National Studbook of Indian Wild Ass (*Equus hemionus khur*)

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority

August, 2010

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Data current till July 31st 2008

Compiled and analysed by

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Supported by

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Authors

Contents

Indian Wild Ass: Biology and Status

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Perissodactyla
Family:	Equidae
Scientific Name:	*Equus hemionus* ssp. *khur*
Infra-specific Authority:	(Lesson, 1827)
Common Name/s:	Indian wild ass, Khur, *Ghorkhar* or *Ghorkhad* (Gujarati)

Taxonomy

The taxonomy of Asian wild ass is still to be completely deciphered. It is however, widely accepted from morphological, chromosomal and mitochondrial DNA studies that six geographically isolated subspecies of Asian wild ass exist, namely:

1. Syrian Wild Ass (*Equus hemionus hemippus*)
2. Iranian Wild Ass (*Equus hemionus onager*)
3. Trans-caspian Wild Ass (*Equus hemionus kulan*/*finschii*)
4. Mongolian Wild Ass (*Equus hemionus hemionus*/ *dzigettai*) (from northern Mongolia)
5. Southern Mongolia and northern China Wild Ass (*Equus hemionus luteus*)
6. Indian Wild Ass (*Equus hemionus khur*)

Of the six subspecies the *Equus hemionus hemippus* is considered extinct since 1927. The holotype of *Equus hemionus*, described by Pallas in 1775, was based on a specimen collected close to the northeastern boundary of Mongolia

Biology

Equids are generalist herbivores; they effectively utilize coarse plants being hindgut fermenters. Water availability restricts their ranges, as they have large water requirements. The activity pattern of the Indian wild ass remains consistent throughout the year. Annual time budget of family bands suggest that they spend 28%, and all-male herds 24% of the daytime feeding. In winters, less time is spent in feeding during the day, as they raid agricultural fields by night. Wild asses in the Little Rann of Kutch are active during the night. This is to maximise resource utilization at the natural vegetation-agriculture interface. In the Wild Ass Sanctuary Indian wild ass occupy the saline mudflats, grassland, bets (vegetated islands on the barren Rann), and the fringes where natural vegetation is interspersed with croplands.

Scrubland with low to medium density of shrubs primarily *Prosopis juliflora* an introduced exotic and Rann grassland were the most preferred habitat, providing thermal cover during the hot day, and foaling ground for gravid mares.

Behaviour

Studies on social organization and behavioural ecology of the Indian wild ass (*Equus hemionus khur*) suggest that breeding is a seasonal activity occurring predominantly during monsoon. During the breeding season males depending on their dominance hierarchy protect territories, males higher up in the hierarchy tend to have better habitat conditions in their territories while subordinate males are relegated to inferior territories. The females tend to move between territories and select mates with the best territory. Females with young tend to live in small groups of 2 – 5 adults.

Distribution

The subspecies khur was once widely distributed across the arid region of north-west India (including present day Pakistan) and westwards through much of central Asia towards Syria. However, the range is now restricted to the Little Rann of Kutch (Wild Ass Sanctuary) in Gujarat and in adjoining districts. Surveys conducted by Shah in 1993 showed the emigration from the Sanctuary into adjoining areas that are interspersed with fallow and saline lands in Surendranagar, a breeding herd was also recorded in the north-eastern part of the Nal Sarovar Bird Sanctuary.

Figure 1 Distribution of Asiatic Wild Ass
Map Source: http://www.wii.gov.in/envis/ungulates ofindia/indian_wild.htm

Threats & Status

The Indian wild ass is a species with a small distribution range restricted to the salt desert in the Little Rann of Kutch. Surra an arthropod transmitted protozoan disease devastated the population in 1958 and 1960, and this coupled with drought reduced the population to 720 in 1976. The declaration of the Little Rann of Kutch as a wildlife sanctuary in 1973 led to the recovery of the population to 2839 individuals in 1999. Current estimates suggest a population of approximately 4000 individuals.

The species is currently under severe threat from anthropogenic activities. The area has a large reserve of table salt and its extraction is a serious threat to the habitat of the wild ass. Due to the various threats faced by it *E. h. khur* Indian wild ass has been listed as **EN** Endangered B1ab(iii,v)C2a(ii) by the IUCN Red List and in Schedule I of the Wildlife Protection Act (1972)

Conservation Measures

As of March 2008, there were 12 (7 Male & 5 Female) Indian wild ass in captivity in four Indian zoos of which Sakkarbaug Zoo (Gujarat) have eleven (6 Male & 5Female). The only captive breeding Indian wild ass population is based in Sakkarbaug Zoo. In view of this, the Central Zoo Authority, has initiated a conservation breeding programme for the species with Sakkarbaug zoo as the coordinating zoo.

Methods

The data collected for the compilation of the studbook was by way of field visits to collect the data from the concerned zoos and through mailed questionnaire surveys. The data collected was entered in SPARKS 1.5. and studbook report was generated using the reports option. PM 2000 was used to produce the census report, life tables and population projections, as well as founder statistics, inbreeding coefficients, possible pairings and population planning.

For the purpose of genetic and demographic analysis the population present in Sakkarbaug Zoo, Junagadh only was used. The animals present in other zoos were not used for analyses as there was a conflict in dates of acquisition and identity.

Status in Captivity

Table 1 Status of Indian Wild Ass in Indian Zoos as on 31st March 2008

Zoo Name	Male	Female	Unsexed	Total
National Zoological Park, Delhi	1	0	0	1
Sakkarbaug Zoo, Junagadh	6	5	0	11
Total	7	5	0	12

Table 2 Location wise listing of live Indian wild ass

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
1.	John	Tag No. 17	00051	Male	23-Jul-1989	00033	00032	Birth	Junagadh	23-Jul-1989	
2.	Moti	--	00055	Male	9-Jul-1992	Unk	00032	Birth Transfer	Junagadh Delhi	9-Jul-1992 27-May-1993	
3.	Raudra	Tag No. 24	00061	Male	5-Jan-1997	Unk	00032	Birth	Junagadh	5-Jan-1997	
4.	Begum	--	00062	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
5.	Aisha	--	00063	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
6.	Sita	--	00064	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
7.	Rustam	--	00065	Male	31-Jan-2002	Wild	00062	Birth	Junagadh	31-Jan-2002	
8.	Abhee	--	00066	Male	12-Nov-2005	00065	00063	Birth	Junagadh	12-Nov-2005	
9.	67	--	00067	Male	6-Jun-2006	00065	00064	Birth	Junagadh	6-Jun-2006	
10.	68	--	00068	Female	27-Aug-2006	00065	00062	Birth	Junagadh	27-Aug-2006	
11.	69	--	00069	Male	25-Nov-2006	00065	00063	Birth	Junagadh	25-Nov-2006	
12.	70	--	00070	Female	27-Jul-2007	00065	00064	Birth	Junagadh	27-Jul-2007	

Table 3 Historical Listing of Indian Wild Ass in Indian Zoos

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
13.	1	--	00001	Male	6-Jan-1958	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	6-Jan-1958 6-Jan-1958 9-Oct-1972	
14.	2	--	00002	Female	31-May-1960	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	31-May-1960 31-May-1960 15-Nov-1960	
15.	3	--	00003	Female	18-Nov-1964	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	18-Nov-1964 18-Nov-1964 19-Jul-1969	
16.	4	--	00004	Male	6-Dec-1966	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	6-Dec-1966 6-Dec-1966 14-Dec-1966	
17.	5	--	00005	Male	6-Dec-1966	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Ahmedabad Ahmedabad	6-Dec-1966 6-Dec-1966 31-Dec-1970 31-Dec-1970	
18.	6 6	-- -- --	00006	Female	30-Oct-1969	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	30-Oct-1969 30-Oct-1969 2-Nov-1969	
19.	7	--	00007	Female	25-May-1970	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	25-May-1970 25-May-1970 24-Jun-1970	
20.	8	--	00008	Female	30-May-1970	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	30-May-1970 30-May-1970 25-Jul-1970	
21.	9	--	00009	Female	23-Jun-1970	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Jun-1970 23-Jun-1970 25-Jul-1970	
22.	10	--	00010	Male	4-Jun-1971	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Ahmedabad Ahmedabad	4-Jun-1971 4-Jun-1971 7-Jan-1977 7-Jan-1977	
23.	11	--	00011	Female	4-Jun-1971	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	4-Jun-1971 4-Jun-1971 7-Aug-1971	
24.	Juliyet	--	00012	Female	11-Oct-1974	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	11-Oct-1974 11-Oct-1974 4-Sep-1983	

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
25.	13	--	00013	Female	11-Oct-1974	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	11-Oct-1974 11-Oct-1974 22-Apr-1975	
26.	14	--	00014	Male	10-Jan-1975	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	10-Jan-1975 10-Jan-1975 30-Mar-1975	
27.	15	--	00015	Male	18-Jan-1975	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Ahmedabad Ahmedabad	18-Jan-1975 18-Jan-1975 7-Jan-1977 7-Jan-1977	
28.	16	--	00016	Male	31-Jul-1976	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	31-Jul-1976 31-Jul-1976 15-Aug-1976	
29.	17	--	00017	Male	13-Nov-1976	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	13-Nov-1976 13-Nov-1976 16-Jul-1981	
30.	18	--	00018	Male	13-Nov-1976	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	13-Nov-1976 13-Nov-1976 3-Dec-1976	
31.	19	--	00019	Male	23-Mar-1977	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Mar-1977 23-Mar-1977 12-Sep-1977	
32.	20	--	00020	Unknown	15-Aug-1977	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	15-Aug-1977 15-Aug-1977 19-Aug-1977	
33.	21	--	00021	Male	24-Oct-1977	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Hyderabad Hyderabad	24-Oct-1977 24-Oct-1977 15-Nov-1977 15-Nov-1977	
34.	22	--	00022	Male	24-Oct-1977	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	24-Oct-1977 24-Oct-1977 1-Dec-1981	
35.	23	--	00023	Female	8-Jan-1978	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Ahmedabad Ahmedabad	8-Jan-1978 8-Jan-1978 23-Feb-1978 23-Feb-1978	
36.	24	--	00024	Female	8-Jan-1978	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	8-Jan-1978 8-Jan-1978 24-Jan-1980	

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
37.	25	--	00025	Female	1-Jun-1978	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	1-Jun-1978 1-Jun-1978 4-Sep-1978	
38.	26	--	00026	Male	1-Jun-1978	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	1-Jun-1978 1-Jun-1978 6-Sep-1978	
39.	27	--	00027	Male	1-Jun-1978	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	1-Jun-1978 1-Jun-1978 23-Sep-1978	
40.	28	--	00028	Female	3-Jul-1979	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	3-Jul-1979 3-Jul-1979 17-Jul-1979	
41.	29	--	00029	Female	3-Dec-1979	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	3-Dec-1979 3-Dec-1979 6-Dec-1979	
42.	30	--	00030	Male	1-May-1981	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Nandankan Nandankan	1-May-1981 1-May-1981 30-Oct-1984 30-Oct-1984	
43.	31	--	00031	Male	27-Jun-1982	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Ahmedabad Ahmedabad	27-Jun-1982 27-Jun-1982 4-Sep-1985	
44.	Tepudi	Tag No. 12	00032	Female	27-Jun-1982	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	27-Jun-1982 27-Jun-1982 29-Aug-2004	
45.	Halaman	--	00033	Male	18-Sep-1983	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	18-Sep-1983 18-Sep-1983 16-May-1989	
46.	34	--	00034	Male	18-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	18-Aug-1984 18-Aug-1984 24-Aug-1984	
47.	35	--	00035	Male	18-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	18-Aug-1984 18-Aug-1984 24-Aug-1984	
48.	36	--	00036	Female	18-Aug-1984	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Chennai Chennai	18-Aug-1984 18-Aug-1984 19-Sep-1984 19-Sep-1984	

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
49.	37	--	00037	Female	18-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	18-Aug-1984 18-Aug-1984 6-Sep-1984	
50.	38	--	00038	Male	23-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Aug-1984 23-Aug-1984 18-Oct-1984	
51.	39	--	00039	Male	23-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Aug-1984 23-Aug-1984 9-Sep-1984	
52.	40	--	00040	Male	23-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Aug-1984 23-Aug-1984 11-Sep-1984	
53.	41	--	00041	Male	23-Aug-1984	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Chennai Chennai	23-Aug-1984 23-Aug-1984 19-Sep-1984 19-Sep-1984	
54.	42	--	00042	Female	23-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Aug-1984 23-Aug-1984 23-Aug-1984	
55.	43	--	00043	Female	23-Aug-1984	Wild	Wild	Wild Capture Transfer Transfer Go LTF	WAS Junagadh Nandankannan Nandankannan	23-Aug-1984 23-Aug-1984 30-Oct-1984 30-Oct-1984	
56.	Jethi	Tag No. 13	00044	Female	23-Aug-1984	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	23-Aug-1984 23-Aug-1984 19-Oct-1994	
57.	Amar	Tag No. 14	00045	Male	4-Oct-1985	Unk	00032	Birth Transfer Go LTF	Junagadh Ahmedabad Ahmedabad	4-Oct-1985 24-Feb-1989 24-Feb-1989	
58.	Gajara	Tag No. 15	00046	Female	25-Oct-1985	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	25-Oct-1985 25-Oct-1985 2-Oct-1996	
59.	Soniya	Tag No. 16	00047	Female	27-Sep-1987	00033	00032	Birth Death	Junagadh Junagadh	27-Sep-1987 23-Jun-1994	
60.	48	--	00048	Male	15-Jun-1988	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	15-Jun-1988 15-Jun-1988 16-Aug-1988	
61.	Rajiv	--	00049	Male	13-Nov-1988	00033	00047	Birth Transfer Go LTF	Junagadh Ahmedabad Ahmedabad	13-Nov-1988 12-Sep-1991 12-Sep-1991	

Sl. No.	Home Name/ Local ID	Tag No.	National Studbook No.	Sex	Date of Birth	Sire (National Studbook No.)	Dam (National Studbook No.)	Event	Location	Date	Remarks
62.	50	--	00050	Female	28-Feb-1989	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	28-Feb-1989 28-Feb-1989 3-Mar-1989	
63.	John	Tag No. 17	00051	Male	23-Jul-1989	00033	00032	Birth	Junagadh	23-Jul-1989	
64.	Madhav	--	00052	Male	31-Jan-1990	Wild	Wild	Wild Capture Transfer Death	WAS Junagadh Junagadh	31-Jan-1990 31-Jan-1990 18-Feb-1990	
65.	Revati	Tag No. 18	00053	Female	10-Feb-1991	Unk	00047	Birth Death	Junagadh Junagadh	10-Feb-1991 6-Jul-1991	
66.	Sujata	--	00054	Female	27-Jun-1992	Unk	00046	Birth Transfer Go LTF	Junagadh Delhi Delhi	27-Jun-1992 27-May-1993 27-May-1993	
67.	Moti	--	00055	Male	9-Jul-1992	Unk	00032	Birth Transfer	Junagadh Delhi	9-Jul-1992 27-May-1993	
68.	Radha	Tag No. 19	00056	Female	19-Jul-1993	Unk	00047	Birth Death	Junagadh Junagadh	19-Jul-1993 15-Aug-1996	
69.	57	--	00057	Male	11-Jun-1994	Unk	00046	Birth Death	Junagadh Junagadh	11-Jun-1994 11-Jun-1994	
70.	58	Tag No. 20	00058	Male	23-Jun-1995	Unk	00032	Birth Death	Junagadh Junagadh	23-Jun-1995 15-Aug-1996	
71.	Akbar	Tag No. 21	00059	Male	23-Jul-1995	Unk	00046	Birth Death	Junagadh Junagadh	23-Jul-1995 11-Jun-2003	
72.	60	--	00060	Female	17-Aug-1996	Unk	Unk	Birth Death	Junagadh Junagadh	17-Aug-1996 10-Sep-1997	
73.	Raudra	Tag No. 24	00061	Male	5-Jan-1997	Unk	00032	Birth	Junagadh	5-Jan-1997	
74.	Begum	--	00062	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
75.	Aisha	--	00063	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
76.	Sita	--	00064	Female	18-Aug-2001	Wild	Wild	Wild Capture Transfer	WAS Junagadh	18-Aug-2001 18-Aug-2001	
77.	Rustam	--	00065	Male	31-Jan-2002	Wild	00062	Birth	Junagadh	31-Jan-2002	
78.	Abhee	--	00066	Male	12-Nov-2005	00065	00063	Birth	Junagadh	12-Nov-2005	
79.	67	--	00067	Male	6-Jun-2006	00065	00064	Birth	Junagadh	6-Jun-2006	
80.	68	--	00068	Female	27-Aug-2006	00065	00062	Birth	Junagadh	27-Aug-2006	
81.	69	--	00069	Male	25-Nov-2006	00065	00063	Birth	Junagadh	25-Nov-2006	
82.	70	--	00070	Female	27-Jul-2007	00065	00064	Birth	Junagadh	27-Jul-2007	

L**ocation Glossary:** WAS: Wild Ass Sanctuary, Junagadh; Sakkarbaug Zoo, Junagadh; Chennai: Arignar Anna Zoological Park, Vandalur, Chennai; Delhi: National Zoological Park, Delhi; Hyderabad: Nehru Zoological Park, Hyderabad; Ahmedabad: Kamala Nehru Zoological Park, Ahmedabad; Nandankannan: Nandankanan Biological Park, Bhubaneswar

Population Planning/ Recommendations

Habitat fragmentation, disease and developmental activities are severe threats to the continued survival of Indian Wild Ass. Due to the various threats it is listed in Schedule I of the Wildlife Protection Act (1972) India and as endangered in the IUCN Red List of Threatened Species. Ensuring the long term survival of the species necessitates the protection of habitat and ensuring habitat connectivity. Due to the various threats to the long-term survival of the species it becomes essential to maintain a demographically stable and genetically viable population for future reintroductions if required; and insurance.

The Indian captive population is an effort in this direction. The captive population comprises of 12 specimens distributed across 2 zoos. Of these the population at Sakkarbaug Zoo, Junagadh alone is capable of breeding as National Zoological Park, Delhi has a single male. PM 2000 has a total of 25 animals as alive in the studbook as it treats lost to follow up animals as alive. The total number of animals across time in the studbook is 70, of these 51 individuals are of wild origin and only 7 of these have contributed to the gene pool of the captive population. The captive population retains a small part of the genetic variability of the founder population (Table 4) and needs to be intensively managed to maintain a demographically viable and genetically stable population.

Table 4 Genetic Summary Table:

	Current	Potential
Founders	7	10 additional
Founder genome equivalents	3.6	15.76
Founder genome surviving	5	15.76
Gene diversity retained	0.861	0.968
Population mean kinship	0.139	0.032
Mean inbreeding	0.05	0.032
Ne / N	0.13	-----
% of pedigree known	91	-----

Management strategy

Population modeling of the Captive Indian Wild Ass population was carried out using PM 2000. Based on the analysis it is envisaged that a population of 176 individuals to be achieved over a span of the next 20 years. The management strategy for the species is summarized in table 5.

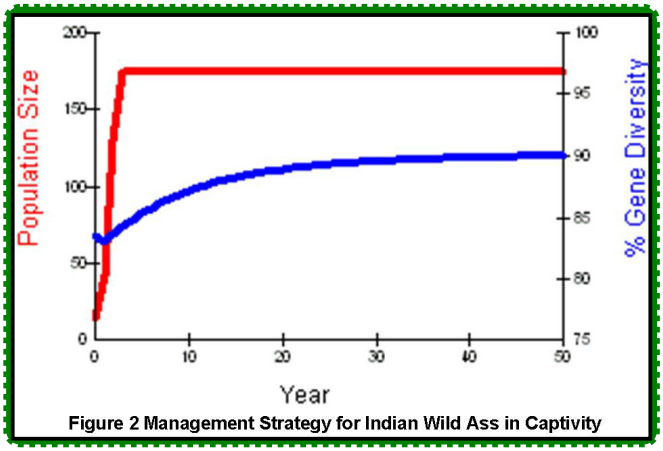

Figure 2 Management Strategy for Indian Wild Ass in Captivity

The maintenance of the desired level of genetic diversity (90% of the founder gene diversity) can be done by the addition of one founder animal for the next 50 years with a maximum population size of 200 individuals.

Table 5 Management Strategy

	Planned
Generation length	5.3
Population growth rate	3
Ne / N ratio	0.13
Initial gene diversity	0.887
Target population size	176
Maximum Allowable Population Size	200.0000
New Founders per Addition Event	1.0000
Year to Start Adding Founders	1.0000
Year to Stop Adding Founders	50.0000
Years Between Addition Events	1.0000
FGE Recruited per New Founder	0.4000

Generation length: 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.

Effective Population Size (Ne / N ratio) -- 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).

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).

Pairings

Possible pairings of living individuals were carried out using PM 2000. Individuals at Sakkarbaug Zoo, Junagadh only, were selected for this purpose. The individuals at other locations were excluded out from the analysis because they are single animals and the possibility of finding mates for them is low. Transfer of animals from Sakkarbaug zoo is at present not recommended as it is the lone breeding population.

Table 6 Ordered mean kinships

	Males						Females				
Rank	**Stbk#**	**MK**	**Known**	**Age**	**Location**		**Stbk#**	**MK**	**Known**	**Age**	**Location**
1	00051	0.1125	100.0	21	Junagadh		00063	0.0500	100.0	0	Junagadh
2	00061	0.1375	50.0	14	Junagadh		00064	0.0500	100.0	0	Junagadh
3	00066	0.1438	100.0	5	Junagadh		00062	0.1125	100.0	0	Junagadh
4	00067	0.1438	100.0	4	Junagadh		00070	0.1438	100.0	3	Junagadh
5	00069	0.1438	100.0	4	Junagadh		00068	0.1750	100.0	4	Junagadh
6	00065	0.1875	100.0	8	Junagadh						

Based on the results obtained from the pairing options of PM 2000, the individuals in table 7 are recommended for mating while individuals in table 8 are not suggested for pairing based on the offspring's' inbreeding coefficients obtained from pairings.

Table 7 Pairings recommended for breeding

Sl. No.	Sire	Dam	Inbreeding Coefficient
1.	00061	00062	0
2.	00061	00063	0
3.	00061	00064	0
4.	00061	00068	0
5.	00061	00070	0
6.	00065	00063	0
7.	00065	00064	0
8.	00066	00064	0
9.	00067	00063	0
10.	00069	00064	0

Table 8 Pairings not recommended for breeding

Sl. No.	Sire	Dam	Inbreeding Coefficient
1.	00065	00062	0.25
2.	00065	00068	0.375
3.	00065	00070	0.25
4.	00066	00062	0.125
5.	00066	00063	0.25
6.	00066	00068	0.188
7.	00066	00070	0.125
8.	00067	00062	0.125
9.	00067	00064	0.25
10.	00067	00068	0.188
11.	00067	00070	0.25
12.	00069	00062	0.125
13.	00069	00063	0.25
14.	00069	00068	0.188
15.	00069	00070	0.125

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.

Demographic Analyses

Census

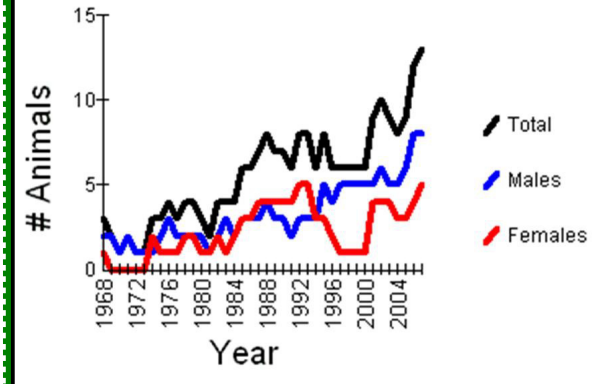

Figure 3 Census details of Indian wild ass in Captivity

The captive Indian Wild Ass population originates from individuals captured/rescued from the wild. Of the 70 individuals listed in the present studbook as many as 51 individuals are of wild origin. The population was initiated in 1958 by way of capture of a male the first female entered the population in 1964. The first captive bred individual was born in 1985.

The population since its inception has been unstable with a low population growth rate (lambda) which at times has dipped below 1 indicating a negative growth rate.

Table 9 Census details of Indian wild ass in captivity

Year	Total	Females	Males	Unsexed	Wild	Captive Bred	Lambda
1958	1		1		1		
1959	1		1		1		1
1960	1		1		1		1
1961	1		1		1		1
1962	1		1		1		1
1963	1		1		1		1
1964	2	1	1		2		2
1965	2	1	1		2		1
1966	3	1	2		3		1.5
1967	3	1	2		3		1
1968	3	1	2		3		1
1969	2		2		2		0.667
1970	1		1		1		0.5
1971	2		2		2		2
1972	1		1		1		0.5
1973	1		1		1		1
1974	3	2	1		3		3
1975	3	1	2		3		1
1976	4	1	3		4		1.333
1977	3	1	2		3		0.75
1978	4	2	2		4		1.333
1979	4	2	2		4		1
1980	3	1	2		3		0.75
1981	2	1	1		2		0.667
1982	4	2	2		4		2
1983	4	1	3		4		1
1984	4	2	2		4		1
1985	6	3	3		5	1	1.5
1986	6	3	3		5	1	1
1987	7	4	3		5	2	1.167
1988	8	4	4		5	3	1.143
1989	7	4	3		4	3	0.875
1990	7	4	3		4	3	1
1991	6	4	2		4	2	0.857
1992	8	5	3		4	4	1.333
1993	8	5	3		4	4	1
1994	6	3	3		3	3	0.75
1995	8	3	5		3	5	1.333
1996	6	2	4		2	4	0.75
1997	6	1	5		2	4	1
1998	6	1	5		2	4	1
1999	6	1	5		2	4	1
2000	6	1	5		2	4	1
2001	9	4	5		5	4	1.5
2002	10	4	6		5	5	1.111
2003	9	4	5		5	4	0.9
2004	8	3	5		4	4	0.889
2005	9	3	6		4	5	1.125
2006	12	4	8		4	8	1.333
2007	13	5	8		4	9	1.083

Age Distribution

The age distribution of the captive Indian wild ass population was modeled using PM 2000 and is based on individuals of known ages. The age distribution suggests that there are very few females in the reproductive age classes, this absence may also be responsible for low levels of population growth. However, known age individuals form a very small part of the total captive population of Indian wild ass, the age distribution is therefore not a true reflection of the captive population.

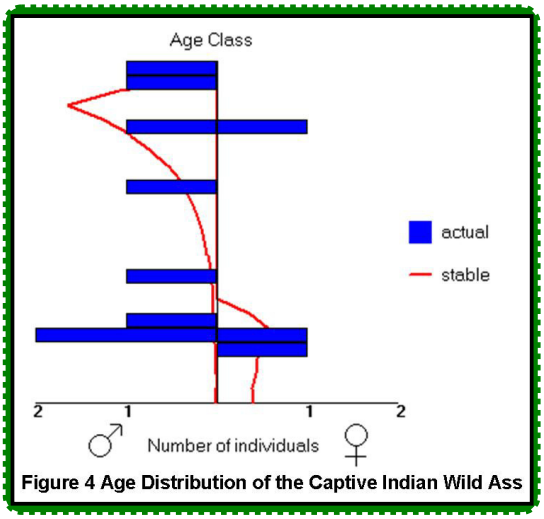

Figure 4 Age Distribution of the Captive Indian Wild Ass

Life Table Analyses

An analysis of life tables for males suggests that a mortality peak is recorded in the first year, thereafter a peak is observed in the 7th year. The first successful reproduction by males was observed to occur between the third and fourth year of life and peaked in the fifth year. Thereafter it abruptly stopped. However, the life table is also based on individuals of known age (N = 6) which forms a small percentage of the total population and hence cannot be used for population predictions. The life tables for females suggests that mortality (Qx) is high in the first two years of life and thereafter shows a peak in the 3rd to 4th year and remains as a plateau after the 6th year. Fecundity peaks in the 5th year and then all breeding activity stops as is suggested by the life table. However the predictive use of the life table is limited due to the small sample size (N = 5). The low levels of fecundity of males and females may be due to the absence of individuals in the reproductive age classes as is evinced from figure 3. The low population growth rate can also be attributed to the same.

