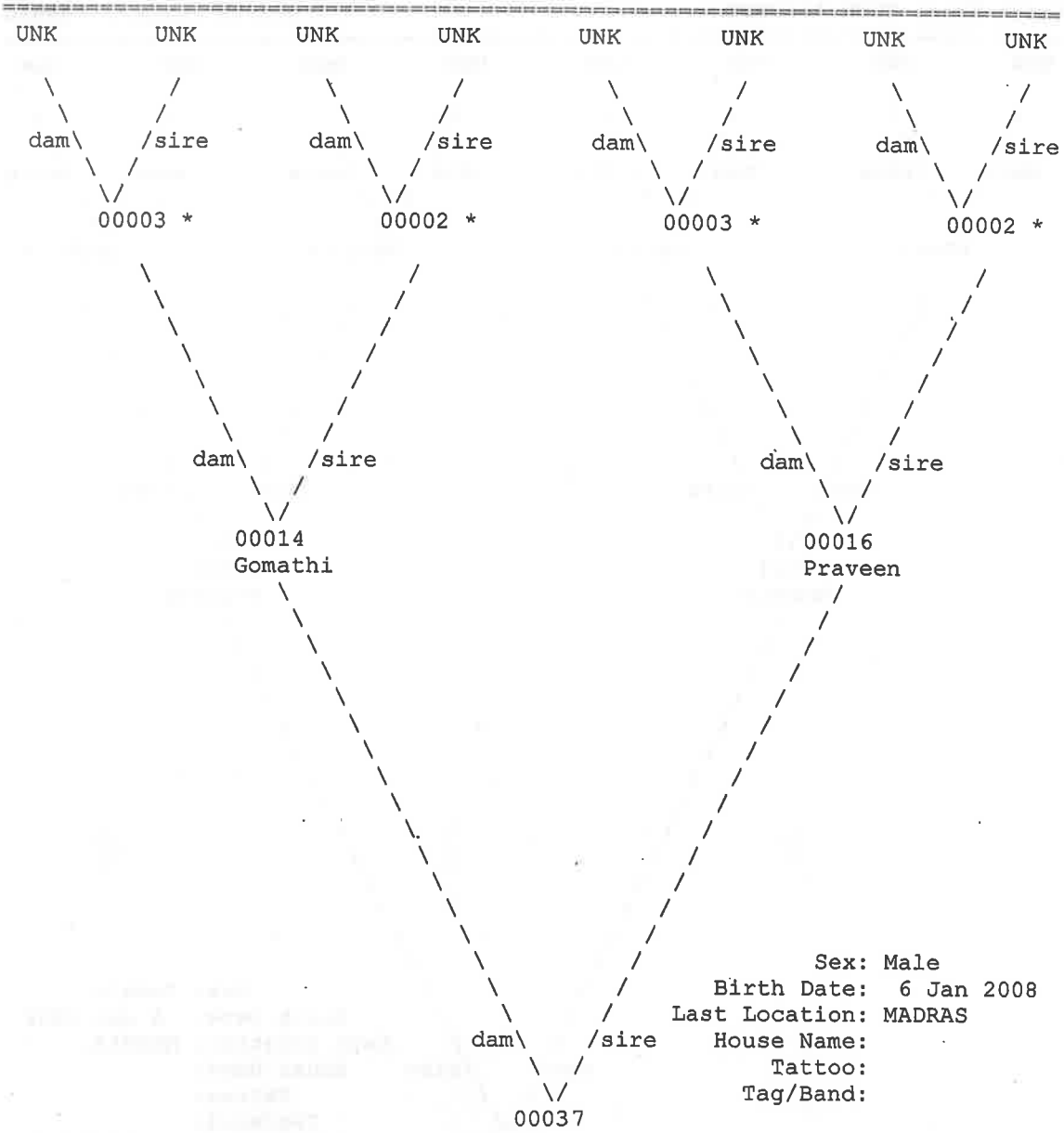
* Appear more than once...

Taxon Name: CUON ALPINUS Studbook Number: 00036



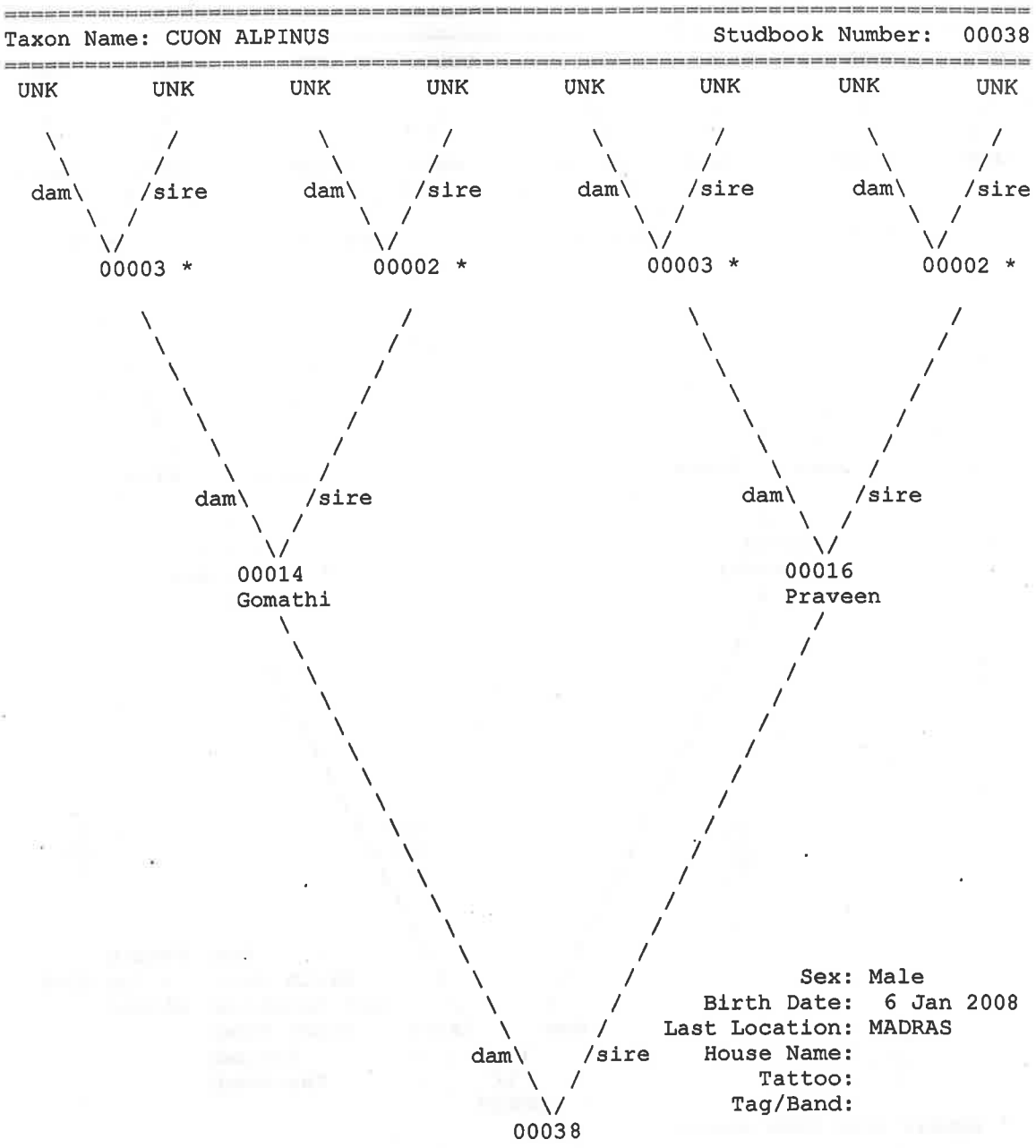
* Appear more than once...