Table 10 Life Table data for known age males and females

Age	Males					Females				
	Qx	Px	Lx	Mx	Vx	Qx	Px	Lx	Mx	Vx
0	0.150	0.850	1.000	0.000	1.081	0.250	0.750	1.000	0.000	1.143
1	0.090	0.910	0.850	0.000	0.939	0.200	0.800	0.750	0.120	1.170
2	0.000	1.000	0.774	0.000	0.752	0.000	1.000	0.600	0.000	0.932
3	0.000	1.000	0.774	0.060	0.573	0.350	0.650	0.600	0.260	0.892
4	0.000	1.000	0.774	0.260	0.391	0.000	1.000	0.390	0.000	0.633
5	0.000	1.000	0.774	0.100	0.100	0.000	1.000	0.390	0.500	0.500
6	0.000	1.000	0.774	0.000	0.000	1.000	0.000	0.390	0.000	0.000
7	0.200	0.800	0.774	0.000	0.000	1.000	0.000	0.000	0.000	0.000
8	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
9	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
10	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
11	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
12	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
13	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
14	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
15	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
16	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
17	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
18	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
19	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
20	0.000	1.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
21	1.000	0.000	0.619	0.000	0.000	1.000	0.000	0.000	0.000	0.000
22	1.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity; Vx = expected future reproduction

The projected population growth rates as determined from life table analysis are summarized in table 11. The table suggests that the population is declining as all the indices used to measure population growth show declining trends.

Table 11 Projected population growth rates

	Males	Females
r	-0.2712	0.2364
lambda	0.7624	0.7895
R_0	0.232	0.297
T	5.38	5.14

Population Projections

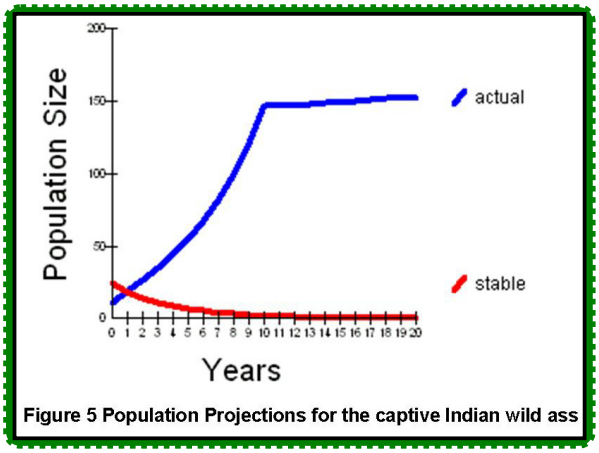

Figure 5 Population Projections for the captive Indian wild ass

A population projection for a stable age distribution of the captive Indian wild ass population was generated using PM 2000. The goals scenario of PM 2000 suggests that a population size of 176 individuals to be achieved over the next 20 years would be required for the maintenance of a genetically viable and demographically stable population. The projection for a stable population with the current population size suggests a declining trend and a total elimination of the captive population by the 10th year, whereas the actual population with the addition of new animals and a positive growth suggests of an increase in population size. Table 12 summarizes the number of births and pairs required each year to achieve a demographically viable population. Table 13 presents the number of individuals required each year for the next 20 years in the various age classes to achieve a target population of 176 individuals at the end of that period.

Table 12 Minimum number of births and pairs required to achieve target population.

Year	# Births	# Pairs
0	11.5048	23
1	7.798205	15.6
2	11.11862	22.2
3	11.36576	22.7
4	10.24456	20.5
5	10.94181	21.9
6	14.69711	29.4
7	17.87202	35.7
8	19.0858	38.2
9	21.67801	43.4
10	24.42243	48.8

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.

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

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.

Table 13 Population projections for the captive Indian wild ass population

Age Class	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	11.50	7.80	11.12	11.37	10.24	10.94	14.70	17.87	19.09	21.68	24.42	27.24	32.07	36.96	41.02	20.14	19.95	19.03	17.05	16.78
0.00	0.00	10.35	7.02	10.01	10.23	9.22	9.85	13.23	16.08	17.18	19.51	21.98	24.52	28.86	33.27	36.92	18.12	17.96	17.13	15.34	15.10
1.00	0.00	0.00	8.55	5.80	8.27	8.45	7.62	8.13	10.93	13.29	14.19	16.11	18.16	20.25	23.84	27.48	30.50	14.97	14.83	14.15	12.67
2.00	0.00	0.00	0.00	7.90	5.36	7.64	7.81	7.04	7.51	10.09	12.27	13.11	14.89	16.77	18.71	22.02	25.39	28.17	13.83	13.70	13.07
3.00	1.00	0.00	0.00	0.00	7.30	4.95	7.05	7.21	6.50	6.94	9.32	11.34	12.11	13.75	15.49	17.28	20.34	23.44	26.02	12.77	12.66
4.00	3.00	0.79	0.00	0.00	0.00	6.69	4.54	6.47	6.61	5.96	6.37	8.55	10.40	11.10	12.61	14.21	15.85	18.65	21.50	23.87	11.72
5.00	1.00	3.00	0.79	0.00	0.00	0.00	6.69	4.54	6.47	6.61	5.96	6.37	8.55	10.40	11.10	12.61	14.21	15.85	18.65	21.50	23.87
6.00	0.00	1.00	2.50	0.39	0.00	0.00	0.00	5.57	3.78	5.38	5.50	4.96	5.30	7.12	8.65	9.24	10.50	11.83	13.19	15.53	17.90
7.00	0.00	0.00	0.90	1.80	0.00	0.00	0.00	0.00	4.00	2.71	3.87	3.96	3.57	3.81	5.12	6.22	6.64	7.55	8.50	9.48	11.16
8.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55	5.53	5.91	6.71	7.56	8.43
9.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55	5.53	5.91	6.71	7.56
10.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55	5.53	5.91	6.71
11.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55	5.53	5.91
12.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55	5.53
13.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39	4.55
14.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17	3.39
15.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52	3.17
16.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44	3.52
17.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41	3.44
18.00	2.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56	2.41
19.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00	3.56
20.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.80	1.60	0.00	0.00	0.00	0.00
21.00	1.00	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.40	0.80	0.00	0.00	0.00
22.00	1.00	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	11.00	18.14	22.76	29.20	35.55	41.34	47.95	56.08	65.28	75.13	86.36	99.18	113.80	131.06	150.67	172.41	173.10	174.69	175.83	176.07	176.30

Genetic analyses

Indian wild ass is facing problems of loss of genetic diversity due to declining numbers, reduction in habitat size and habitat fragmentation. The captive population is a small sample of this already reduced genetic diversity. The genetic management of the captive population therefore assumes greater importance. The genetic summary of the captive population is presented in table 4. The table suggests that the genetic diversity of the population could have been much higher than the existing level. Discussed below are genetic parameters of importance for captive management of the species.

Founder Statistics

Founder analysis of the captive Indian wild ass population was carried out using PM 2000. The results of this analysis are presented in table 14 and figure 6. The analysis suggests that a large number of the founder animals that entered the population exited without contributing their genes to the population. Moreover the animals that contributed their genes did so unequally. An equitable contribution of genes to the population would have a significant impact on the genetic diversity of the population.

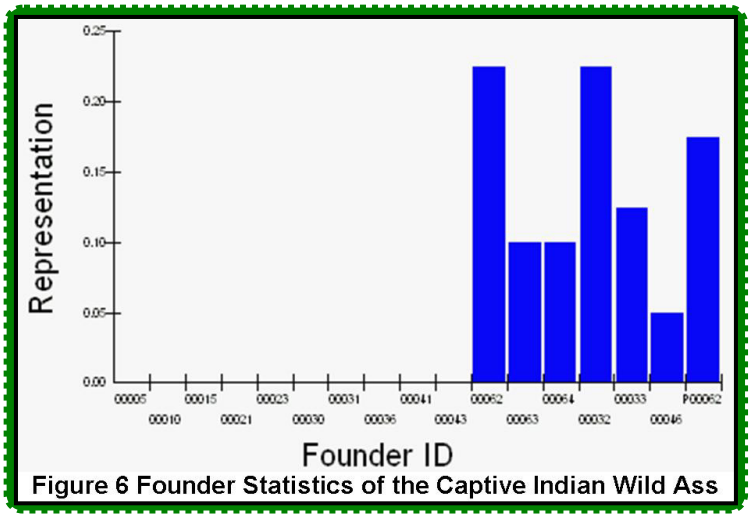

Figure 6 Founder Statistics of the Captive Indian Wild Ass

Table 14 Founder Statistics of the captive Indian wild ass population

Studbook #	Sex	Representation	Contribution	Allele Retent.	Potential Ret.	Descendants
P00062	M	0.1750	1.7500	0.5000	0.5000	6.00
00005	M	0.0000	0.0000	0.0000	1.0000	0.00
00010	M	0.0000	0.0000	0.0000	1.0000	0.00
00015	M	0.0000	0.0000	0.0000	1.0000	0.00
00021	M	0.0000	0.0000	0.0000	1.0000	0.00
00023	F	0.0000	0.0000	0.0000	1.0000	0.00
00030	M	0.0000	0.0000	0.0000	1.0000	0.00
00031	M	0.0000	0.0000	0.0000	1.0000	0.00
00032	F	0.2250	2.2500	0.9515	0.9515	5.00
00033	M	0.1250	1.2500	0.8110	0.8110	2.00
00036	F	0.0000	0.0000	0.0000	1.0000	0.00
00041	M	0.0000	0.0000	0.0000	1.0000	0.00
00043	F	0.0000	0.0000	0.0000	1.0000	0.00
00046	F	0.0500	0.5000	0.5000	0.5000	1.00
00062	F	0.2250	2.2500	0.7400	1.0000	6.00
00063	F	0.1000	1.0000	0.7455	1.0000	2.00
00064	F	0.1000	1.0000	0.7555	1.0000	2.00

Individual Statistics

The genetic details of the captive Indian wild ass population are summarized in table 15. The information can be used to manage pairings. Specimens with low inbreeding coefficients and mean kinship values are suitable for inclusion in the breeding programme as they retain a larger part of the genetic diversity of the wild population. Individuals with fewer numbers of offspring are more preferable for breeding than individuals with a larger number of progeny as the gene pool of the latter is already well represented in the population.

Table 15 Individual Statistics of Captive Indian wild ass

Studbook No.	Sex	Sire	Dam	Age	Location	% Known	F	MK	KV	FOKE	Progeny	Local ID
00051	M	00033	00032	21	Junagadh	100	0	0.112	0	4.5	0	John
00055	M	P00032	00032	18	Delhi	50	0	0.138	0	5.5	0	Moti
00061	M	P00032	00032	14	Junagadh	50	0	0.138	0	5.5	0	Raudra
00062	F	Wild	Wild	0	Junagadh	100	0	0.112	0.191	4.5	2	Begum
00063	F	Wild	Wild	0	Junagadh	100	0	0.05	0.051	2	2	Aisha
00064	F	Wild	Wild	0	Junagadh	100	0	0.05	0.133	2	2	Sita
00065	M	P00062	00062	8	Junagadh	100	0	0.188	0.283	7.5	5	Rustam
00066	M	00065	00063	5	Junagadh	100	0	0.144	0.177	5.8	0	Abhee
00067	M	00065	00064	4	Junagadh	100	0	0.144	0.249	5.8	0	67
00068	F	00065	00062	4	Junagadh	100	0.25	0.175	0.303	7	0	68
00069	M	00065	00063	4	Junagadh	100	0	0.144	0.208	5.8	0	69
00070	F	00065	00064	3	Junagadh	100	0	0.144	0.301	5.8	0	70

Inbreeding statistics

Table 16 summarizes the inbreeding coefficients of the captive population of Indian wild ass in Indian zoos. Studbook number 68 has a significant level of inbreeding and their offspring would accordingly contain lesser genetic diversity. The use of these two individuals and their offspring in the breeding programme should be done with caution.

Table 16 Inbreeding Coefficients of Live Individuals

Studbook #	Sex	Age	Location	% Known	F Inbreeding Coefficient
00051	M	21	Junagadh	100	0
00061	M	14	Junagadh	50	0
00062	F	0	Junagadh	100	0
00063	F	0	Junagadh	100	0
00064	F	0	Junagadh	100	0
00065	M	8	Junagadh	100	0
00066	M	5	Junagadh	100	0
00067	M	4	Junagadh	100	0
00068	F	4	Junagadh	100	0.25
00069	M	4	Junagadh	100	0
00070	F	3	Junagadh	100	0

Conclusions

Indian wild ass, an equid species inhabits the saline-arid region of the Rann of Kutch in Gujarat. The species is increasingly threatened by developmental activities leading to habitat loss and fragmentation. It is currently listed as endangered in the IUCN red list of threatened species and in Schedule I of the Wildlife protection Act of India (1972). The species occurs in captivity only in Indian zoos and Sakkarbaug zoo, Junagadh has the lone breeding population.

Indian zoos have currently 12 specimens in two zoos. Analysis of the captive population suggests that the species has negative growth rates and low levels of genetic diversity. The captive population is being sustained because of continued addition of wild founders. It is suggested that in order to maintain a genetically viable and demographically stable population a population size of 176 individuals to be achieved over the next 20 years is required. The maintenance of 90% genetic diversity over the next 50 years can be achieved by the addition of one founder animal each year for the next 50 years.

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Glossary of Terms

Demographic Terms

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

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.

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").

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.

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

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

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.

Genetic Terms

(Founder) 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.

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 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).

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.

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

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

Appendix I

Pedigree Chart Report

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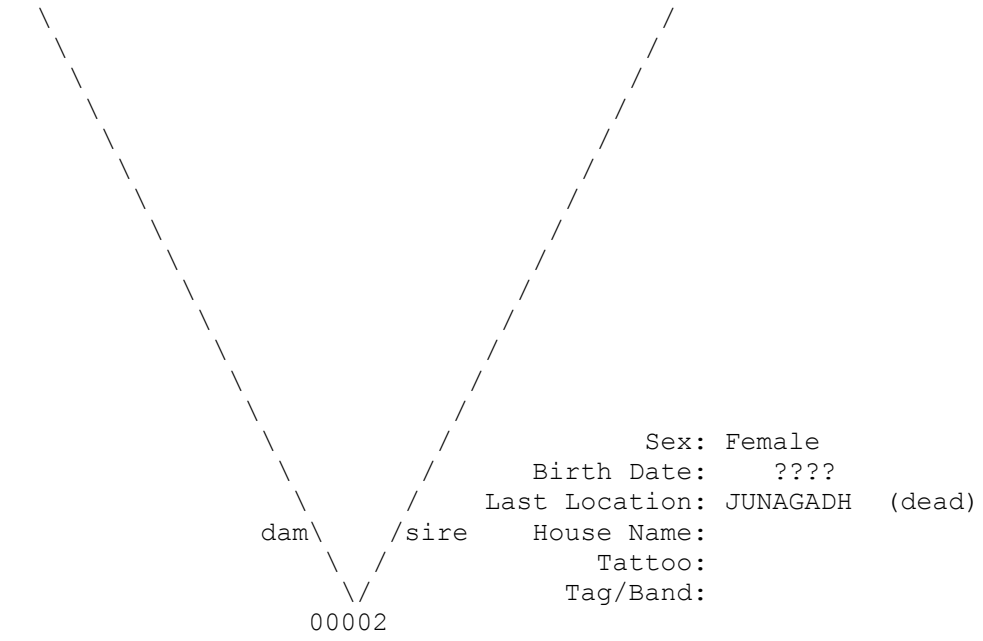
Taxon Name: EQUUS HEMIONUS KHUR — Studbook Number: 00002



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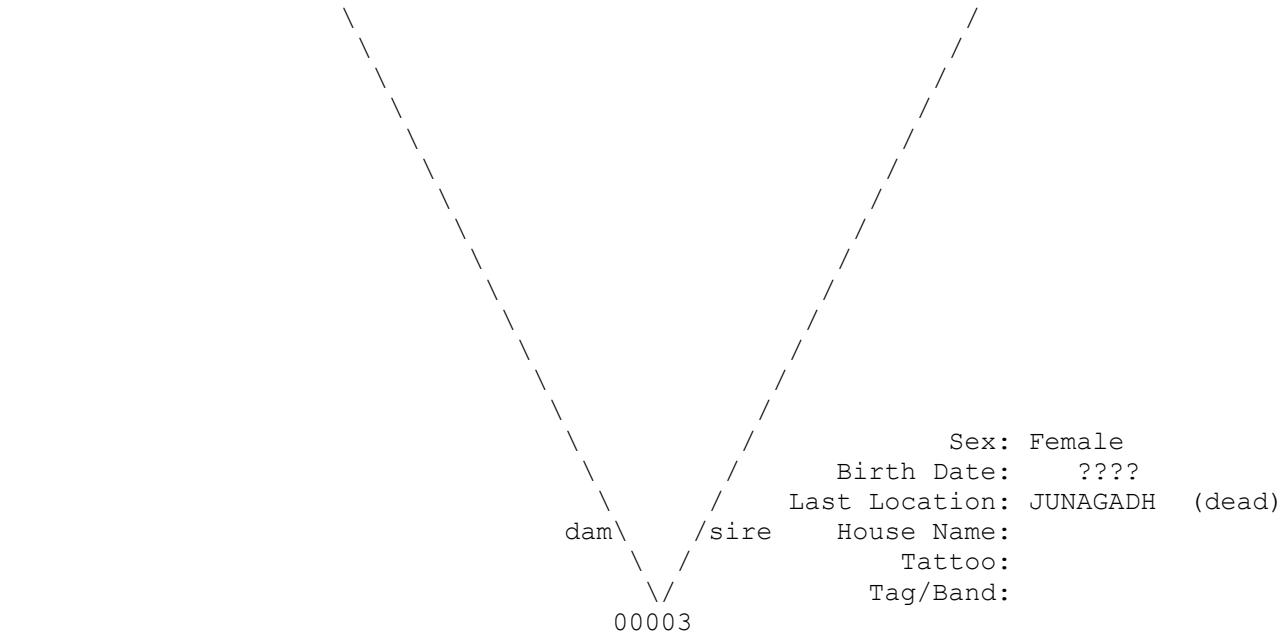

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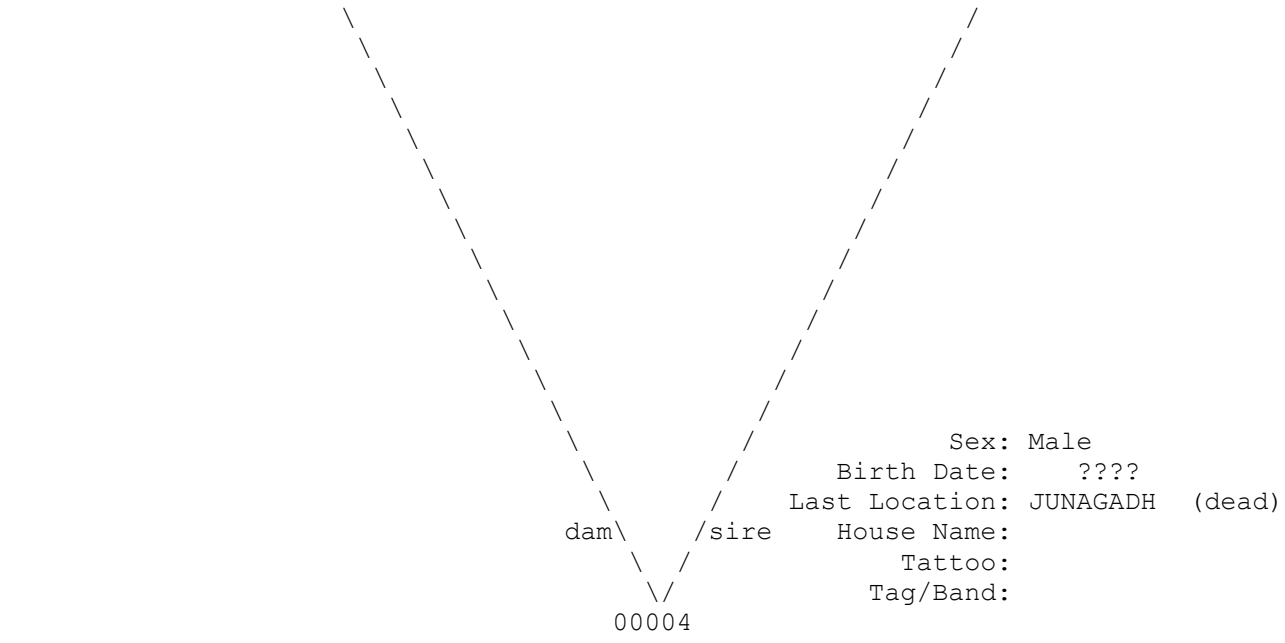

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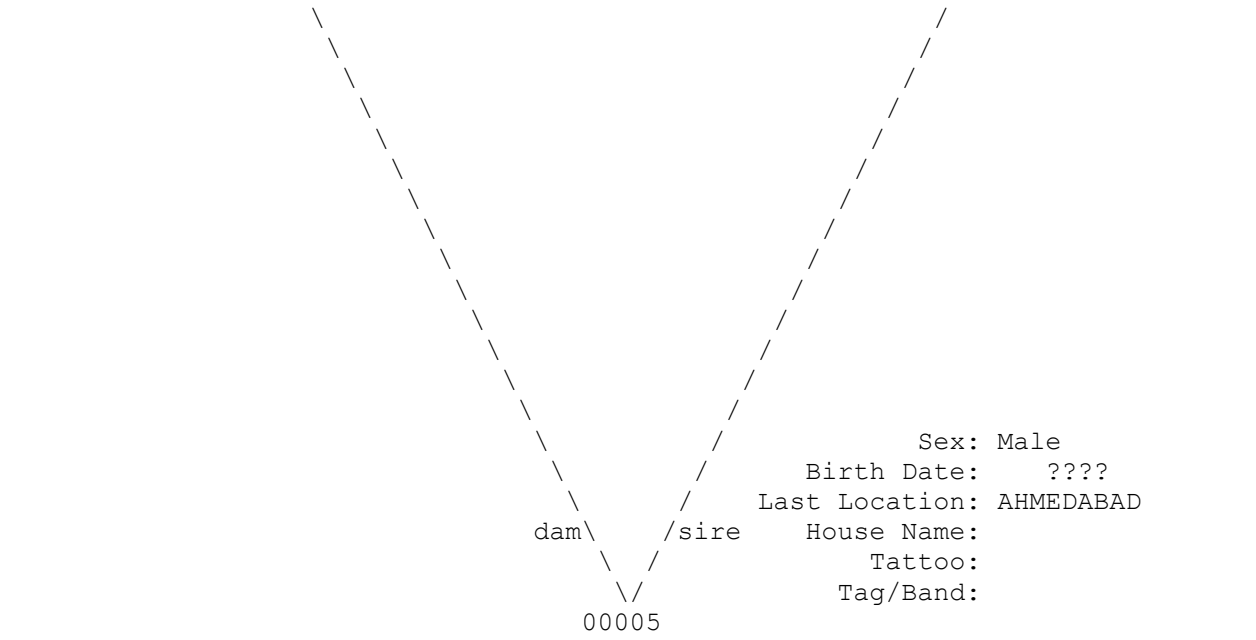

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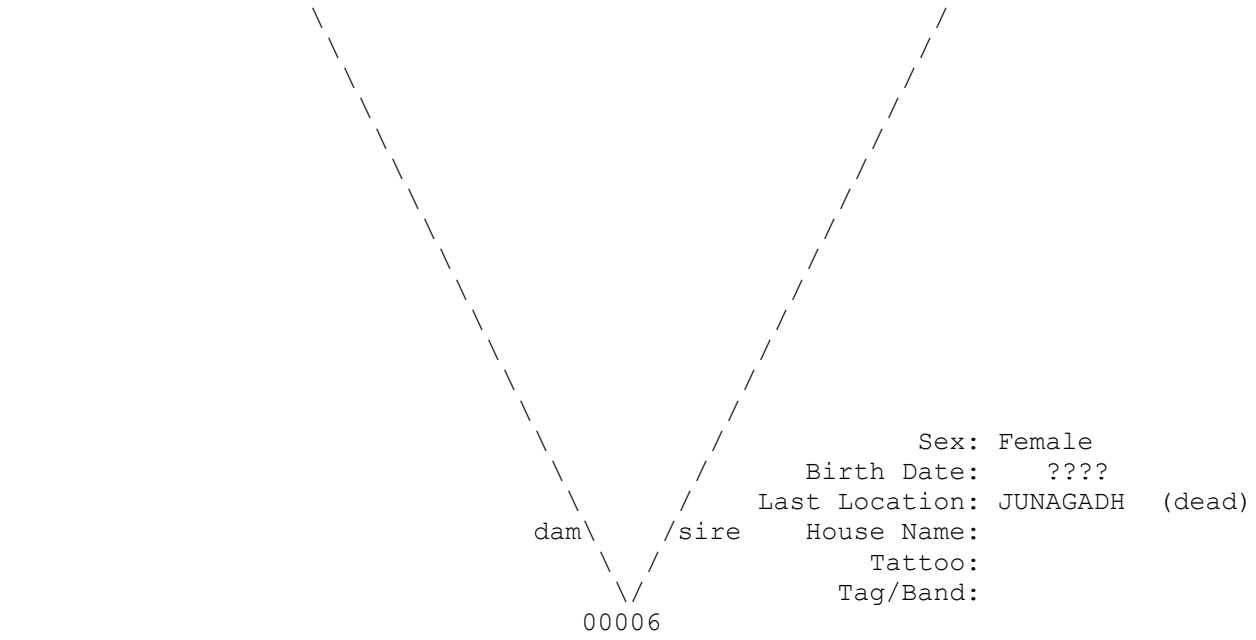

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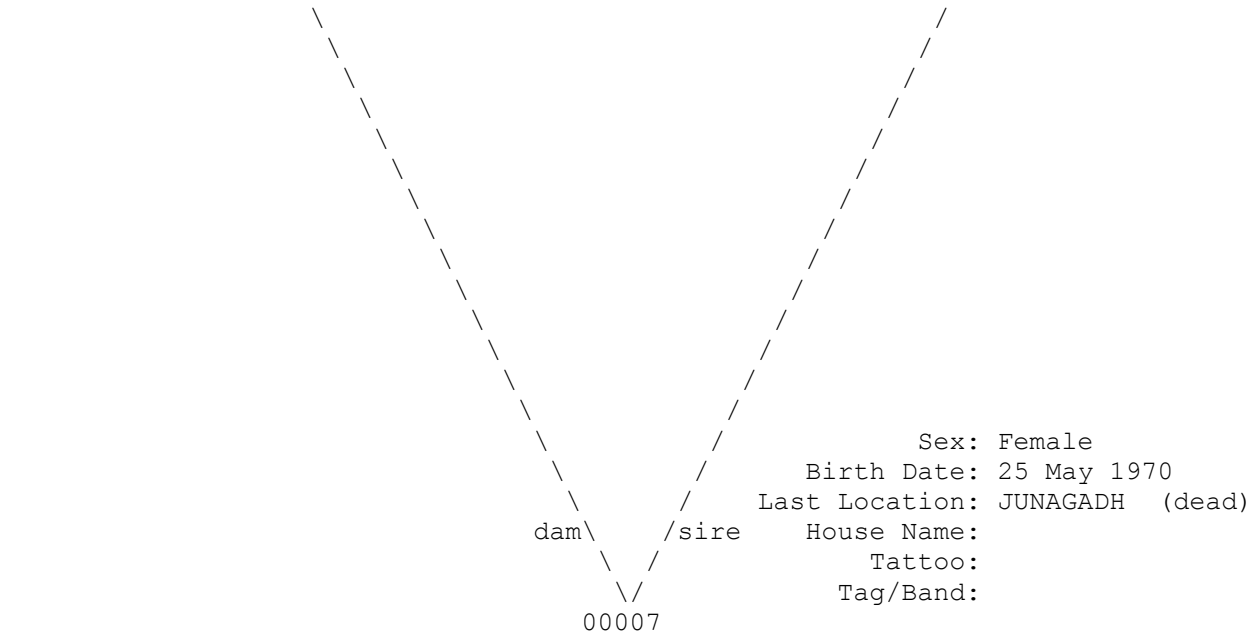

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Birth Date: 25 May 1970
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House Name:
Tattoo:
Tag/Band:

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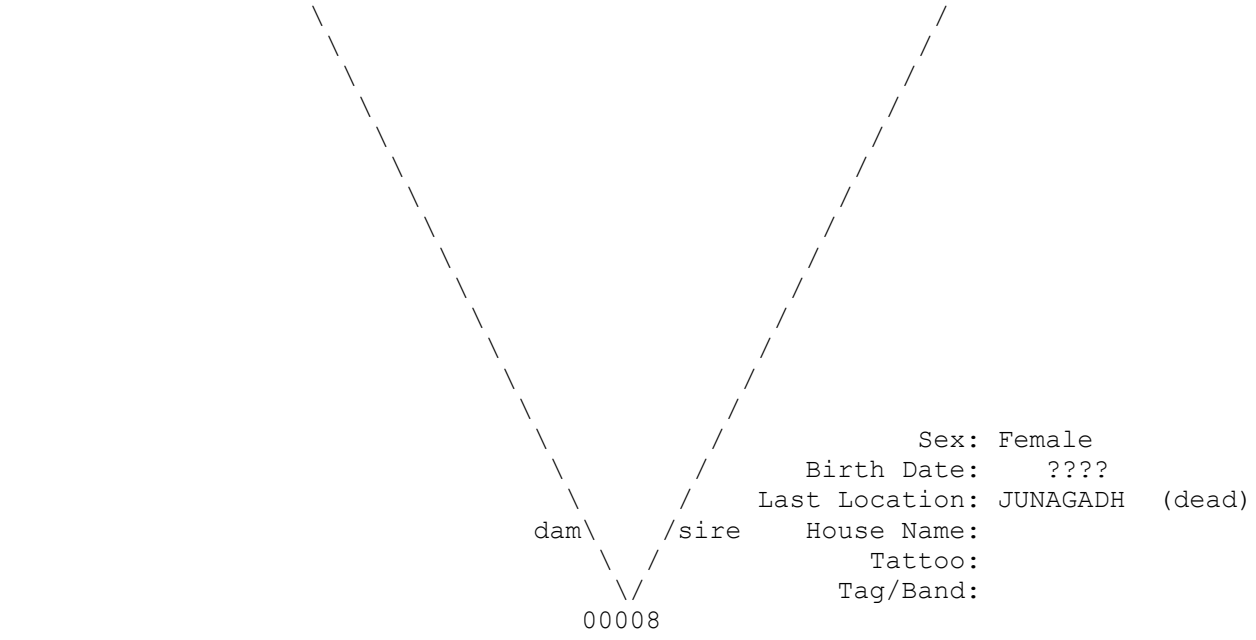

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Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:

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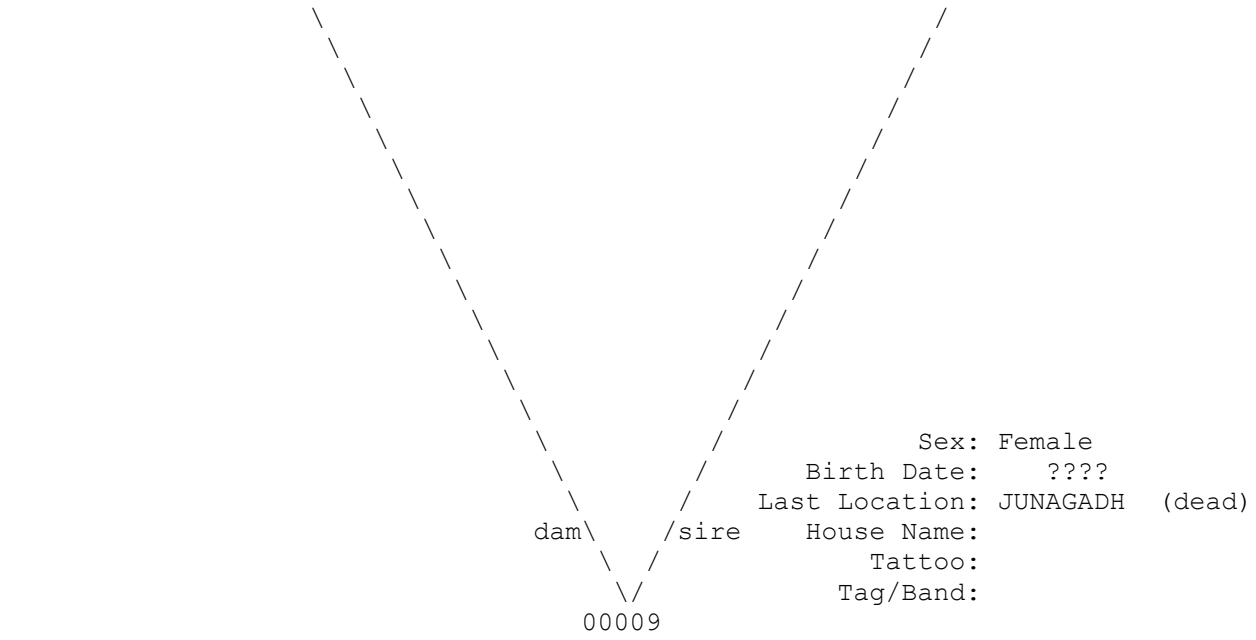

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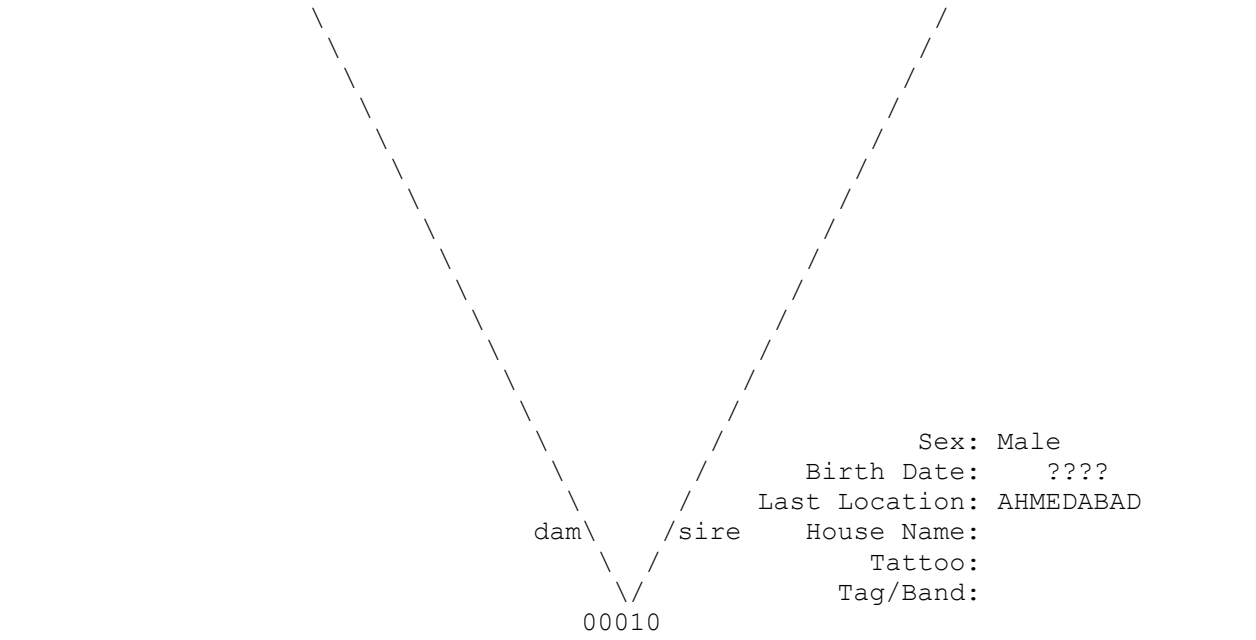

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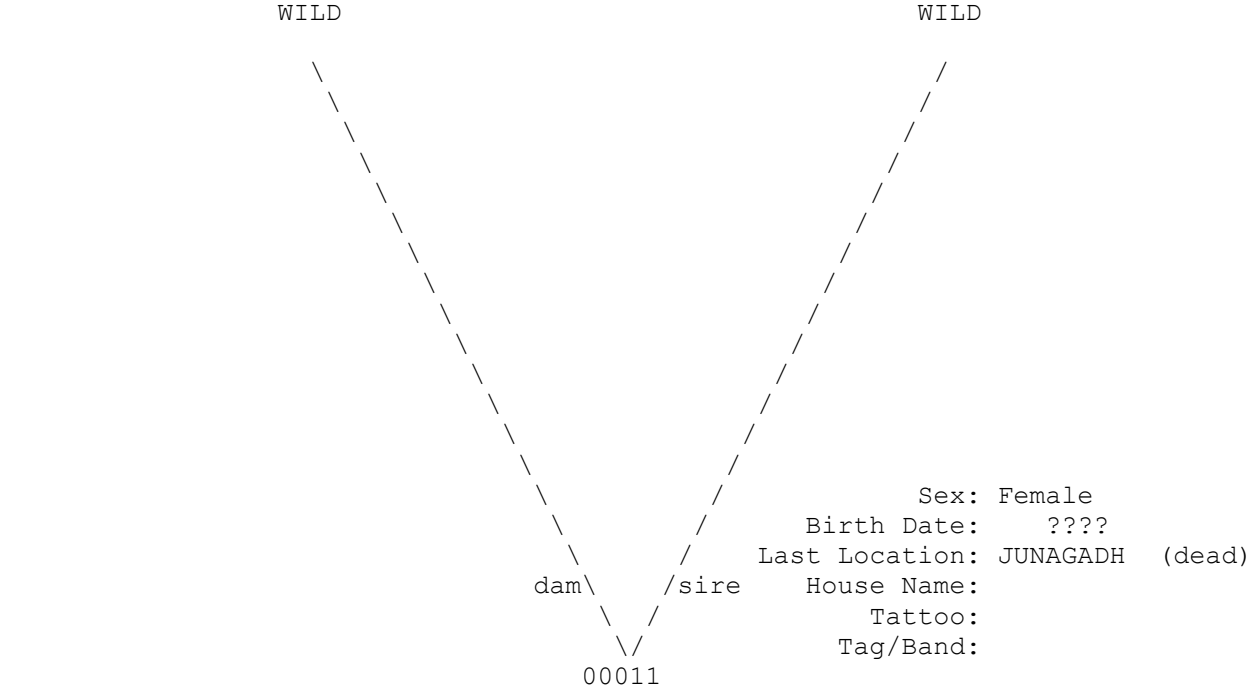

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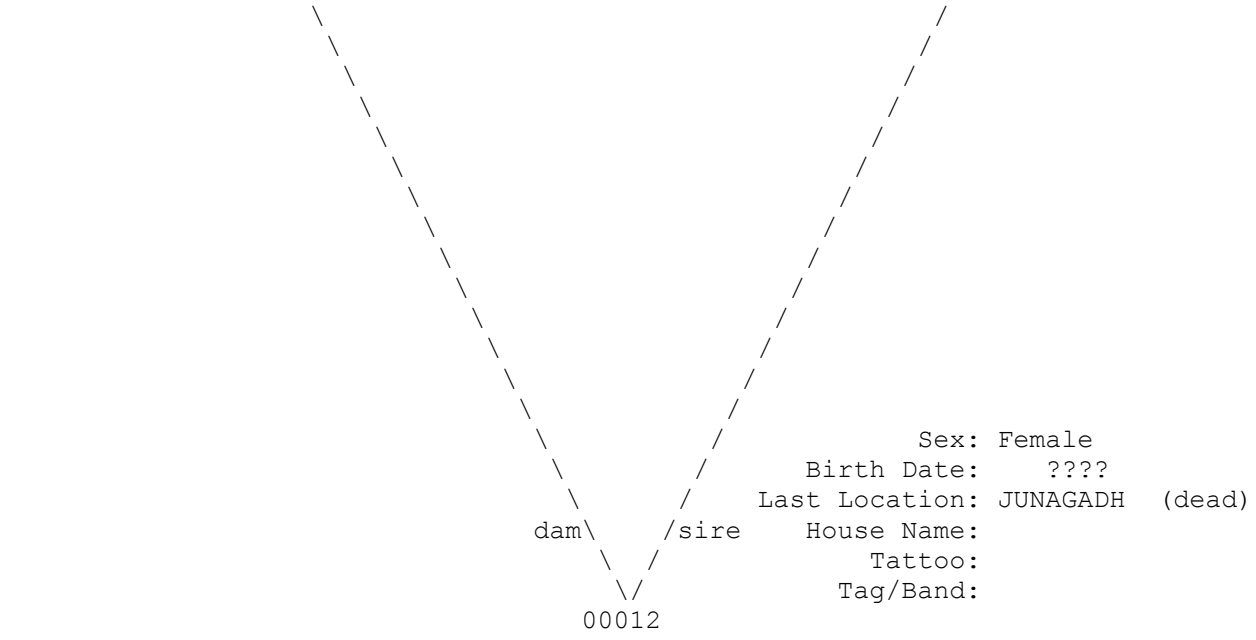

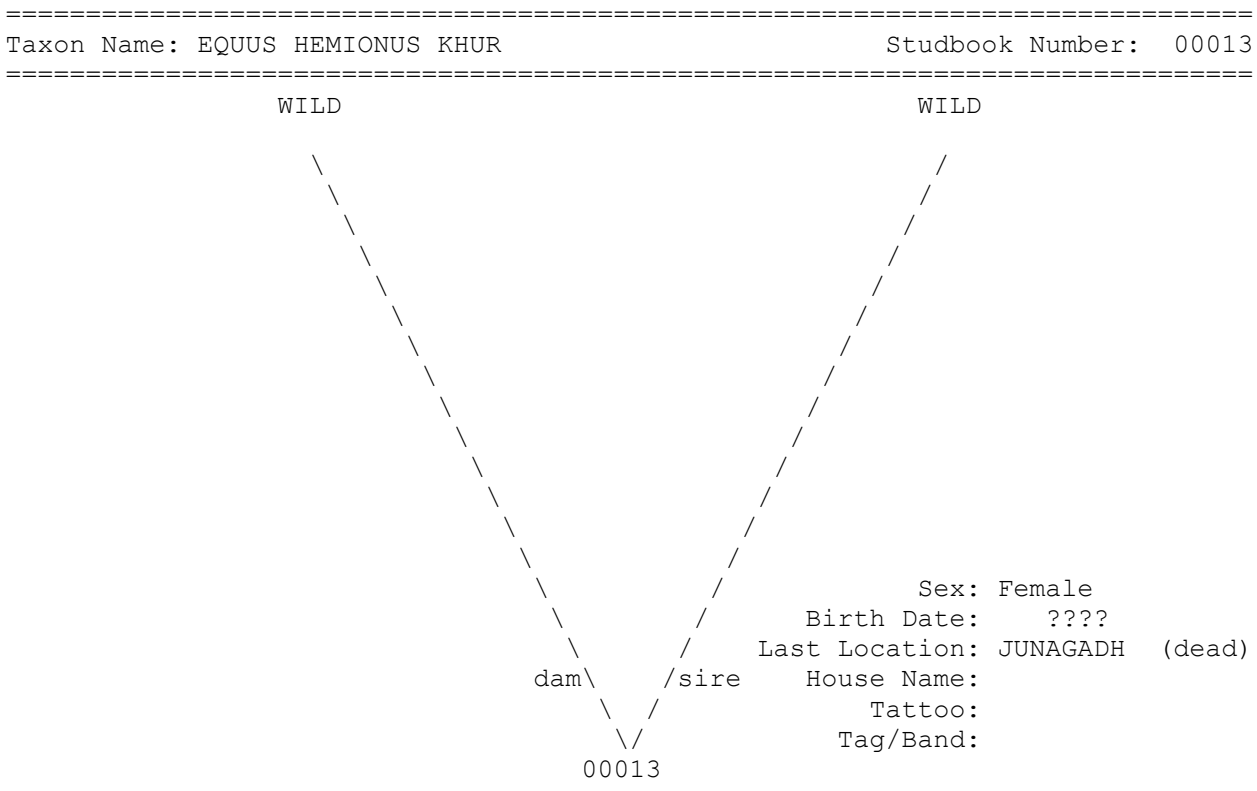
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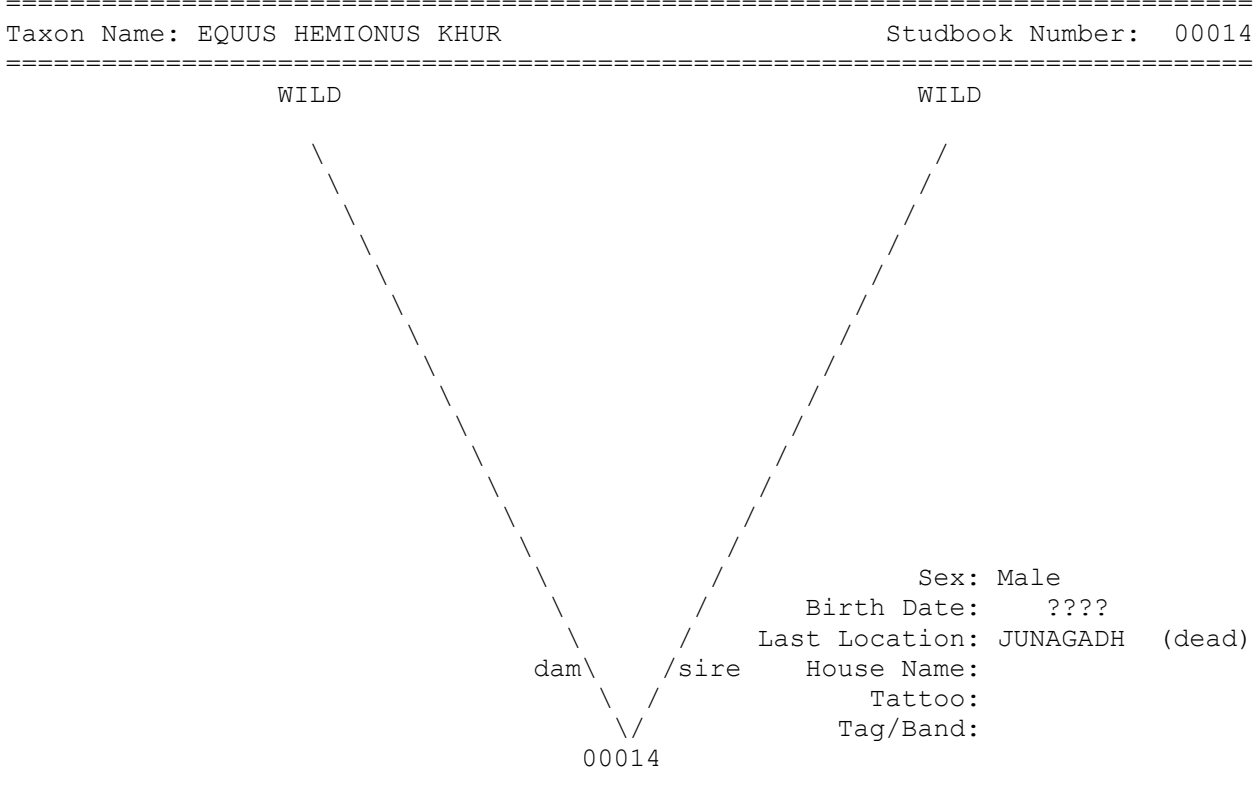
Birth Date: ????
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam
sire
00013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Birth Date: ????
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House Name:
Tattoo:
Tag/Band:
dam
sire
00014

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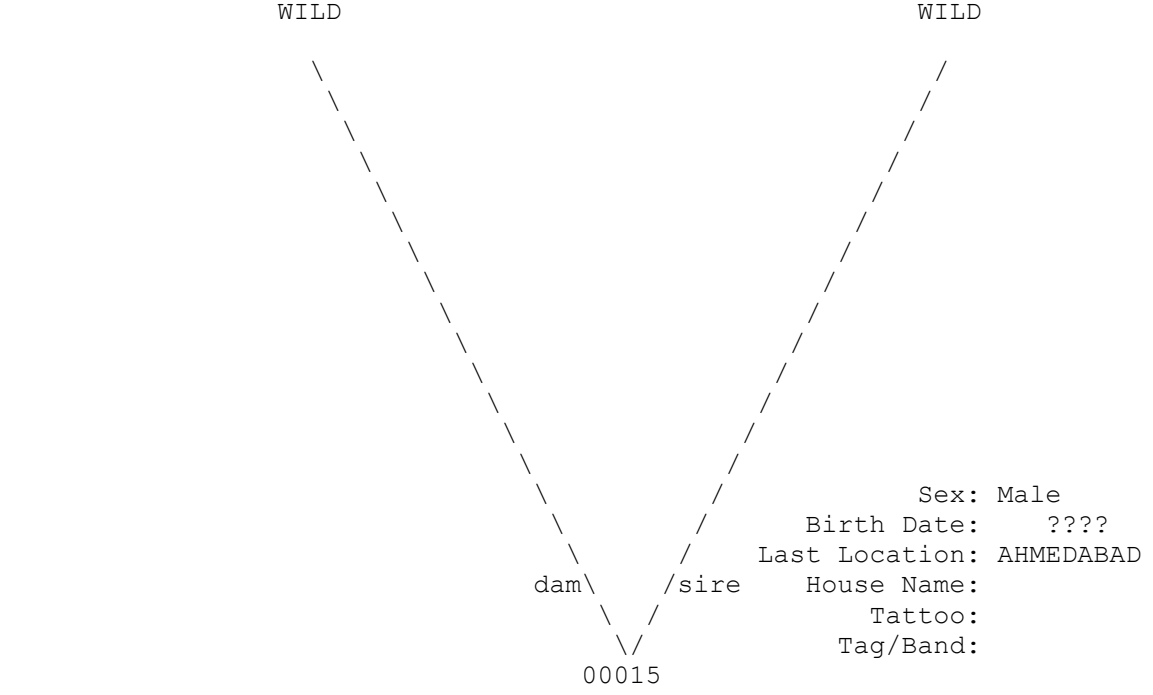

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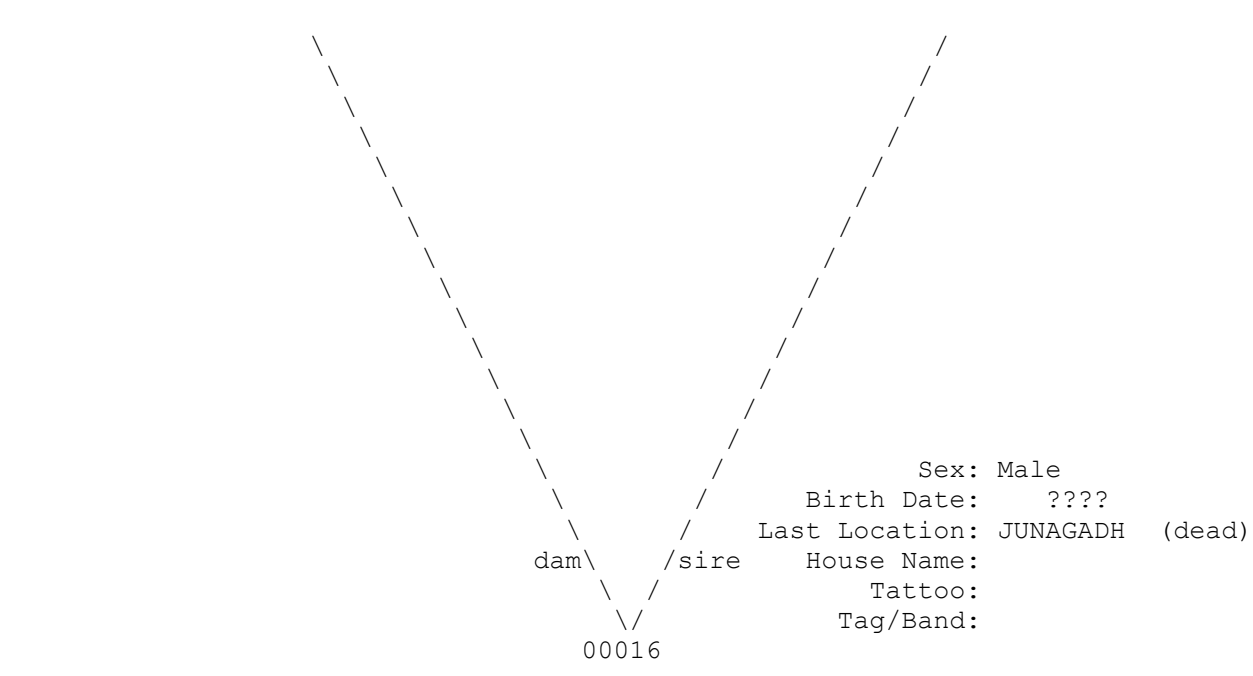