Taxon Name: CUON ALPINUS Studbook Number: 00037



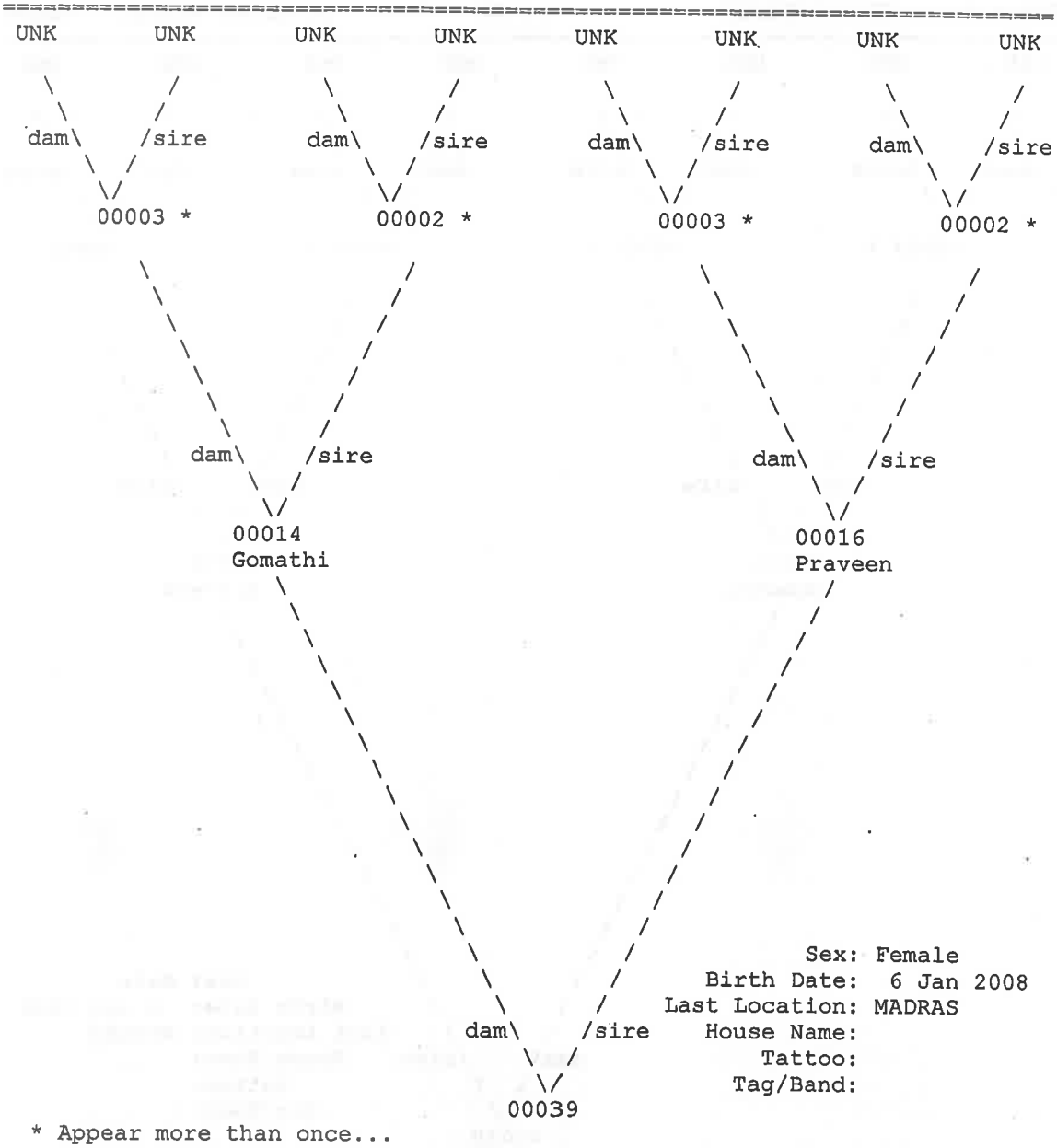
Sex: Male
Birth Date: 6 Jan 2008
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

* Appear more than once...