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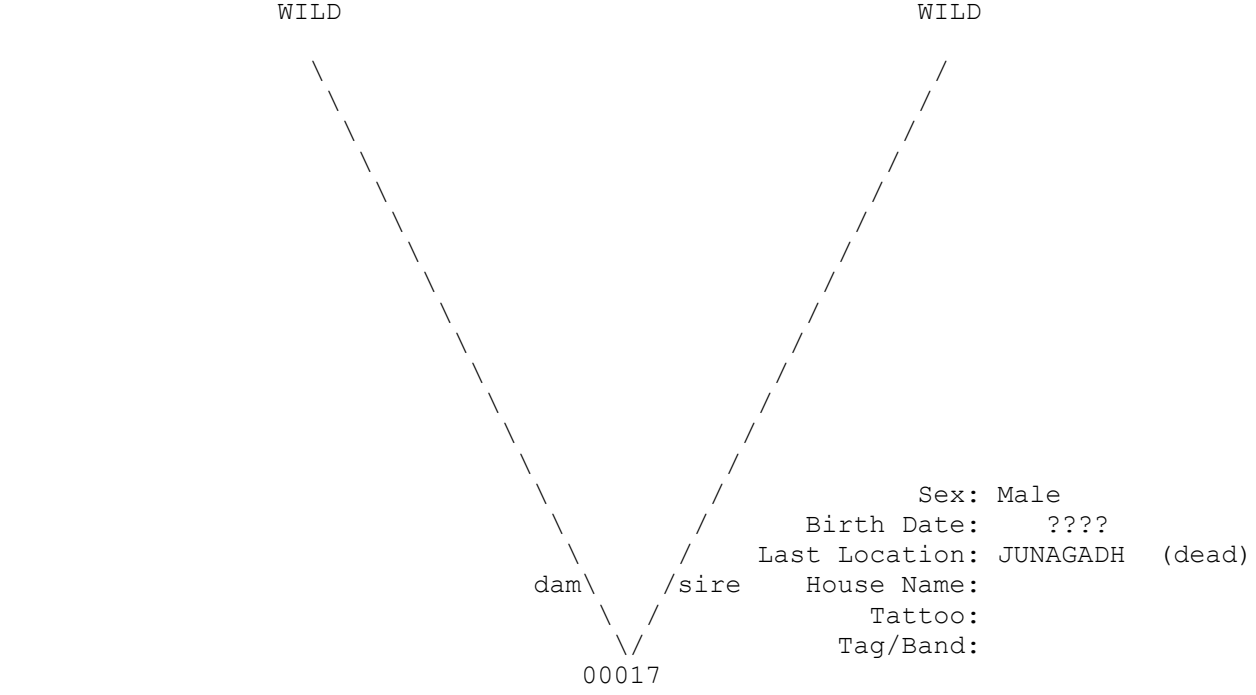

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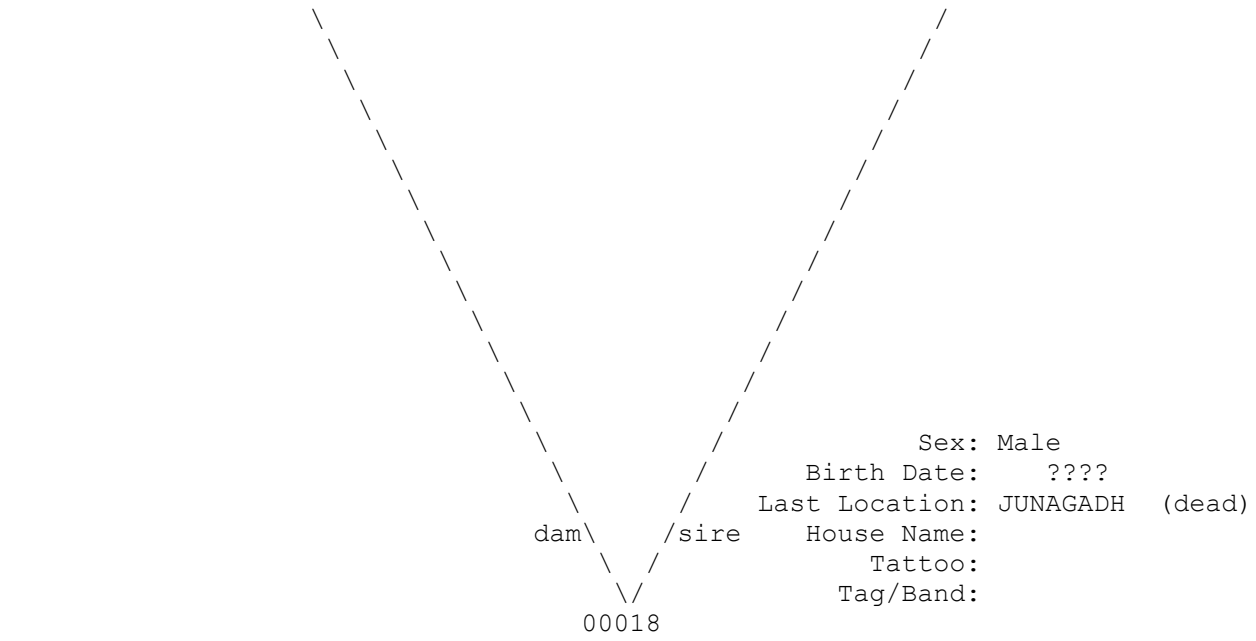

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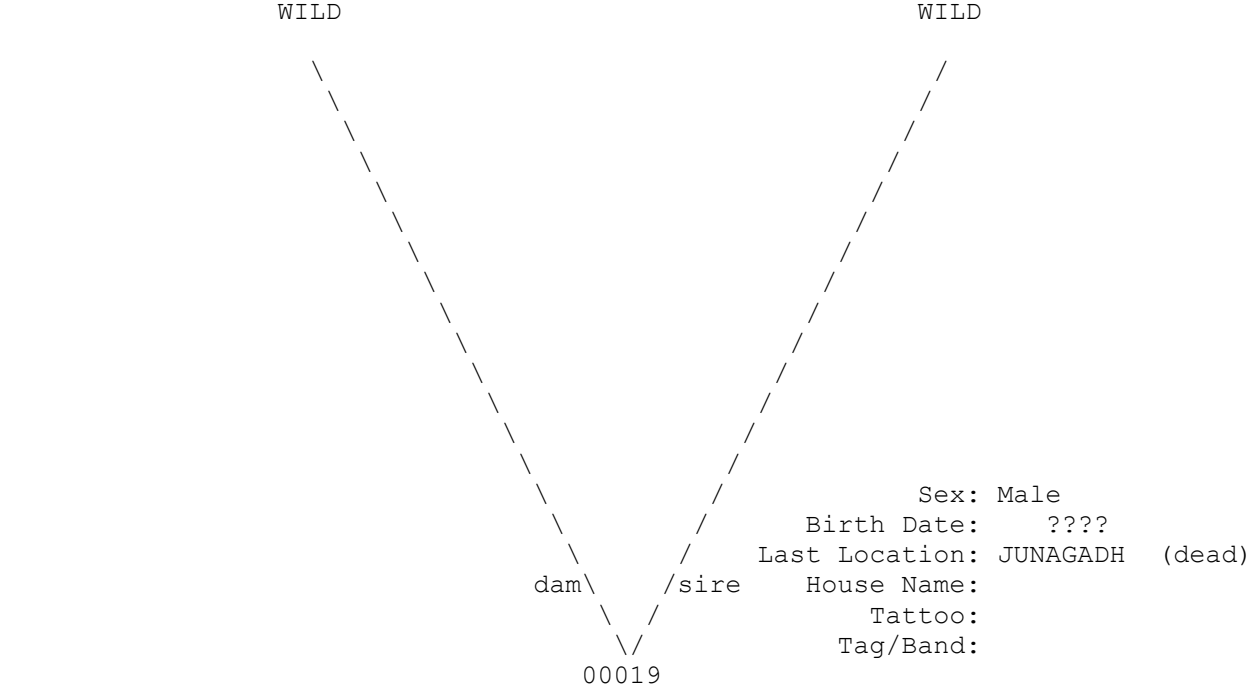

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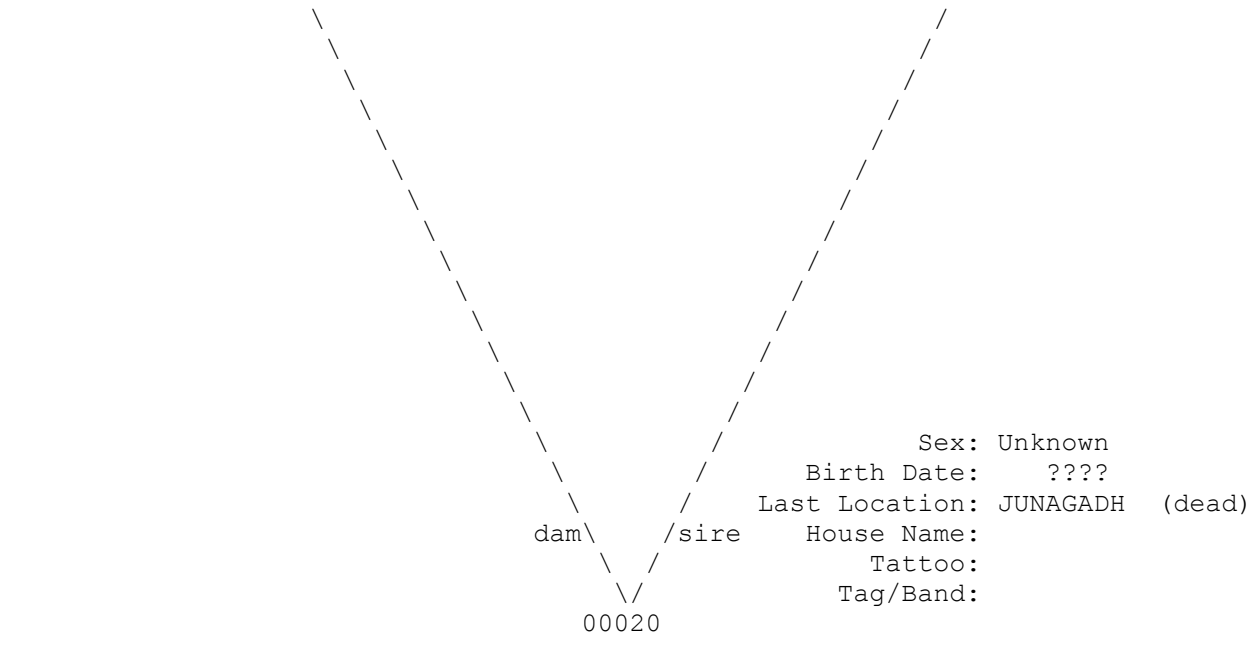

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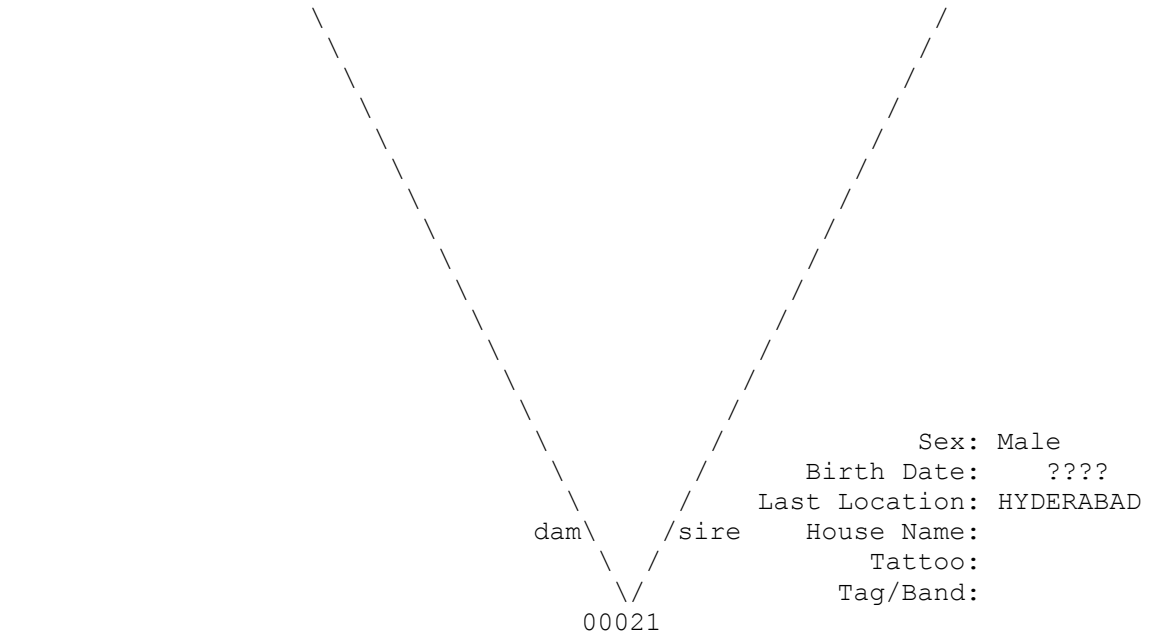

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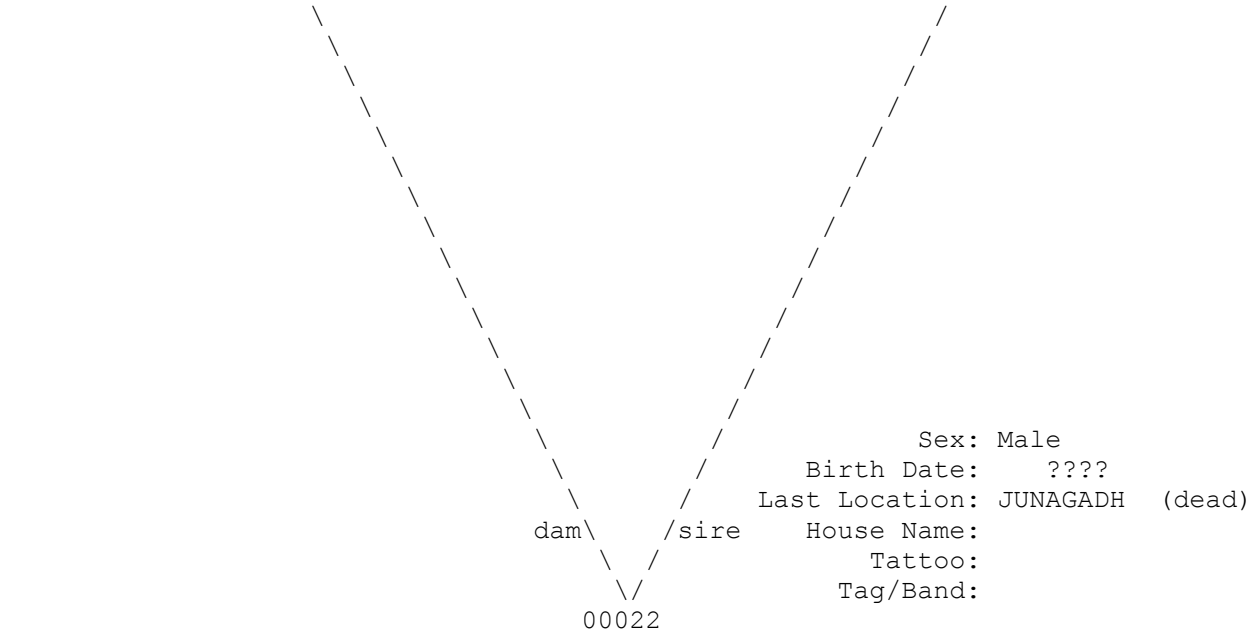

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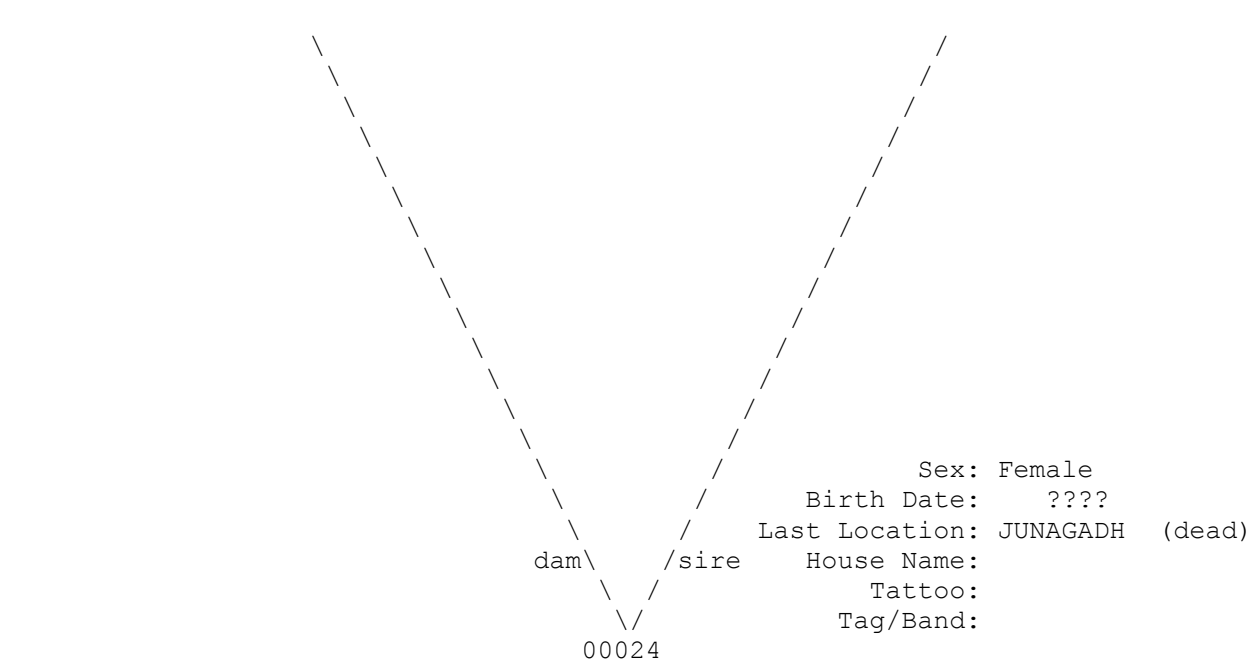

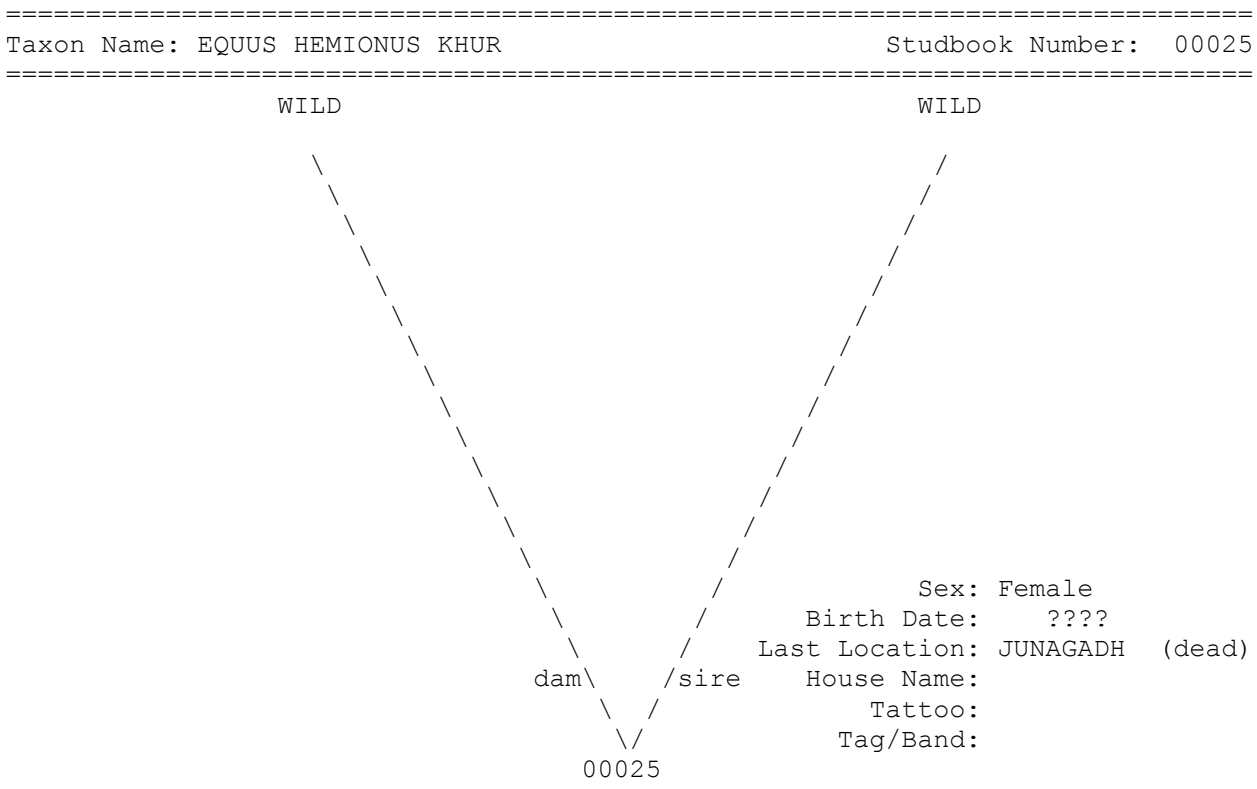
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House Name:
Tattoo:
Tag/Band:
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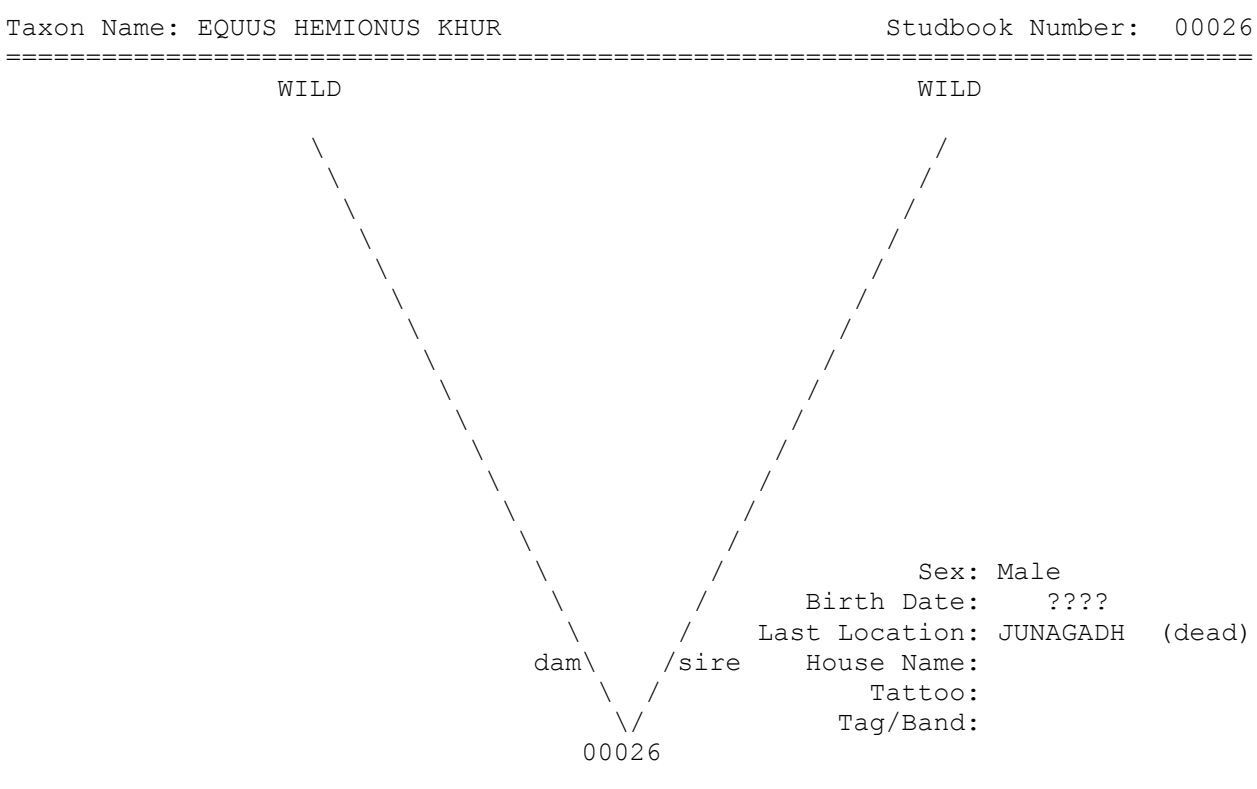
00025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Studbook Number: 00026
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Sex: Male
Birth Date: ????
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam\
/sire
00026

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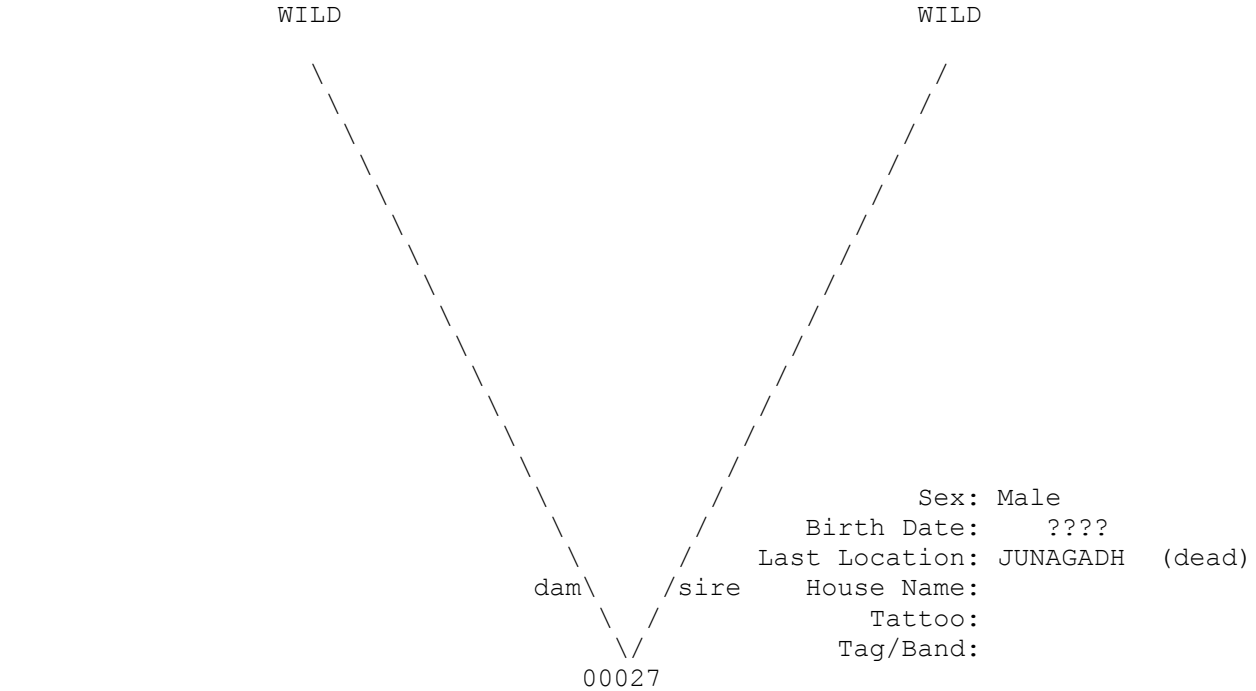

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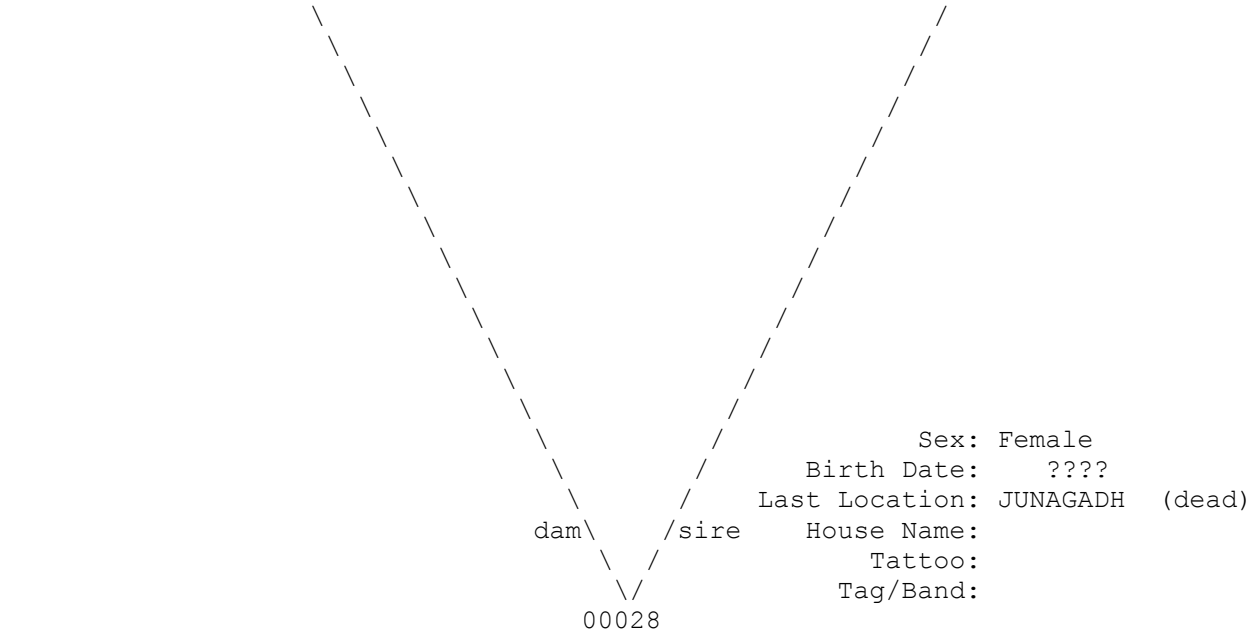

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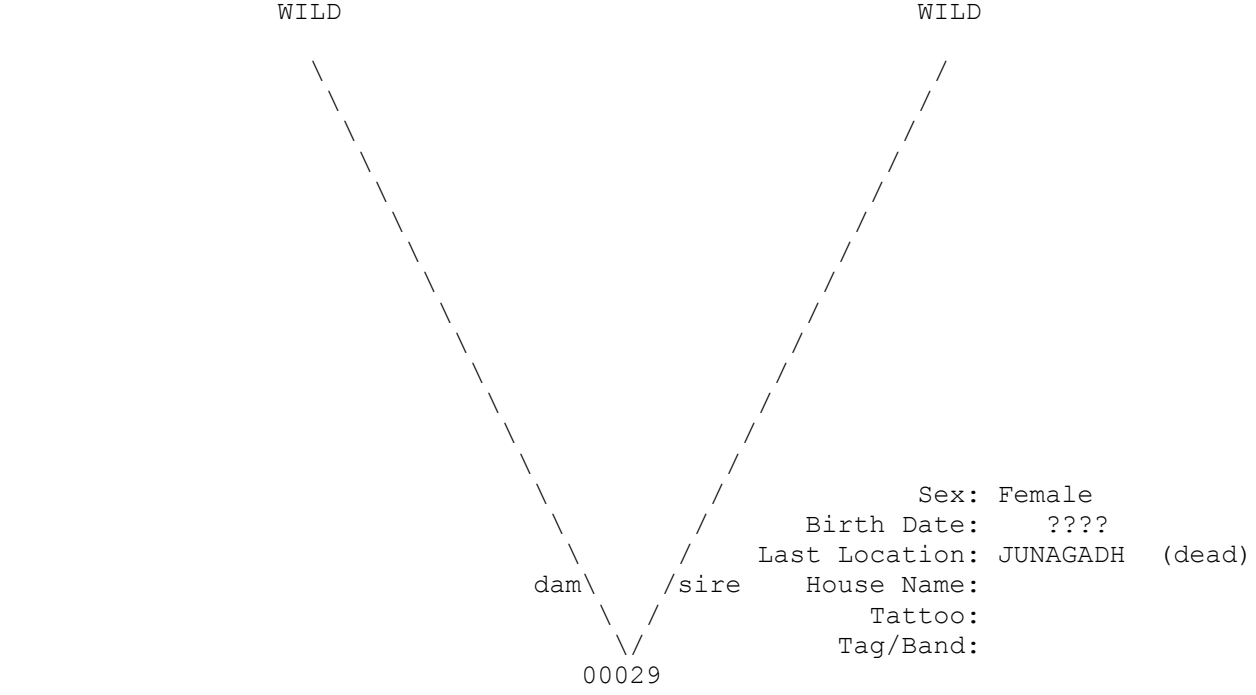

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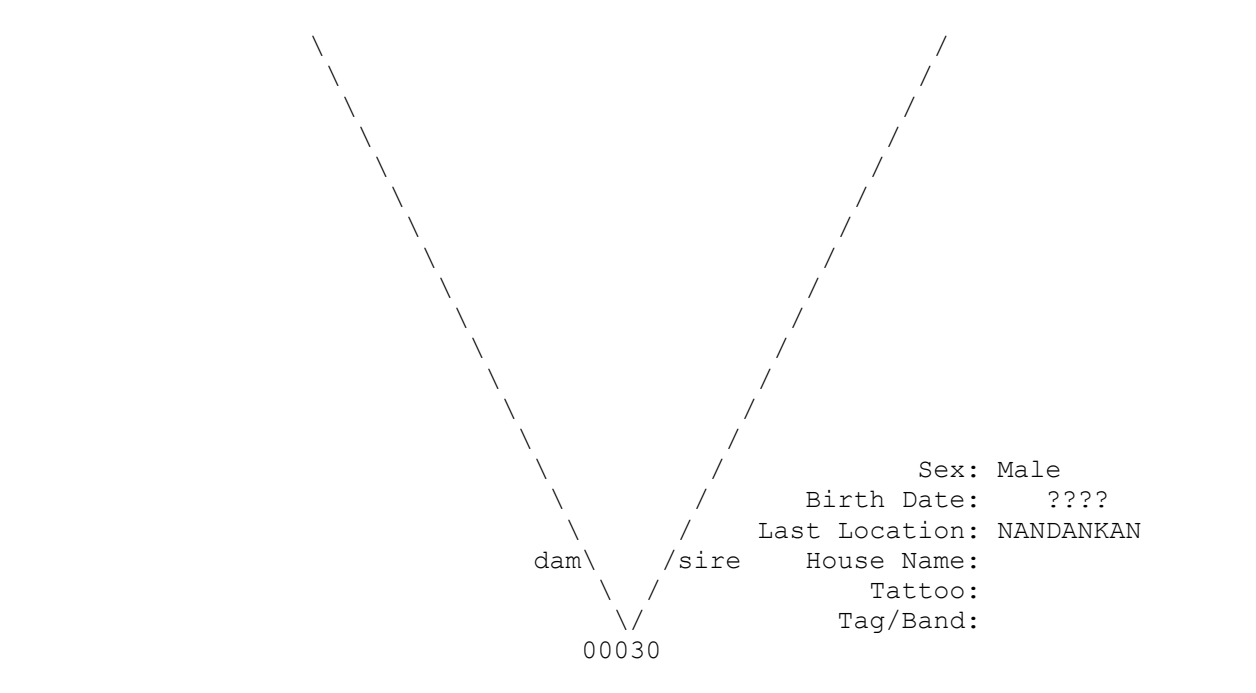

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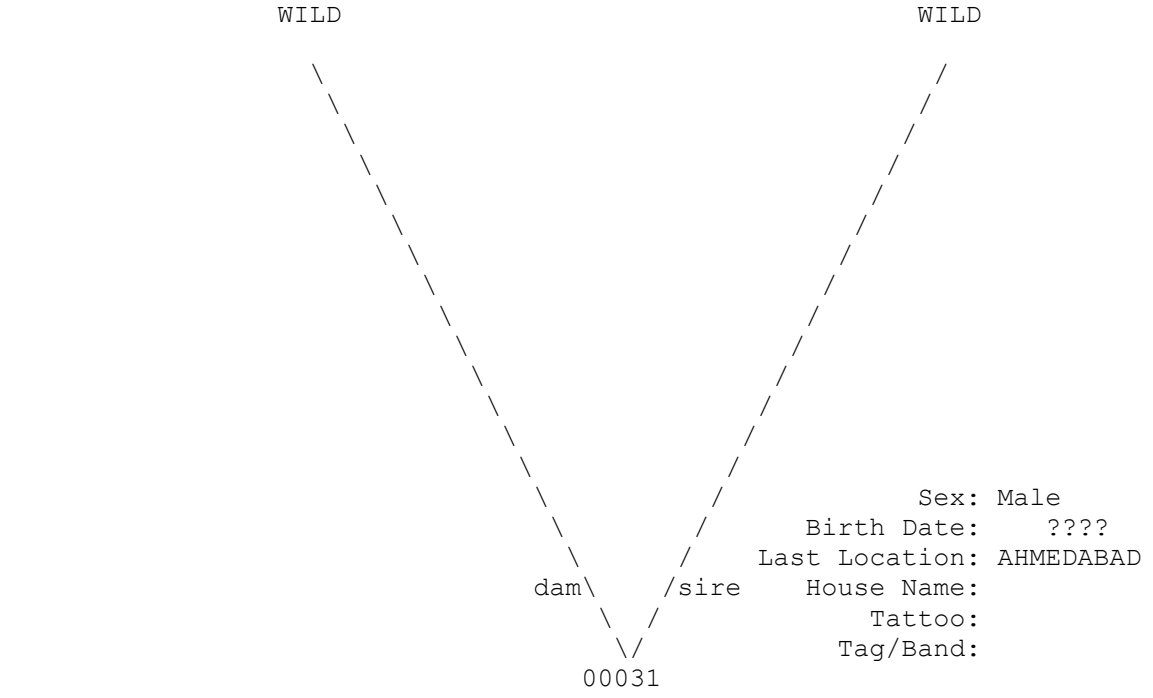

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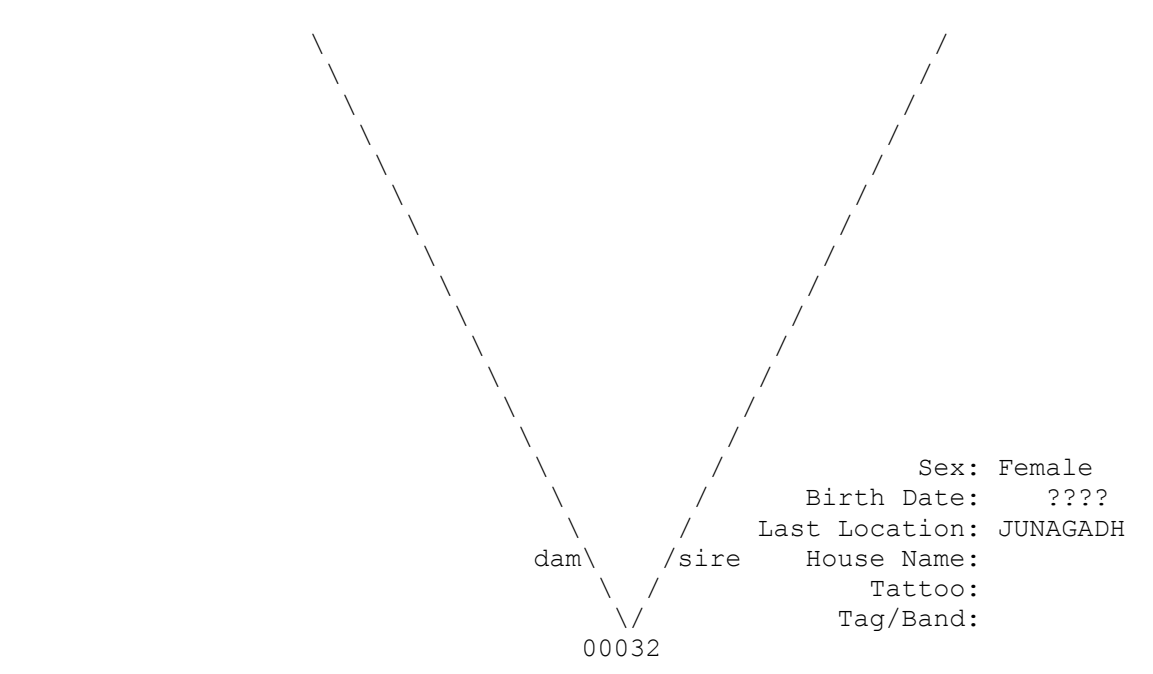

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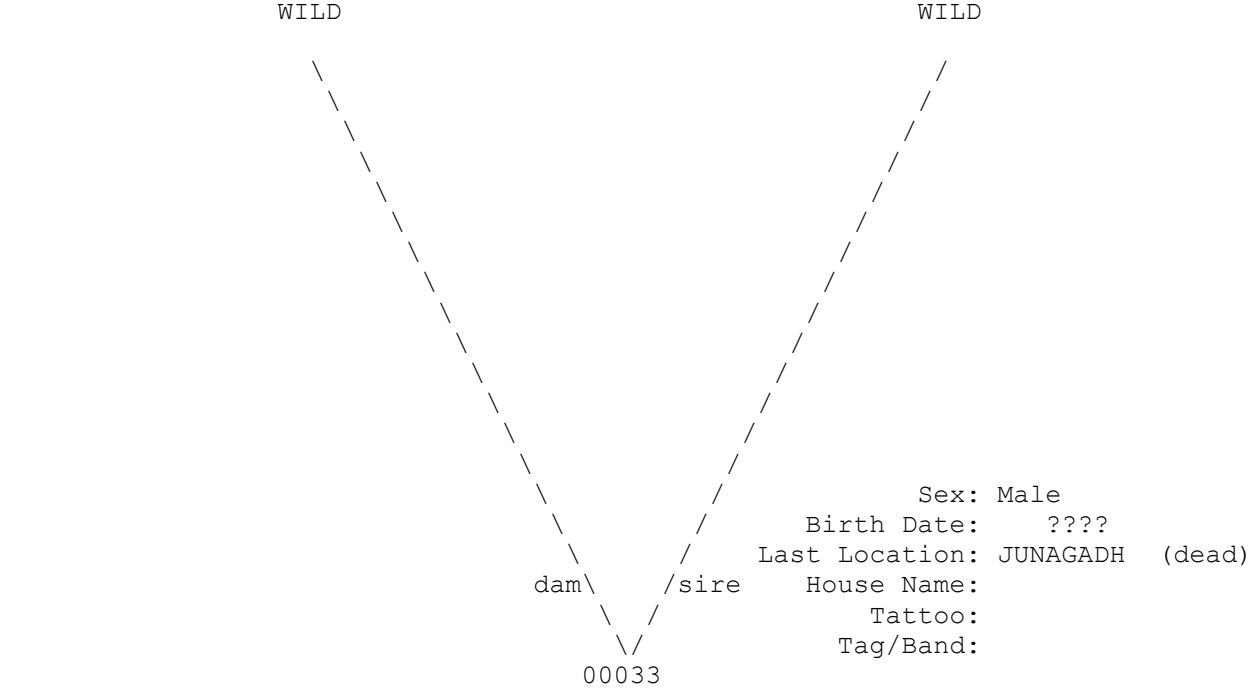

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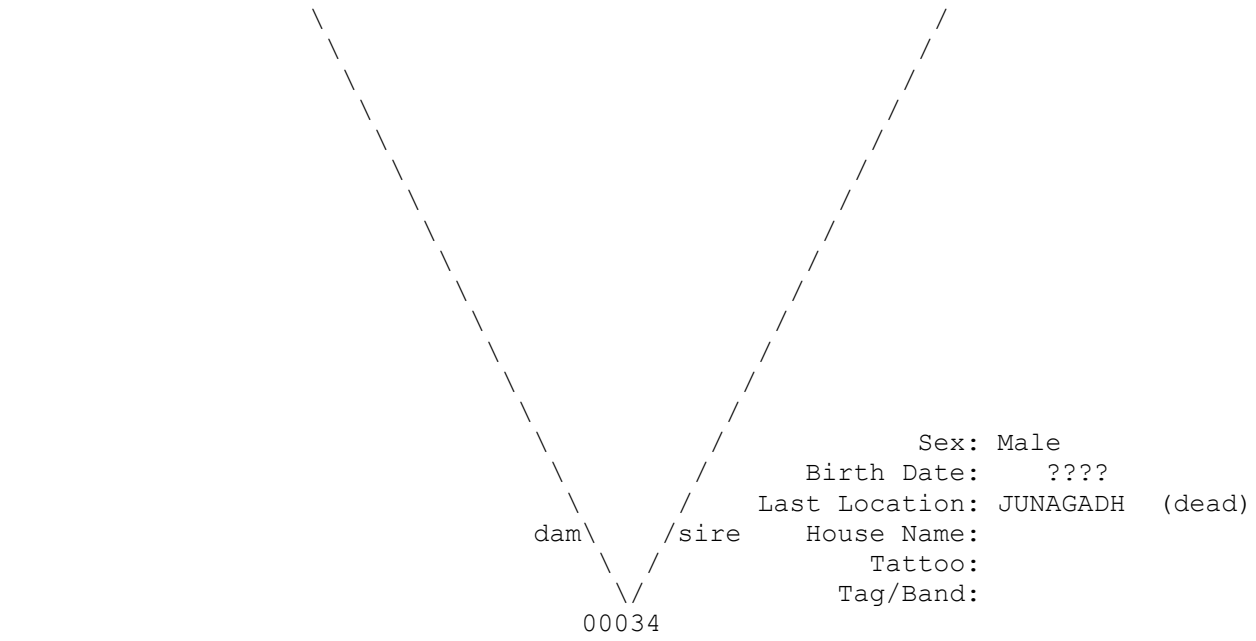

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==============================================================================
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==============================================================================
                 WILD                                        WILD

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                        \                              /
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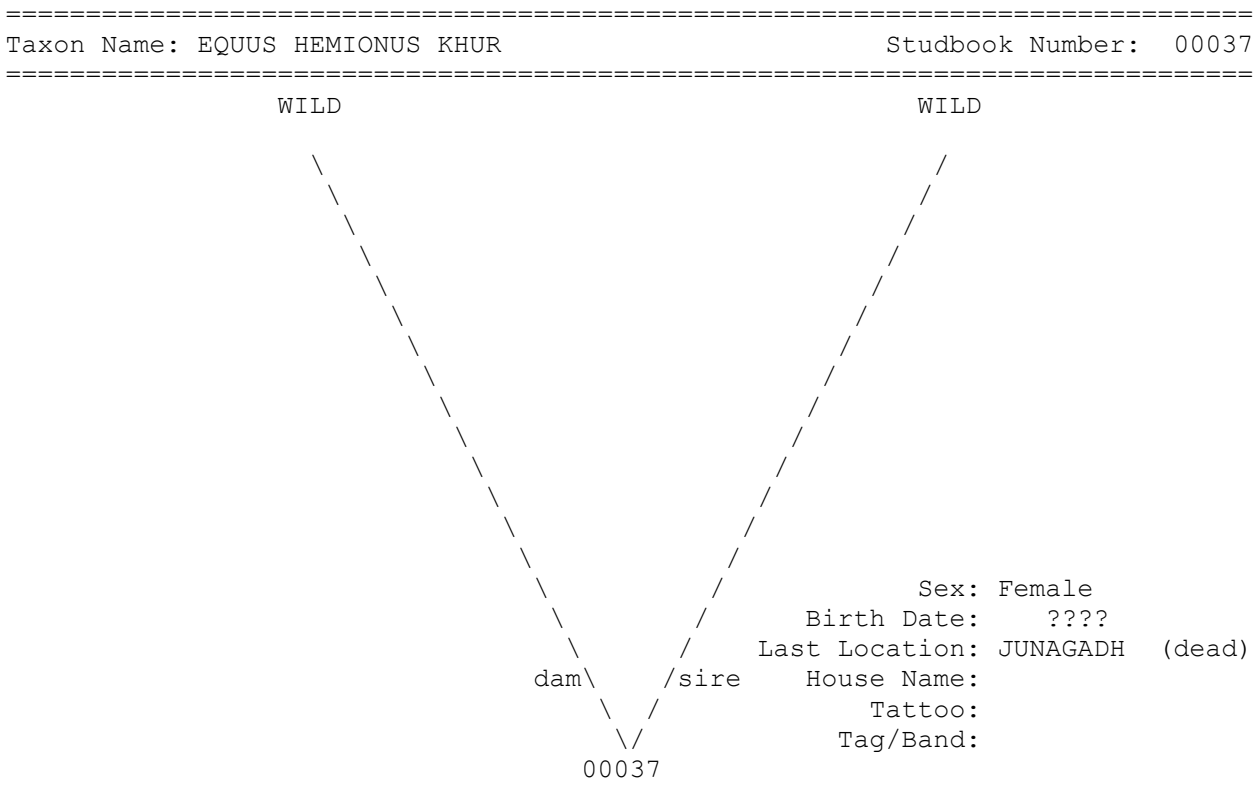
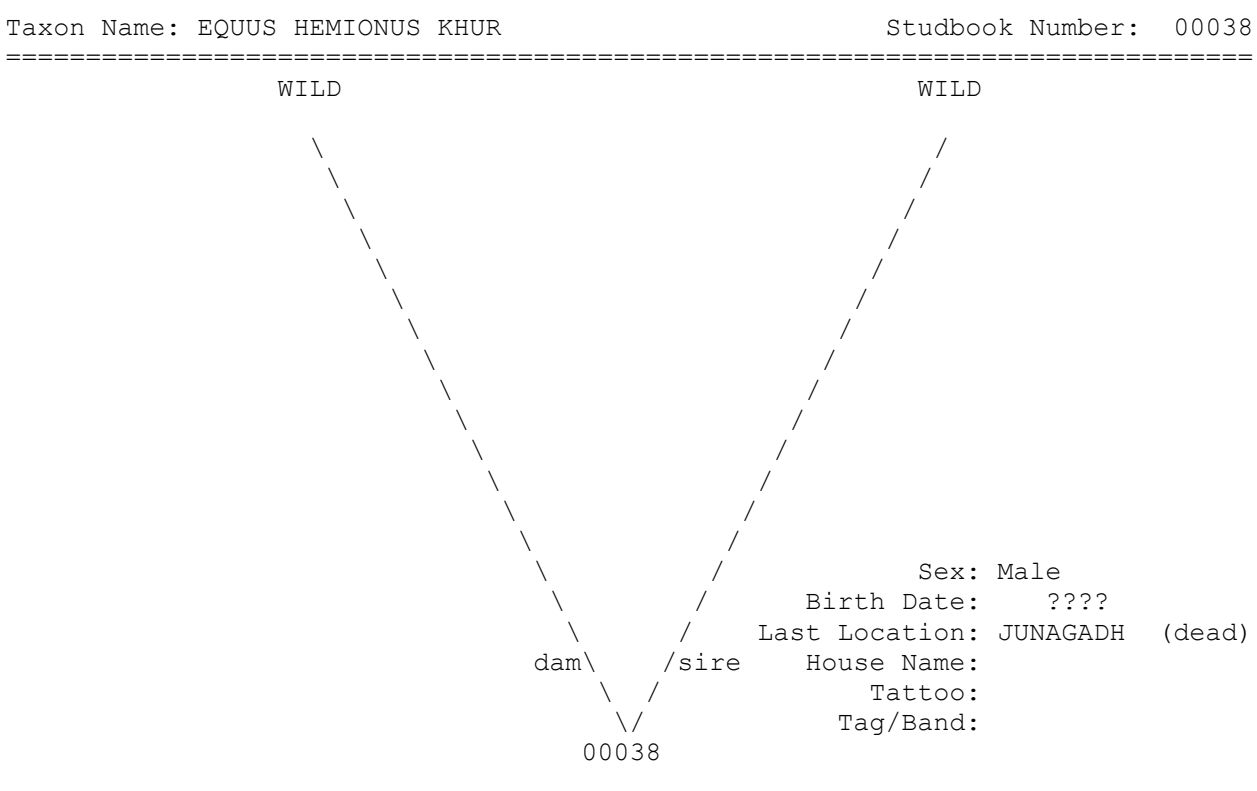
                            \                      /
                             \                    /
                              \                  /
                               \                /
                                \              /
                                 \            /            Sex: Male
                                  \          /      Birth Date:    ????
                                   \        /    Last Location: JUNAGADH  (dead)
                                dam\      /sire     House Name:
                                     \  /              Tattoo:
                                      \/             Tag/Band:
                                   00035
```

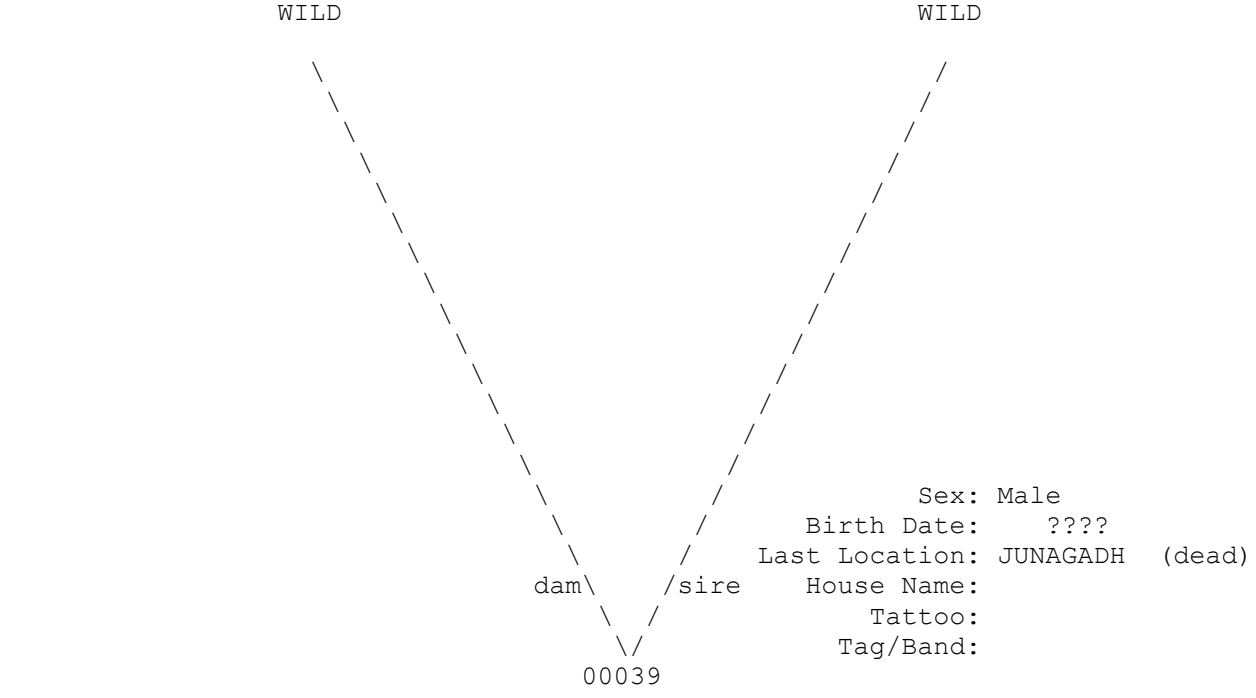
```
==============================================================================
Taxon Name: EQUUS HEMIONUS KHUR                          Studbook Number:  00036
==============================================================================
                 WILD                                        WILD