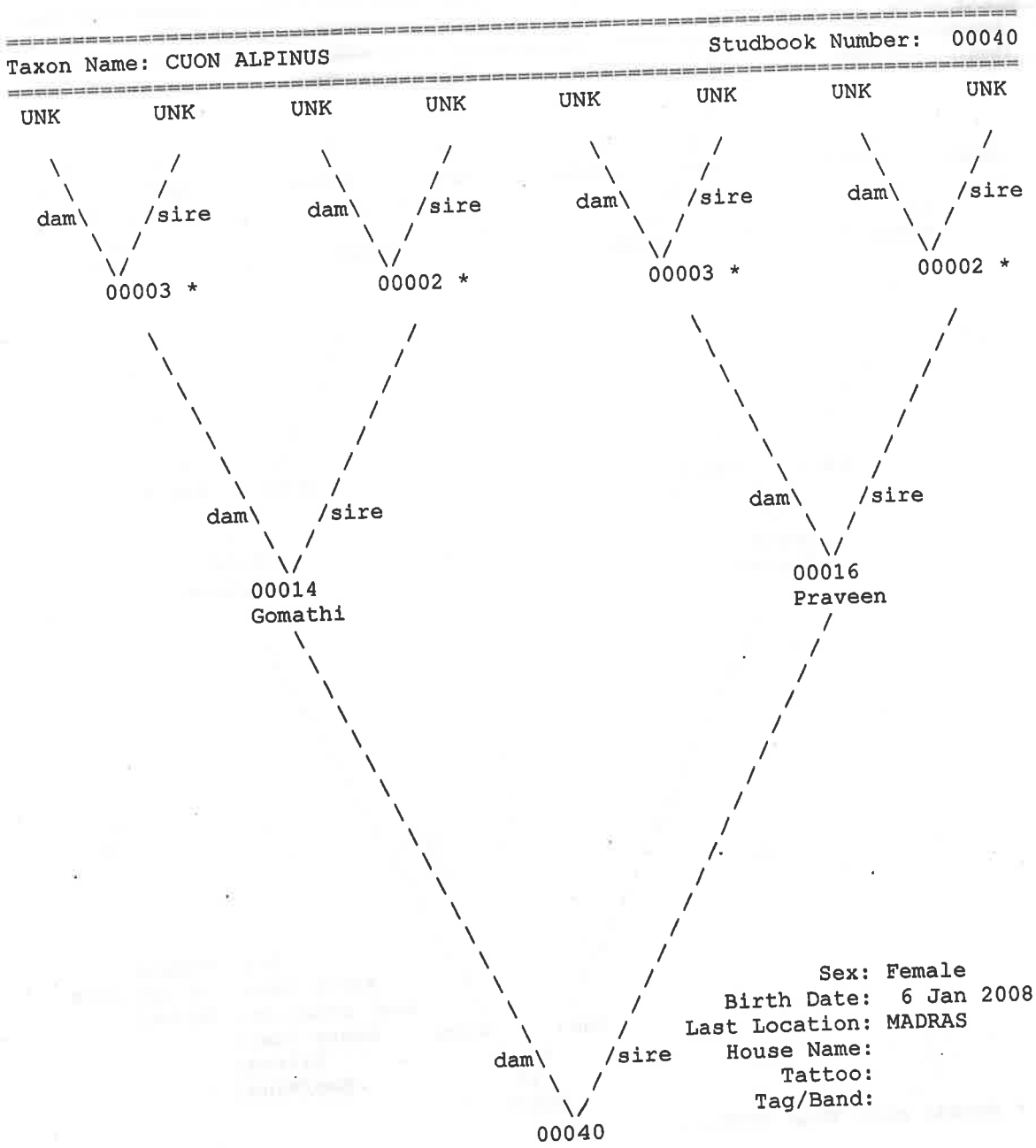
* Appear more than once...

Taxon Name: CUON ALPINUS Studbook Number: 00039

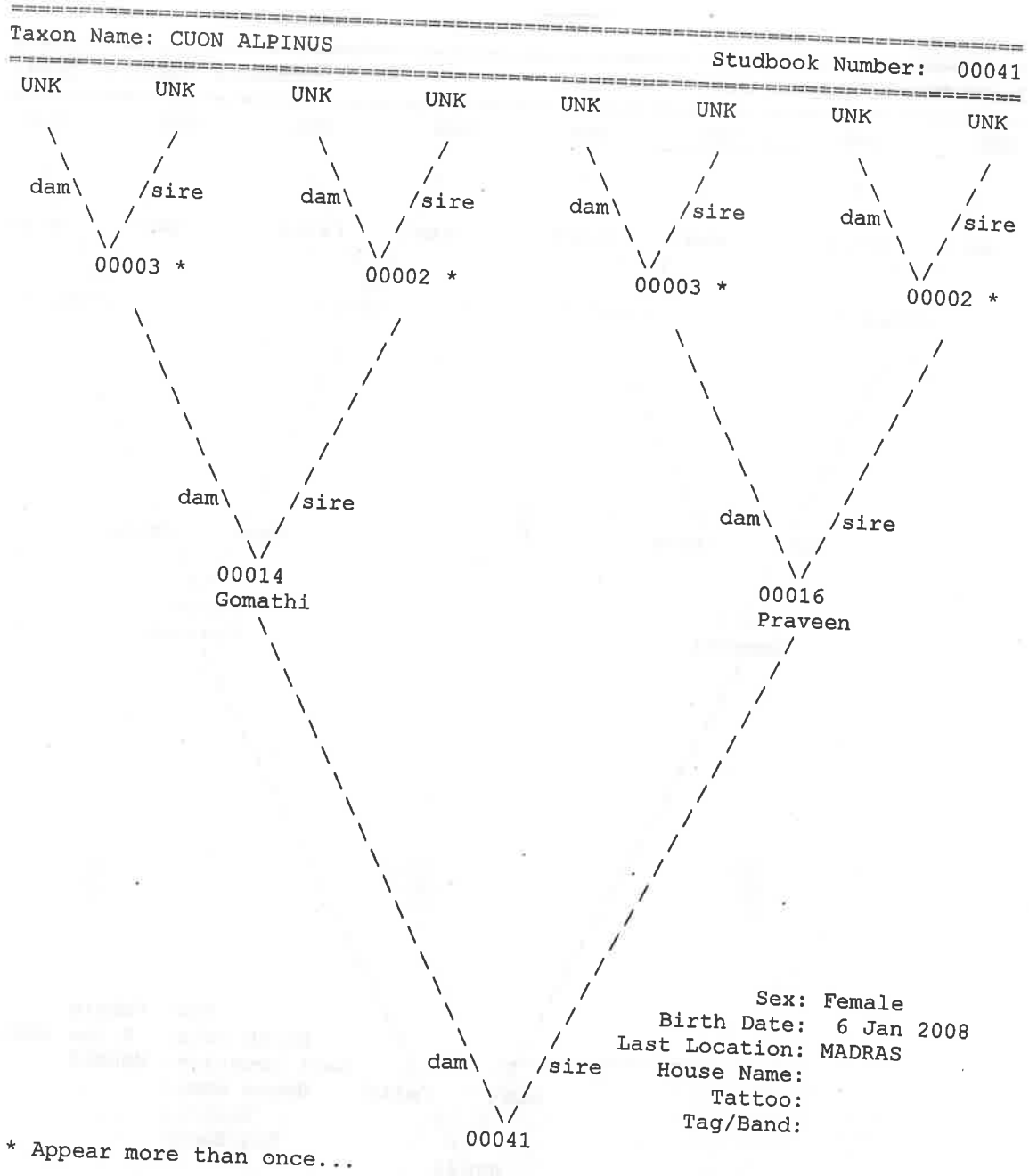


Sex: Female
Birth Date: 6 Jan 2008
Last Location: MADRAS
House Name:
Tattoo:
Tag/Band:

* Appear more than once...



* Appear more than once...



Compiled by: Anupam Srivastav thru Wildlife Institute of India
Data current thru: 1 Jun 2009 Indian regional
Printed on 10 Jun 2010 using Sparks v1.54