                   \                                        /
                    \                                      /
                     \                                    /
                      \                                  /
                       \                                /
                        \                              /
                         \                            /
                          \                          /
                           \                        /
                            \                      /
                             \                    /
                              \                  /
                               \                /
                                \              /
                                 \            /            Sex: Female
                                  \          /      Birth Date:    ????
                                   \        /    Last Location: CHENNAI
                                dam\      /sire     House Name:
                                     \  /              Tattoo:
                                      \/             Tag/Band:
                                   00036
```

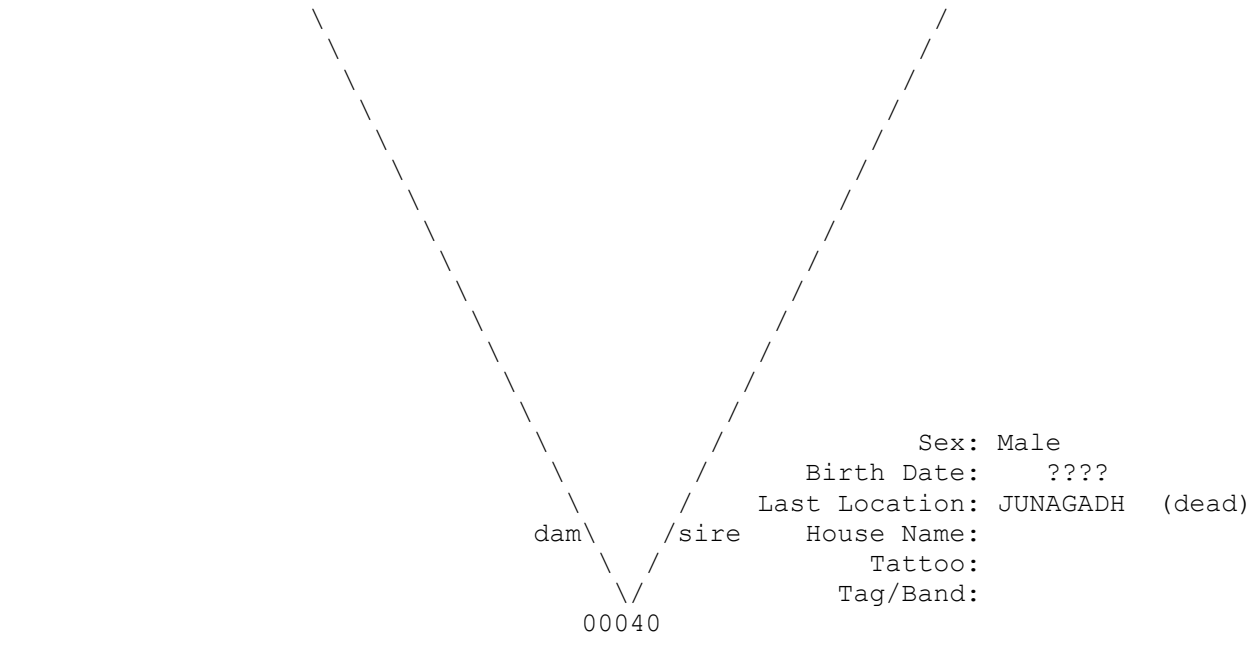

Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00037
WILD
WILD
Sex: Female
Birth Date: ????
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam
sire
00037


Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00038
WILD
WILD
Sex: Male
Birth Date: ????
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam
sire
00038

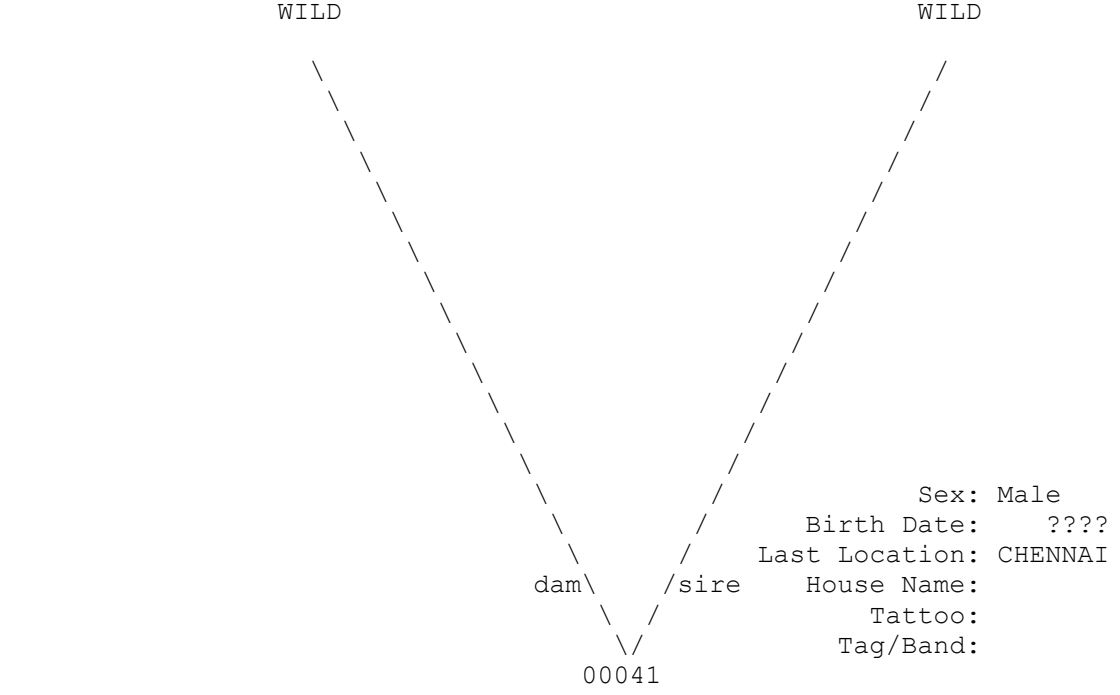
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00039



Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00040

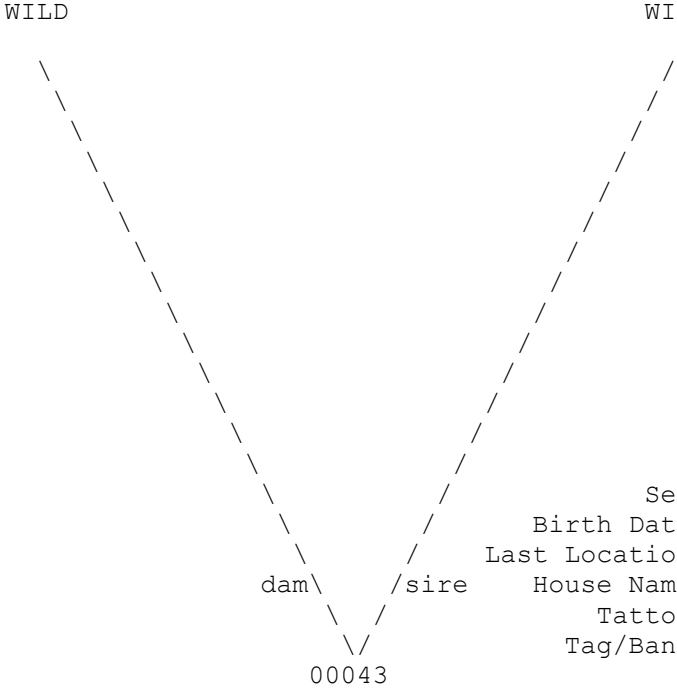


Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00041



Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00042

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00043

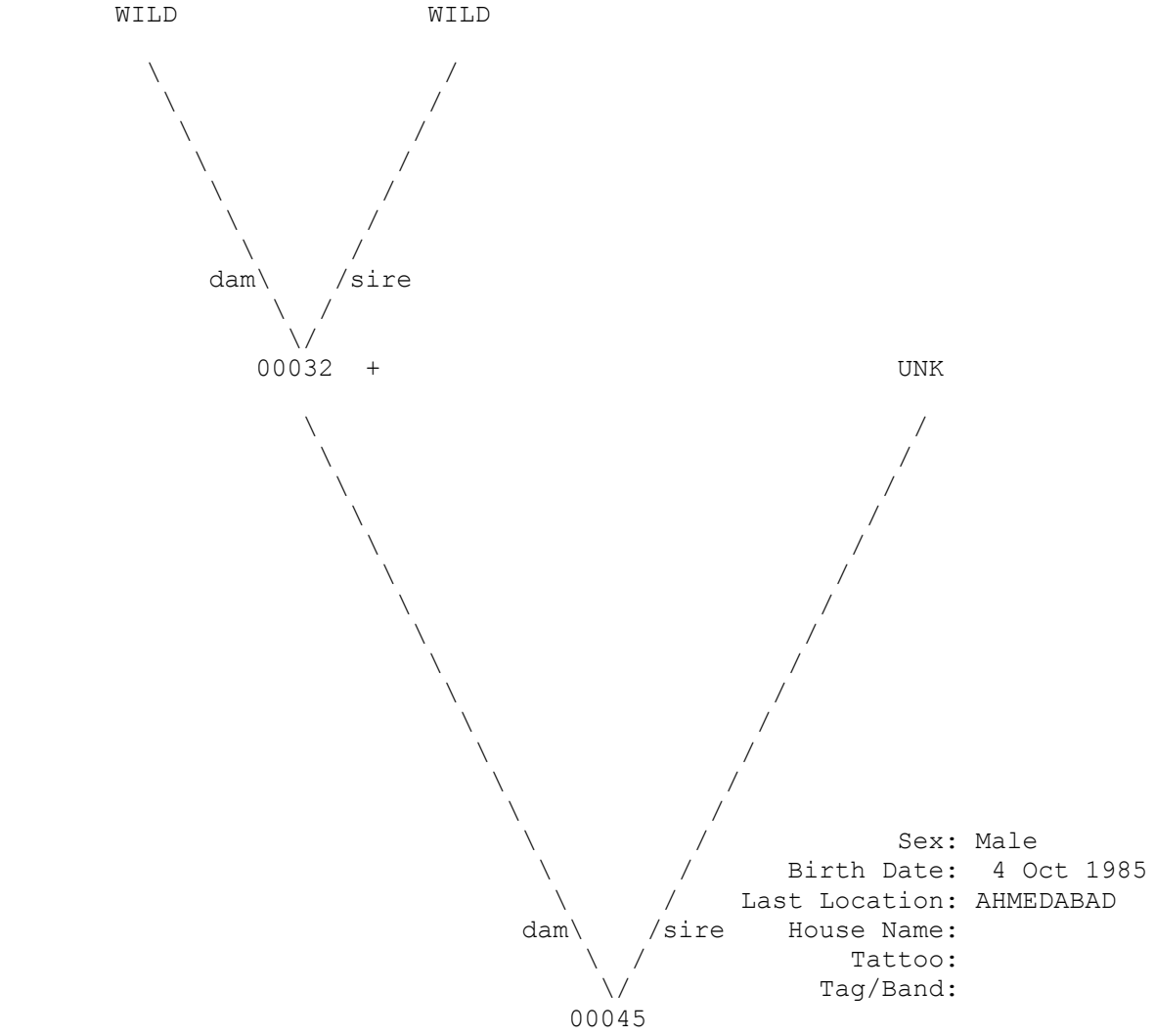


Sex: Female
Birth Date: ????
Last Location: NANDANKAN
House Name:
Tattoo:
Tag/Band:

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00044

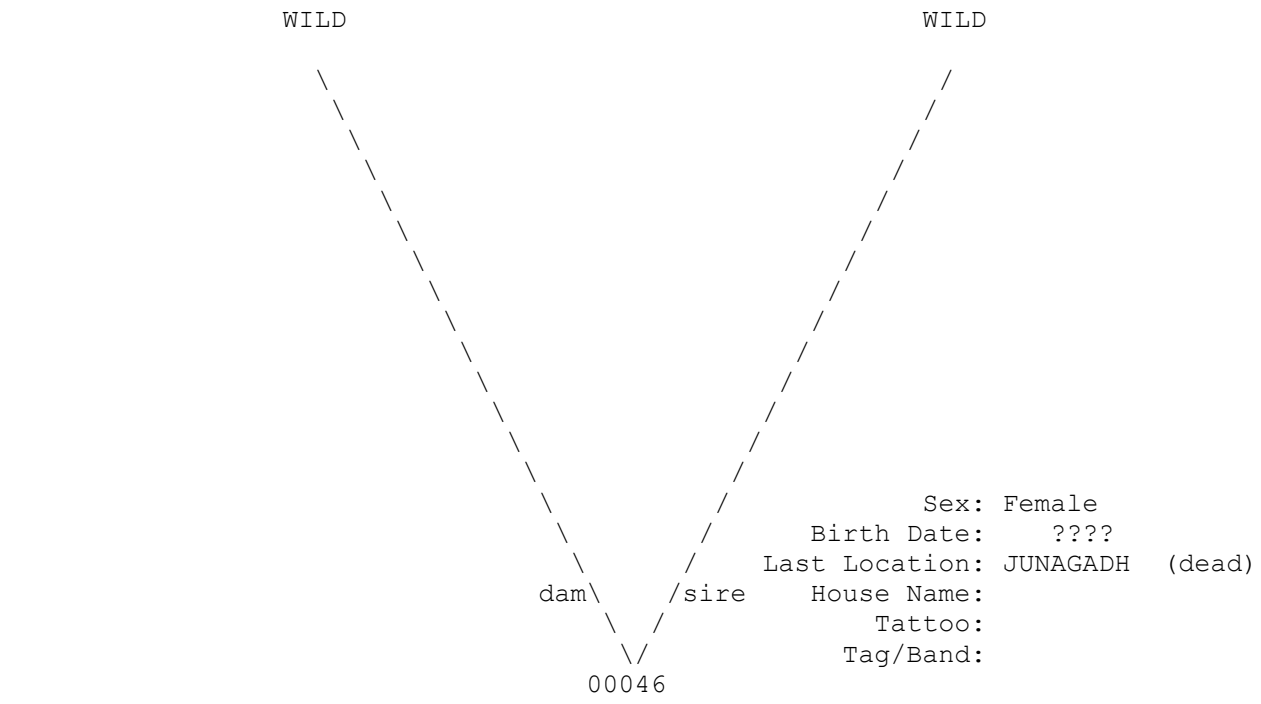
Sex: Female
Birth Date: ????
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00045

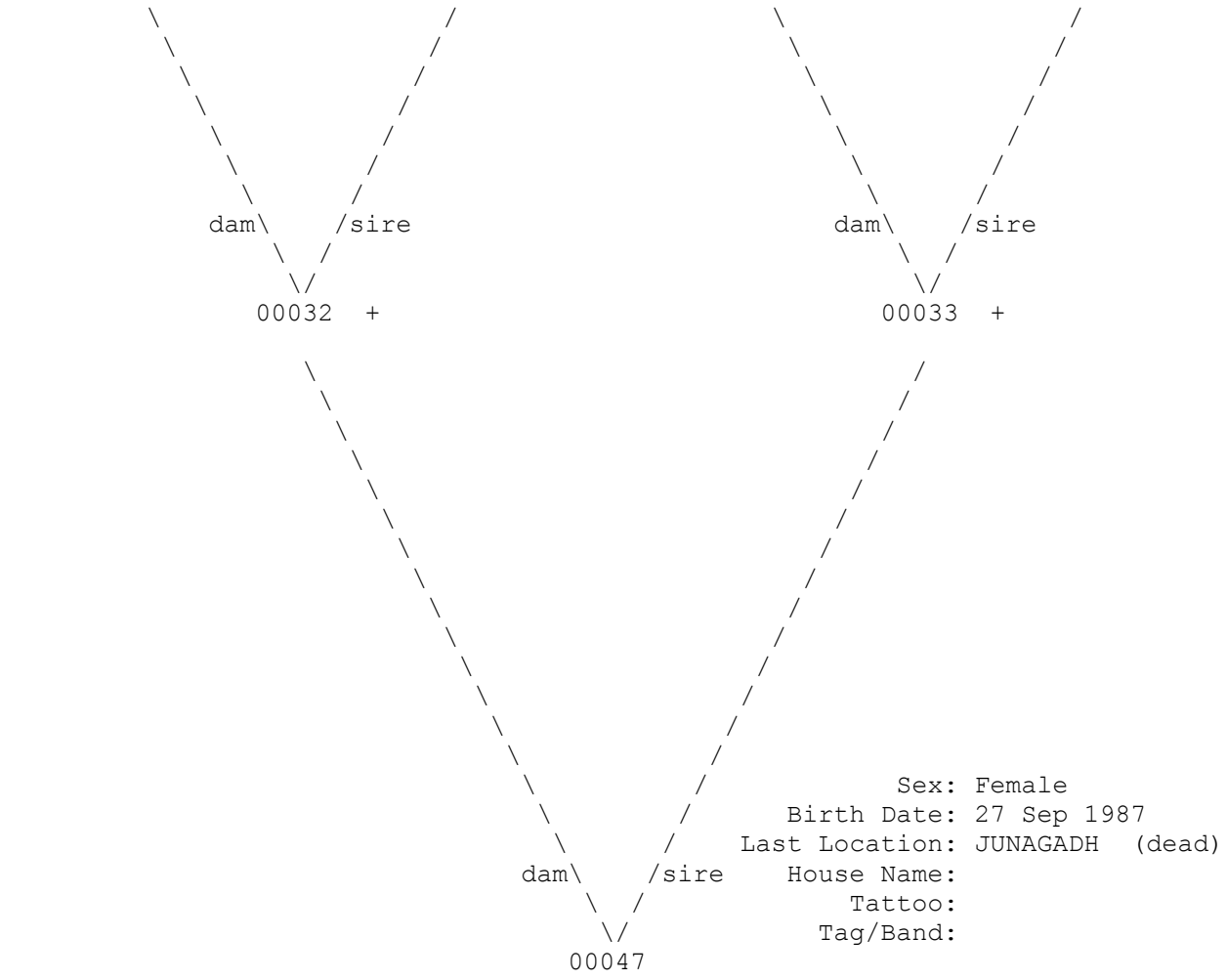


+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00046



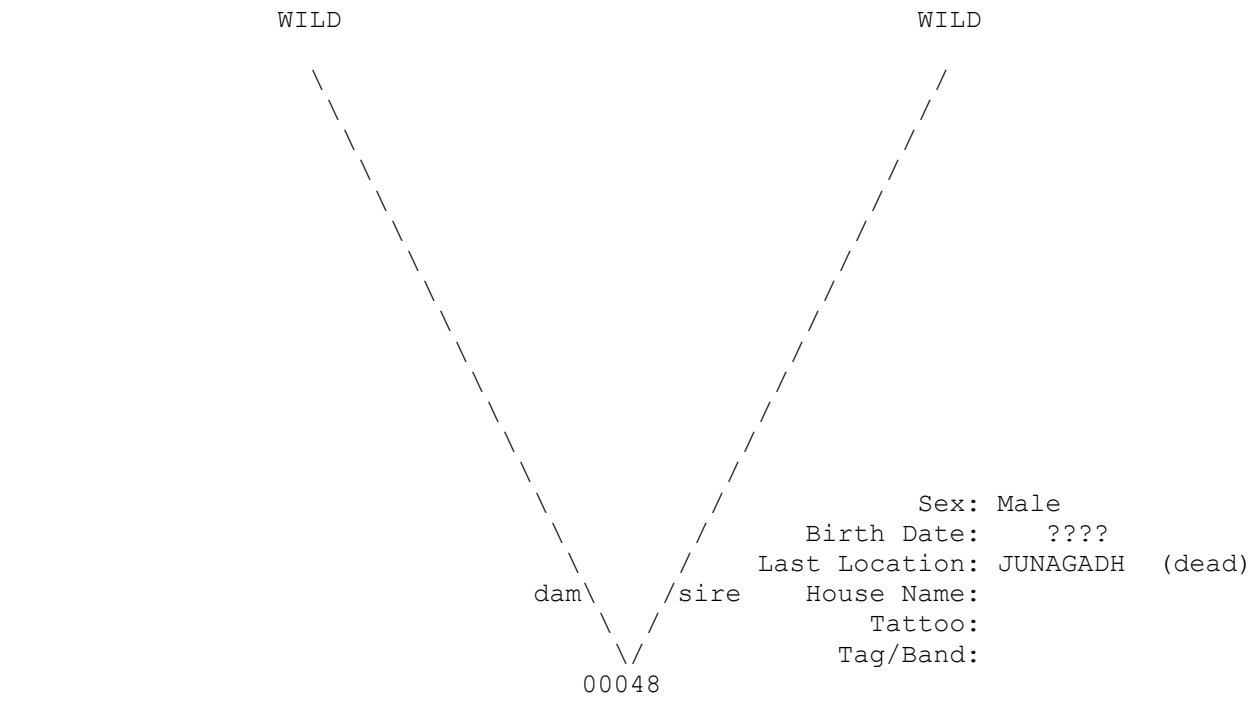
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00047

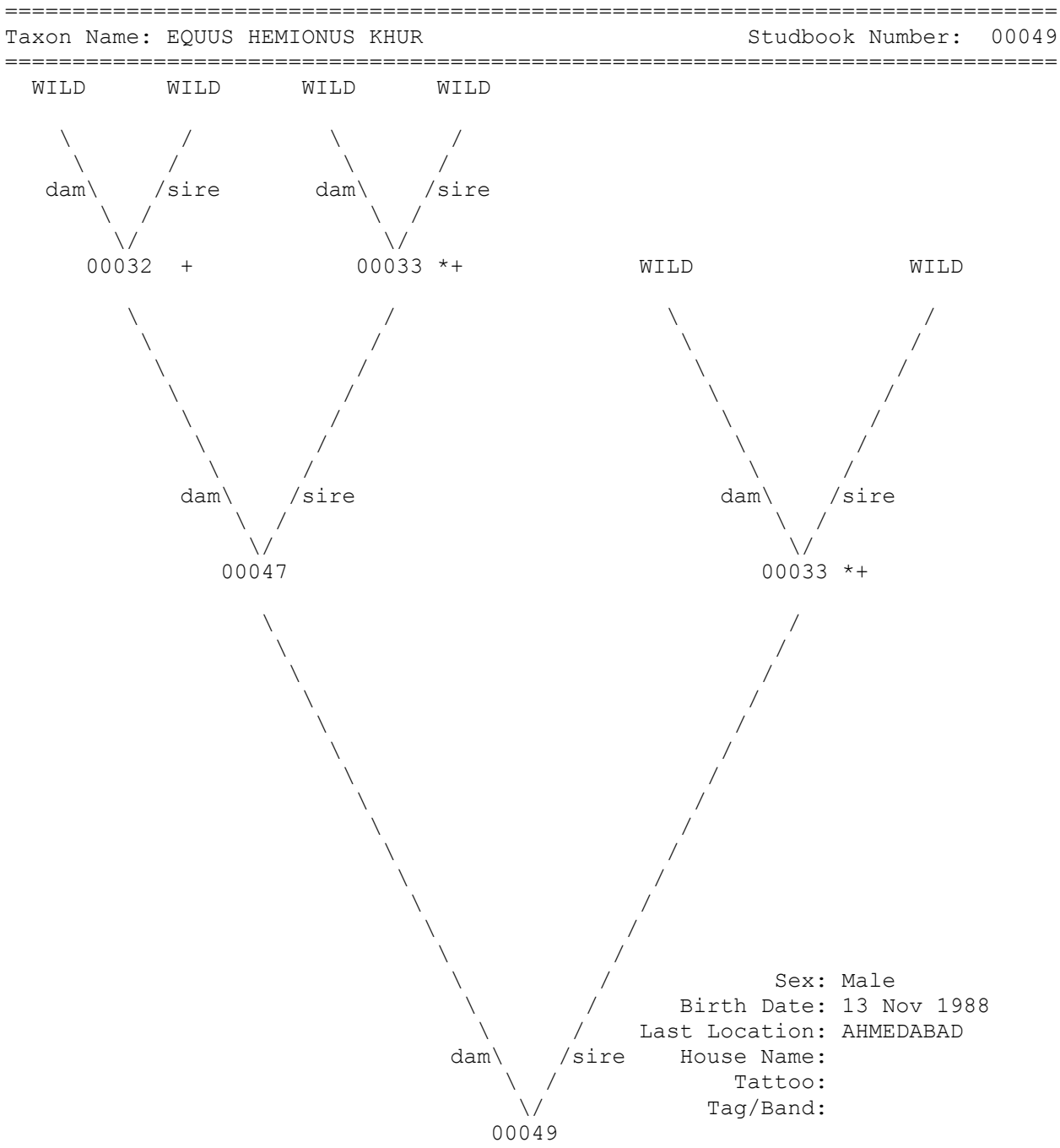


Sex: Female
Birth Date: 27 Sep 1987
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

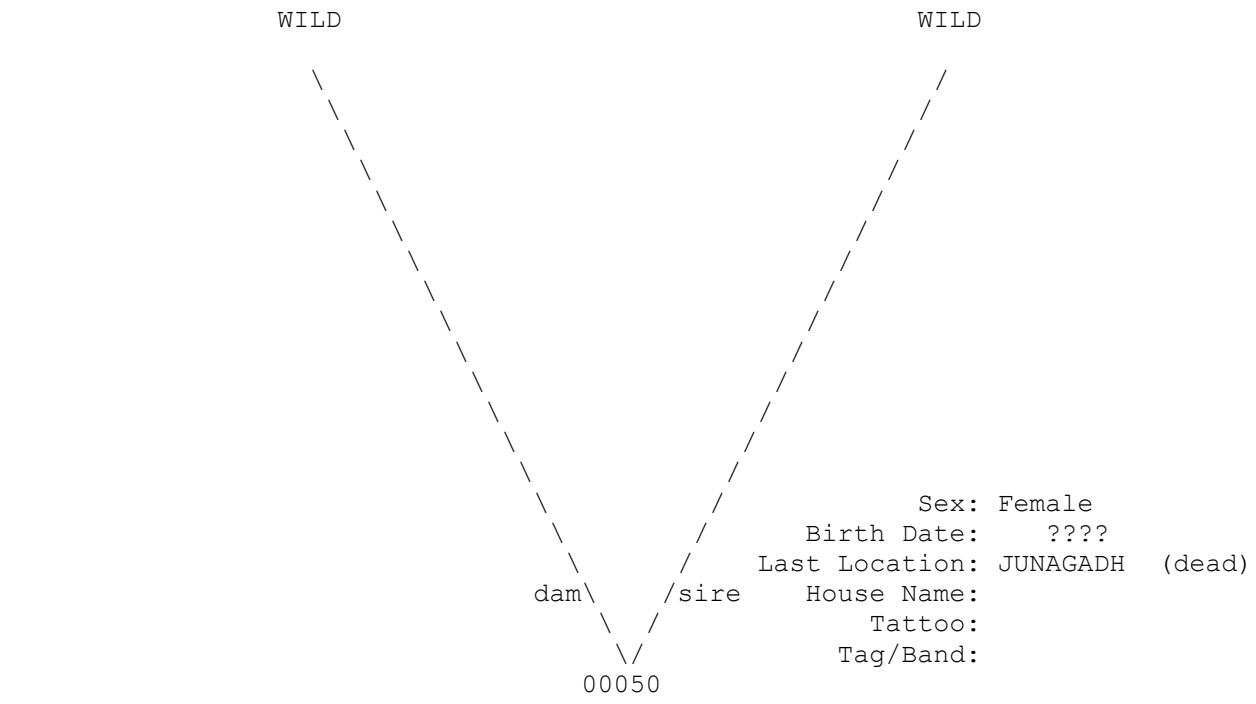
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00048

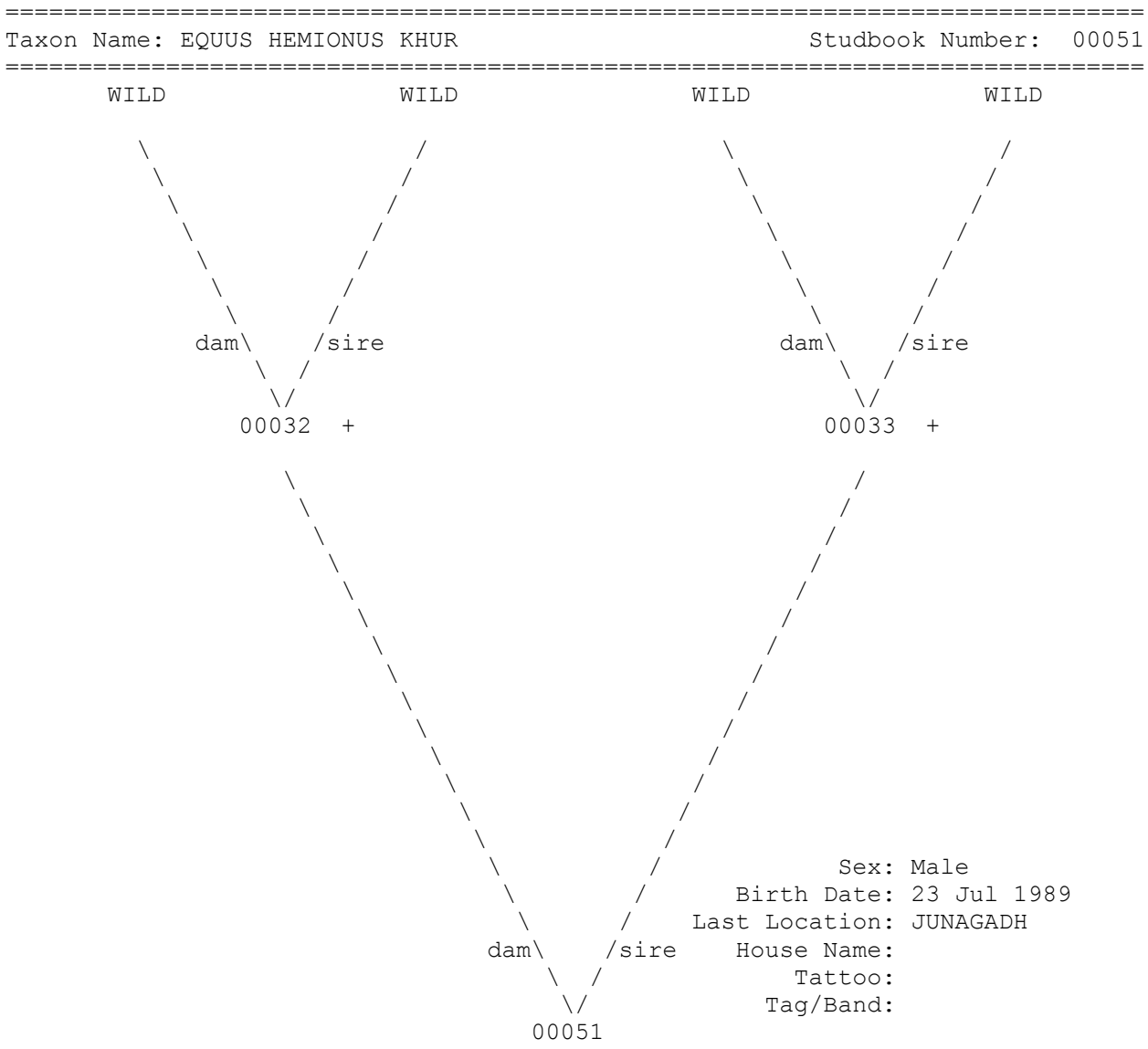




+ Wild-caught... * Appear more than once...

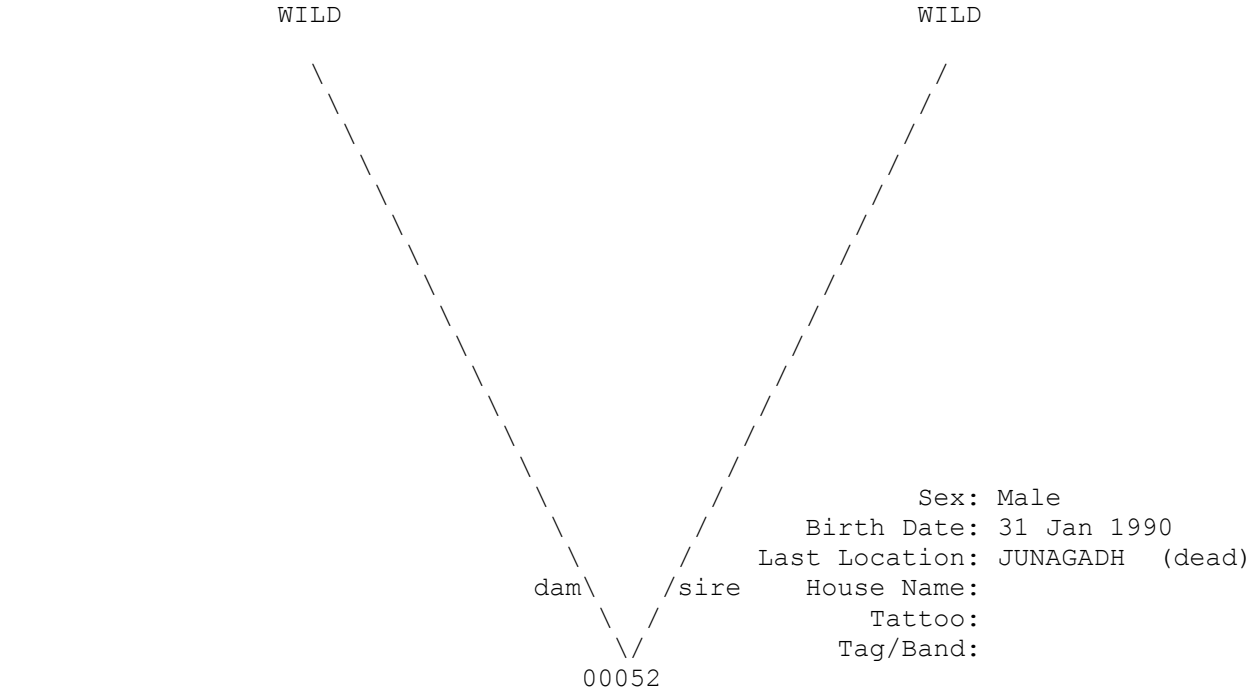
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00050

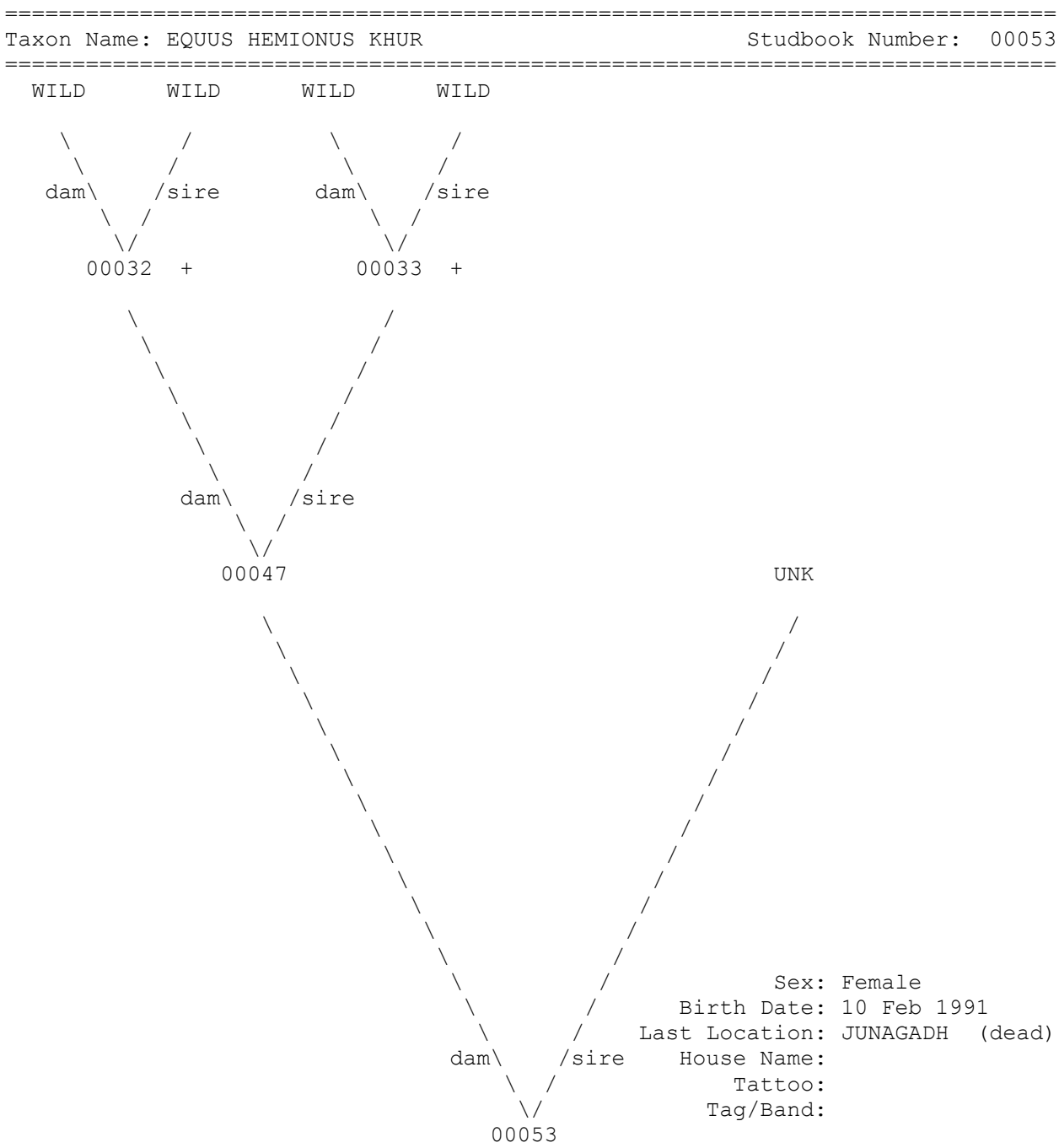



Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00051
WILD
WILD
WILD
WILD
dam
sire
dam
sire
00032 +
00033 +
dam
sire
00051
Sex: Male
Birth Date: 23 Jul 1989
Last Location: JUNAGADH
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

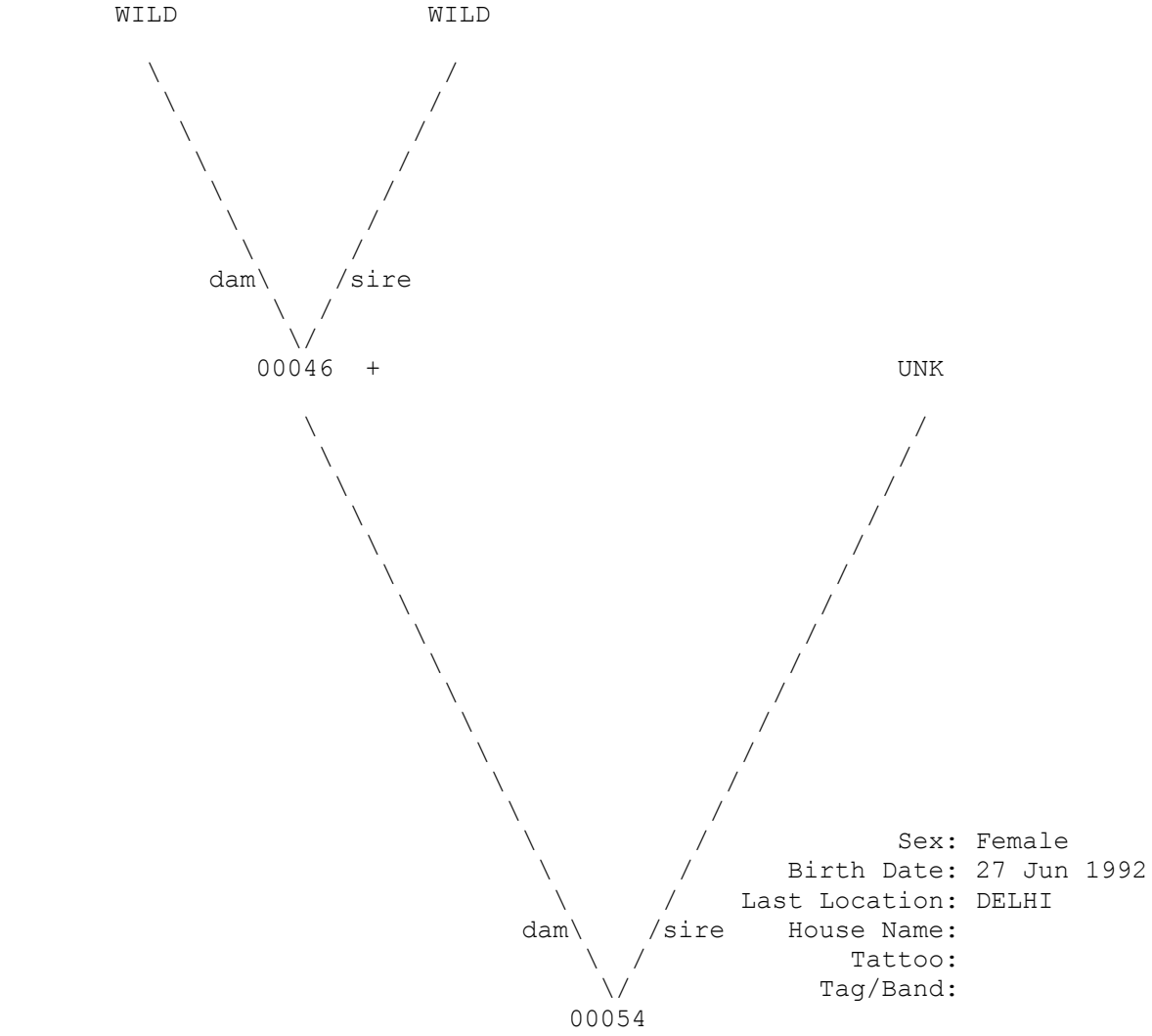
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00052



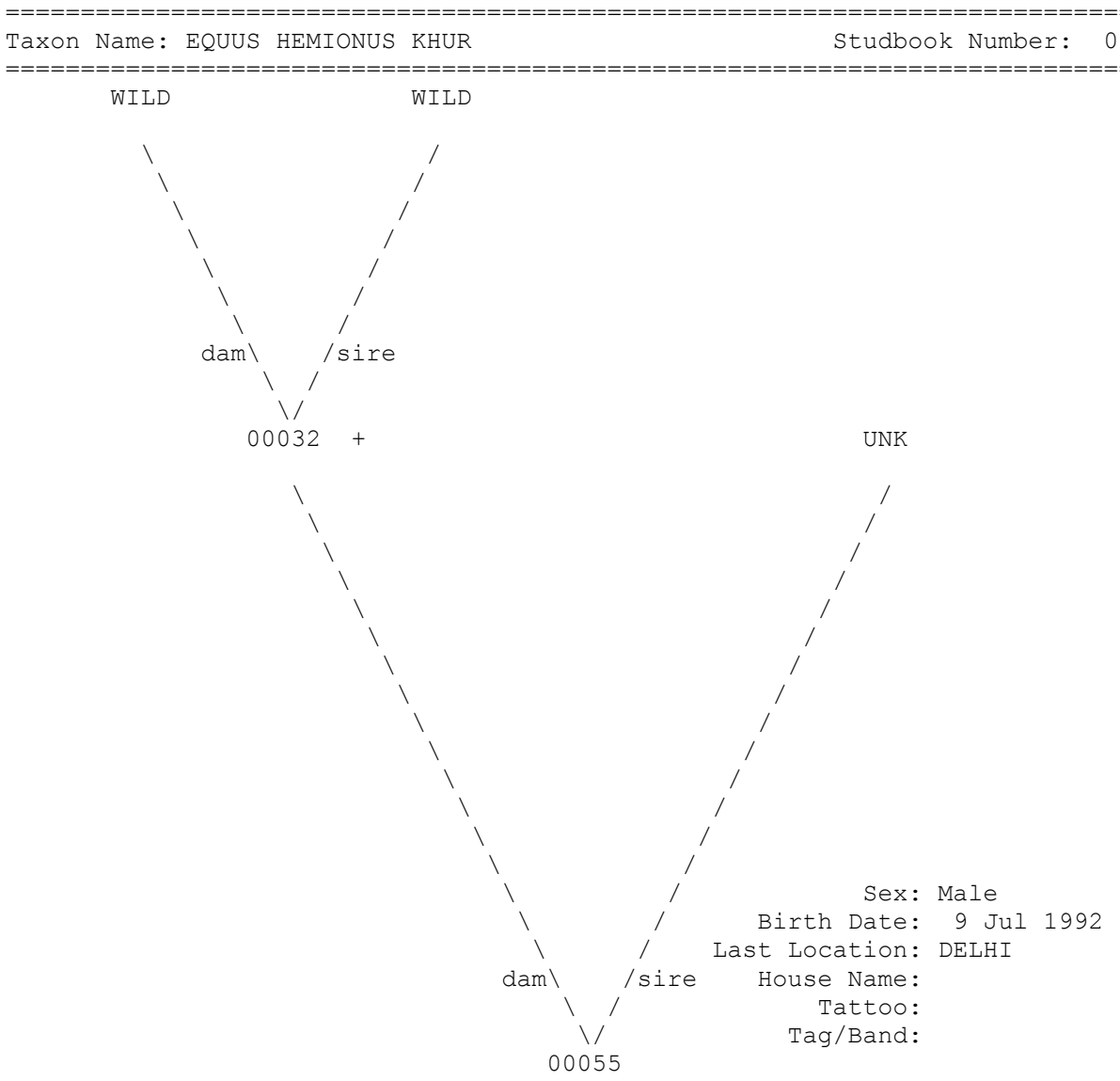

Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00053
WILD
WILD
WILD
WILD
dam
sire
dam
sire
00032 +
00033 +
dam
sire
00047
UNK
Sex: Female
Birth Date: 10 Feb 1991
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam
sire
00053

+ Wild-caught...

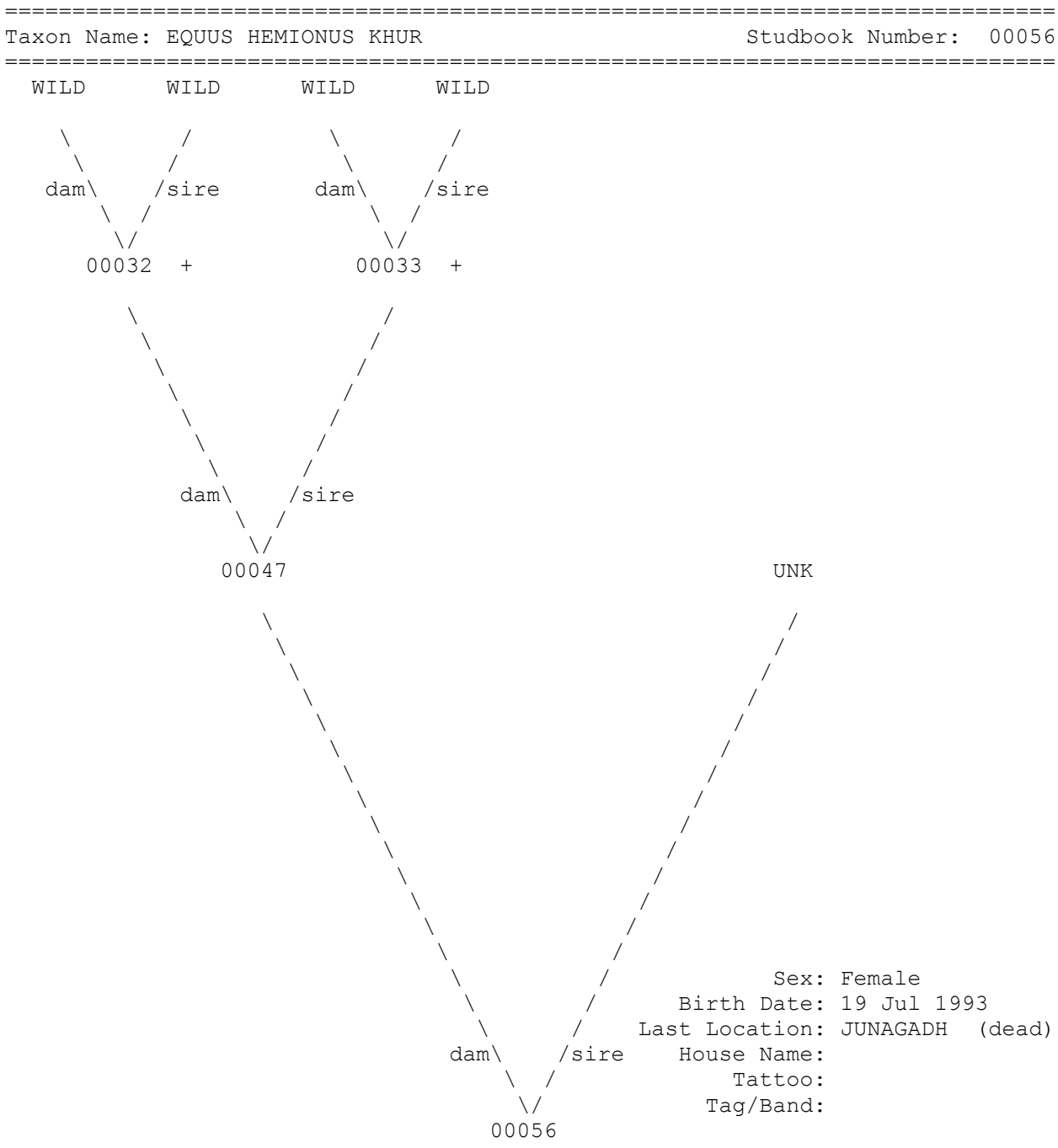
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00054



+ Wild-caught...

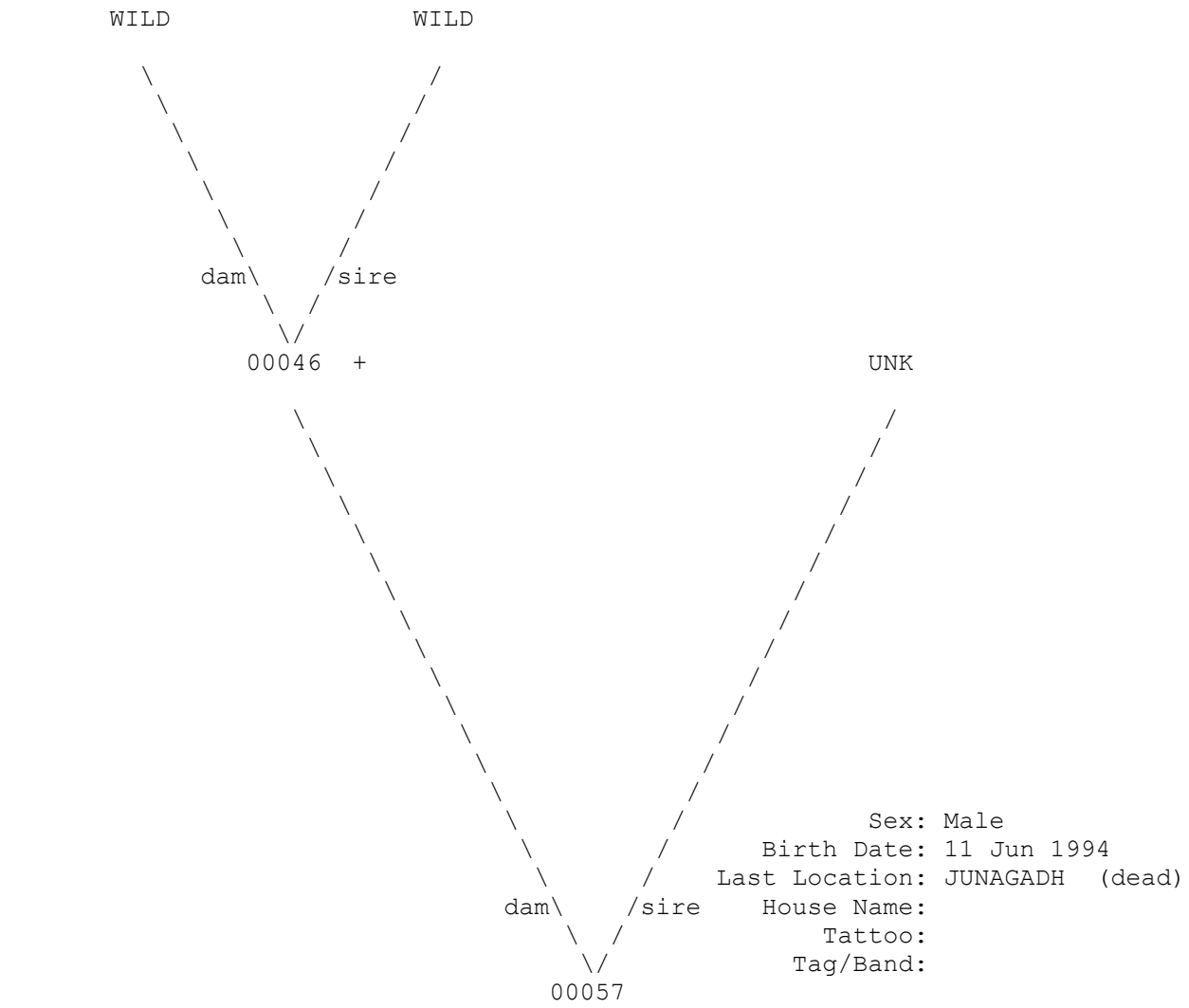

Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00055
WILD
WILD
dam
sire
00032 +
UNK
Sex: Male
Birth Date: 9 Jul 1992
Last Location: DELHI
House Name:
Tattoo:
Tag/Band:
dam
sire
00055

+ Wild-caught...

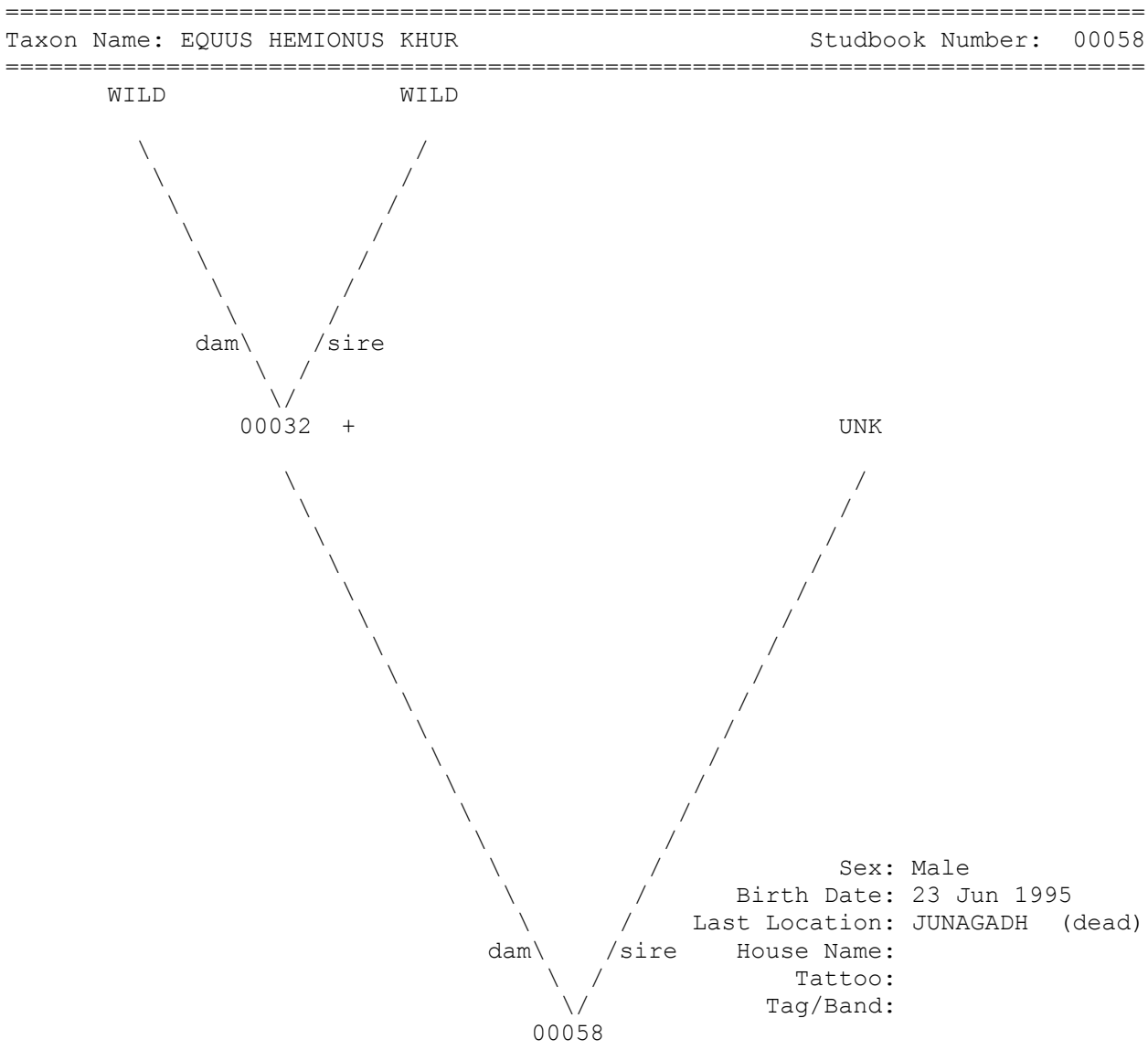

Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00056
WILD
WILD
WILD
WILD
dam
sire
dam
sire
00032 +
00033 +
dam
sire
00047
UNK
Sex: Female
Birth Date: 19 Jul 1993
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:
dam
sire
00056

+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00057

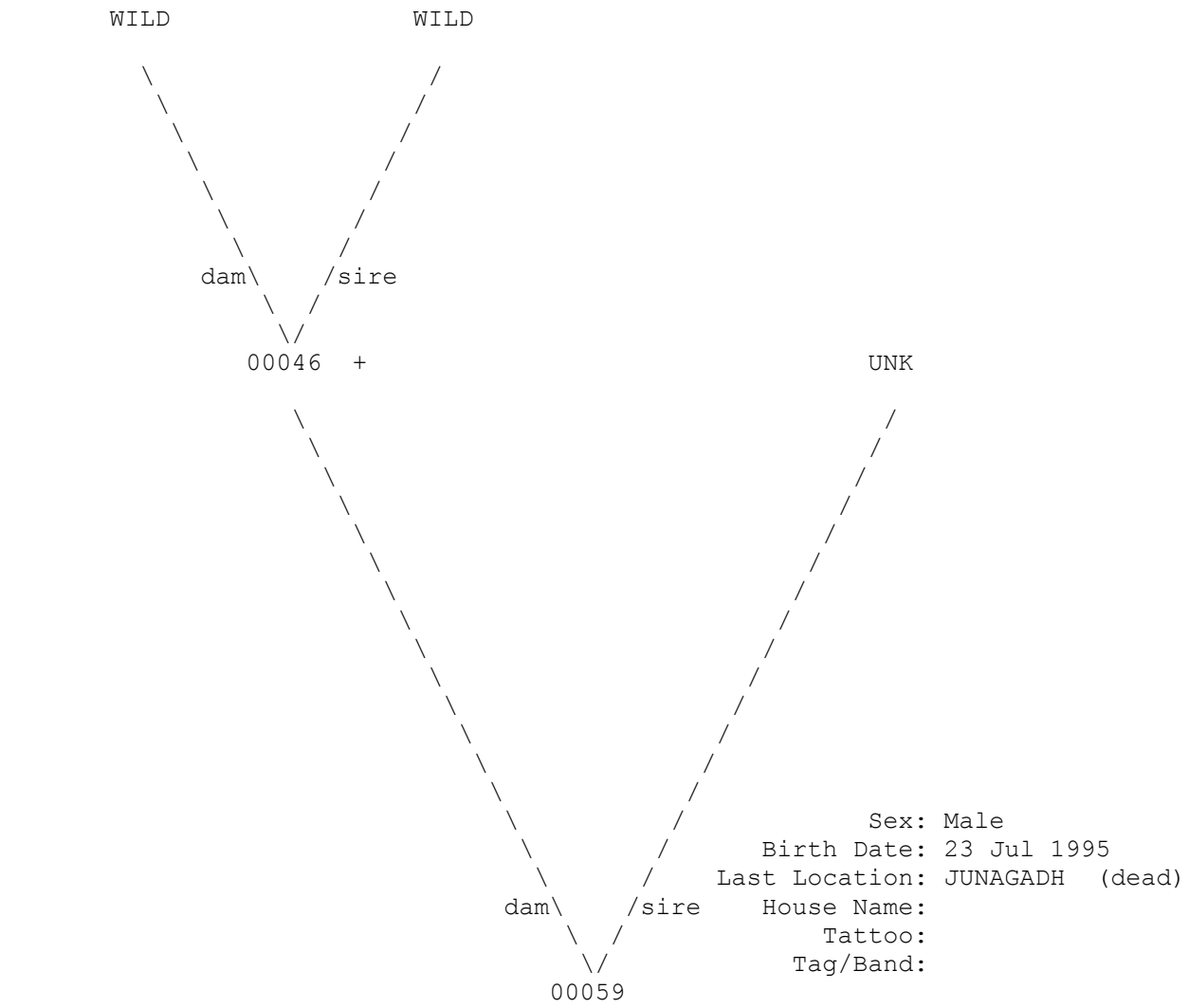


+ Wild-caught...


Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00058
WILD
WILD
dam
sire
00032 +
UNK
dam
sire
00058
Sex: Male
Birth Date: 23 Jun 1995
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:

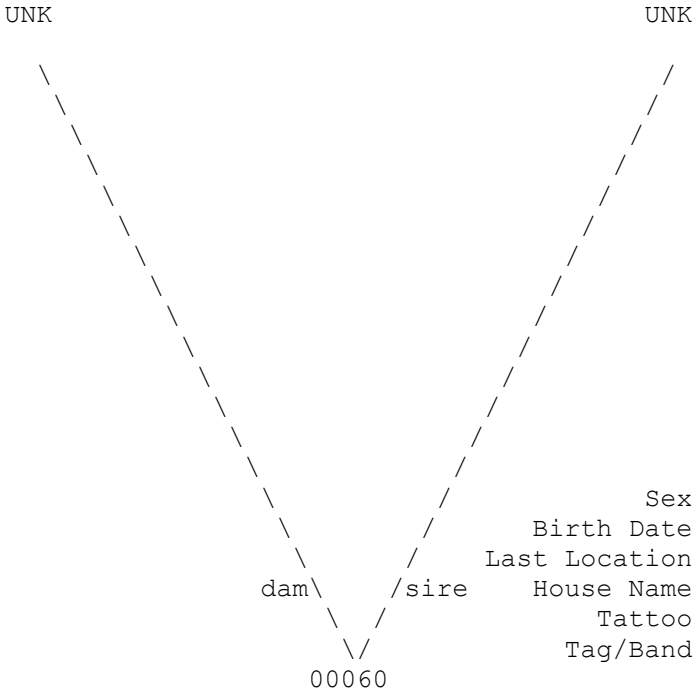
+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00059

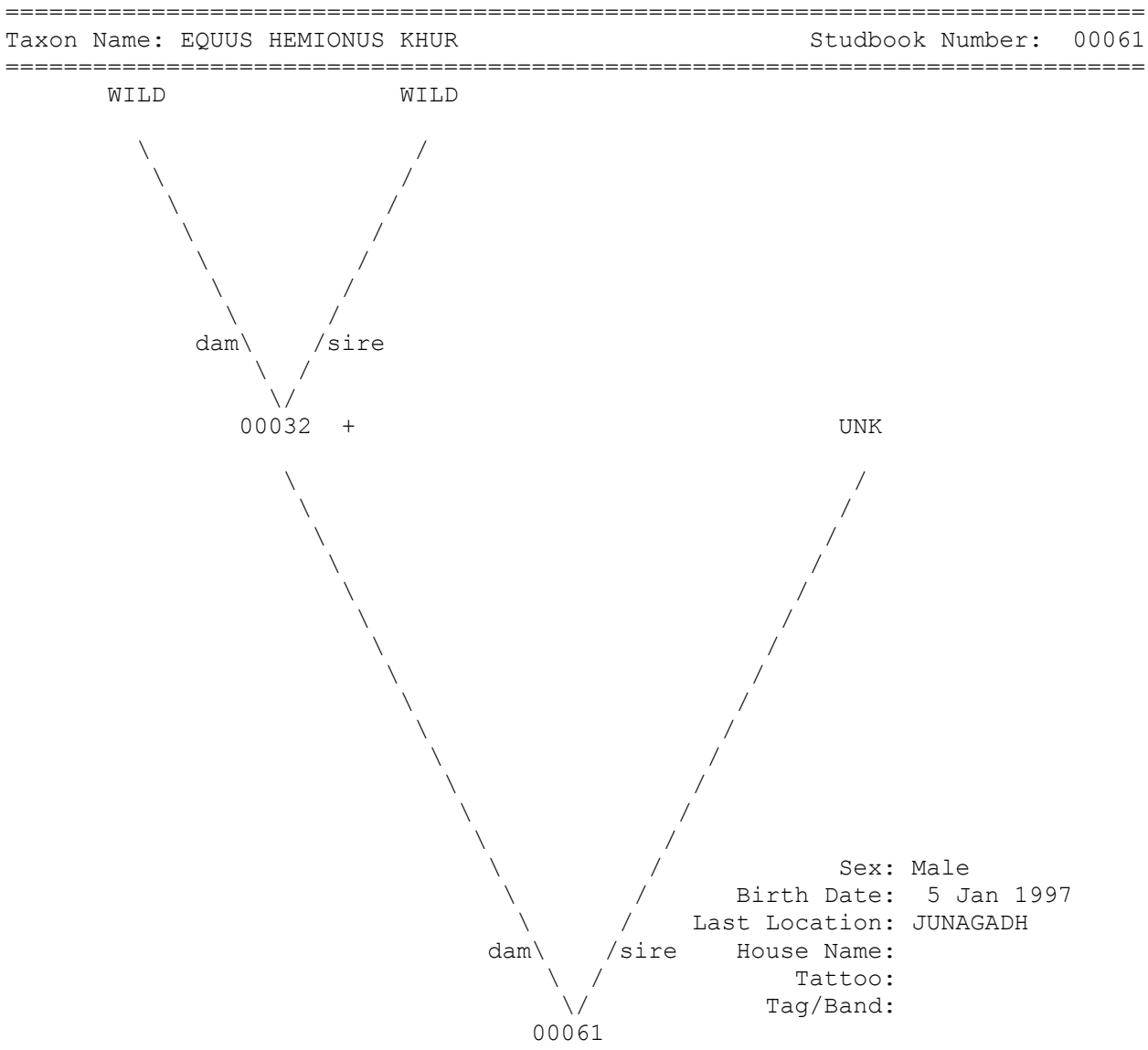


+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00060

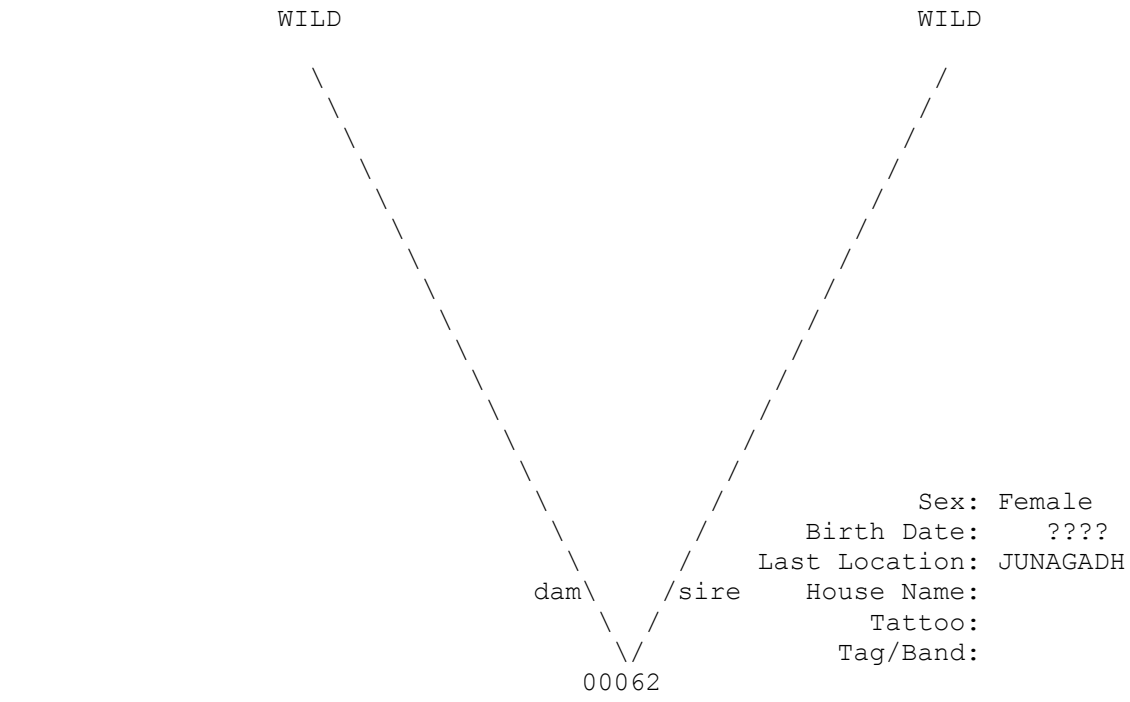


Sex: Female
Birth Date: 17 Aug 1996
Last Location: JUNAGADH (dead)
House Name:
Tattoo:
Tag/Band:

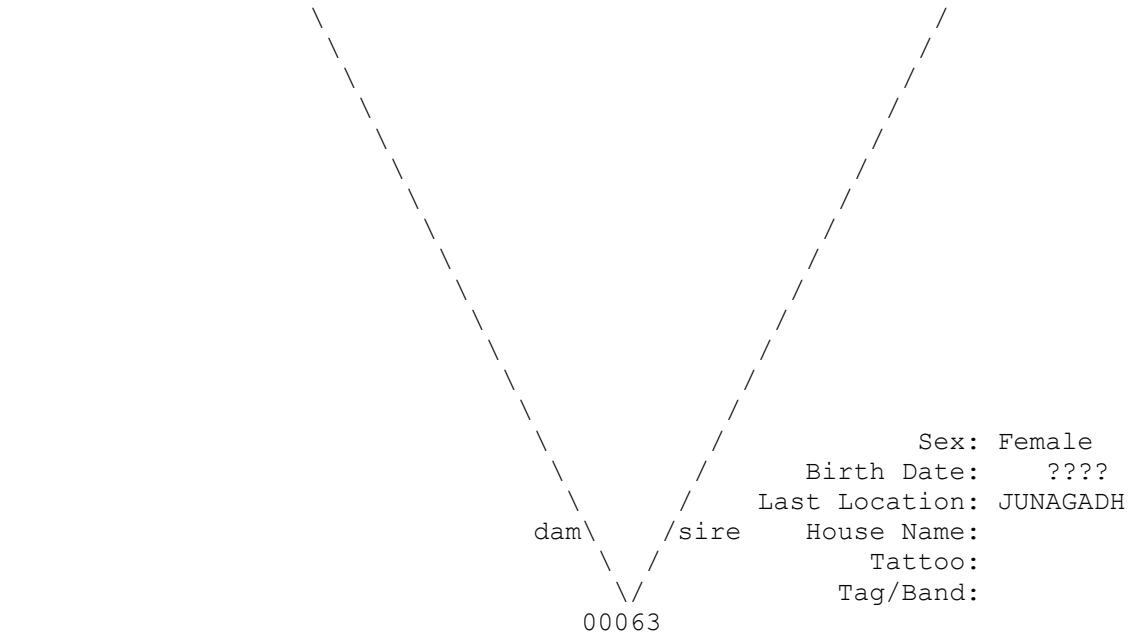

Taxon Name: EQUUS HEMIONUS KHUR
Studbook Number: 00061
WILD
WILD
dam
sire
00032 +
UNK
Sex: Male
Birth Date: 5 Jan 1997
Last Location: JUNAGADH
House Name:
Tattoo:
Tag/Band:
dam
sire
00061

+ Wild-caught...

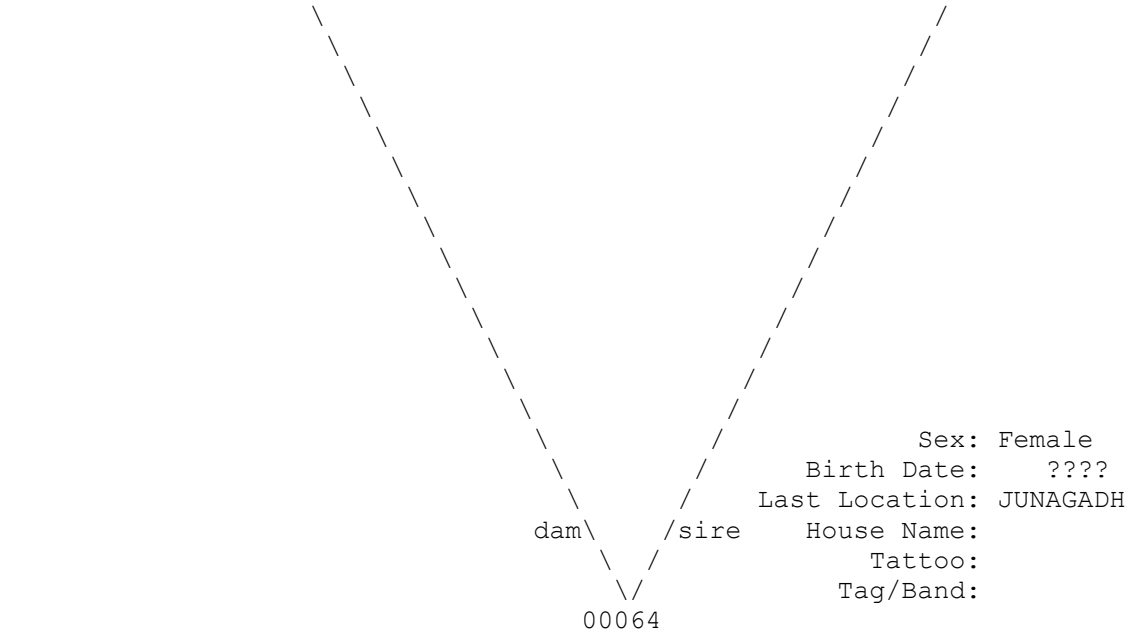
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00062



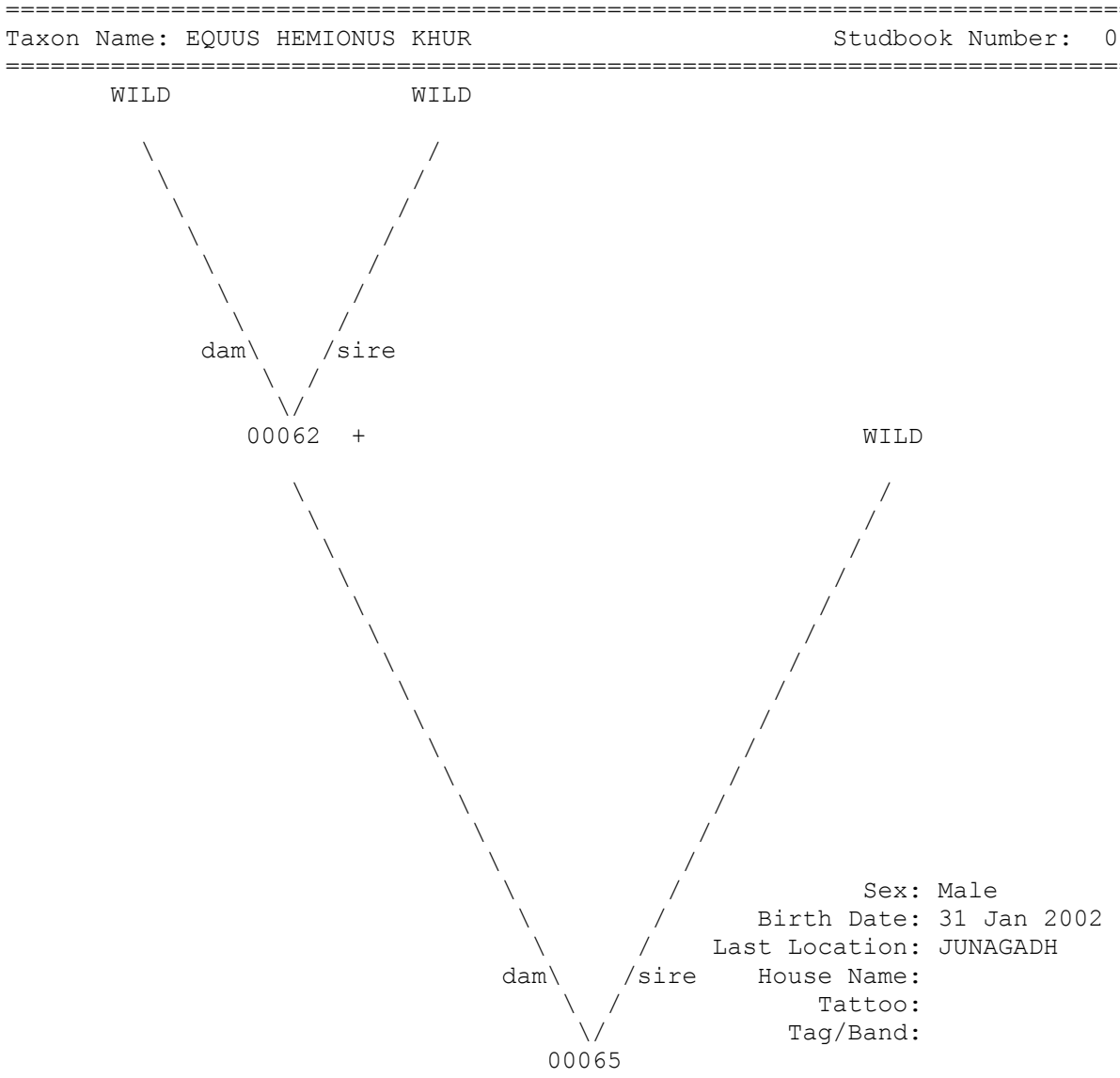
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00063



Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00064

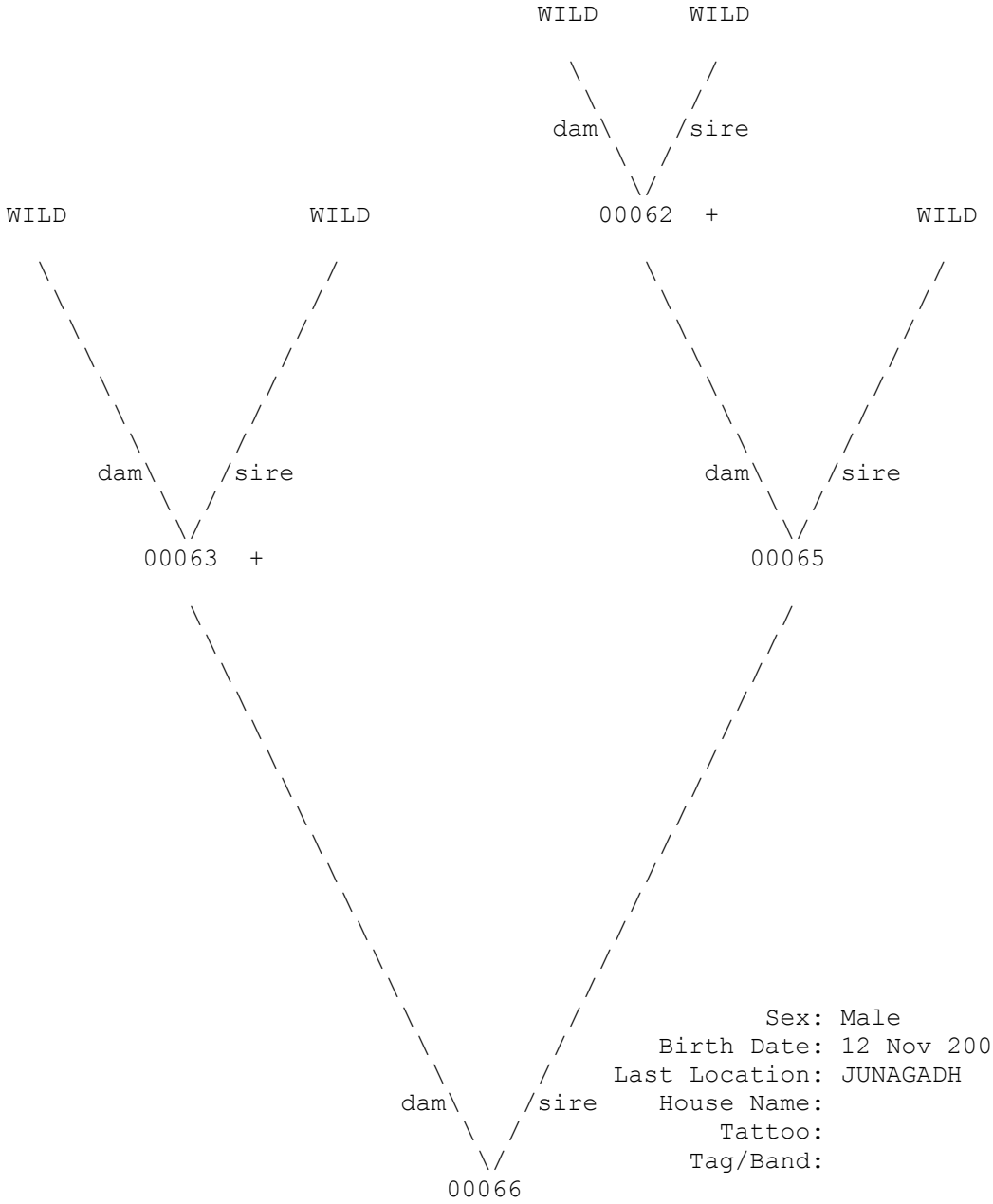


Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00065



+ Wild-caught...

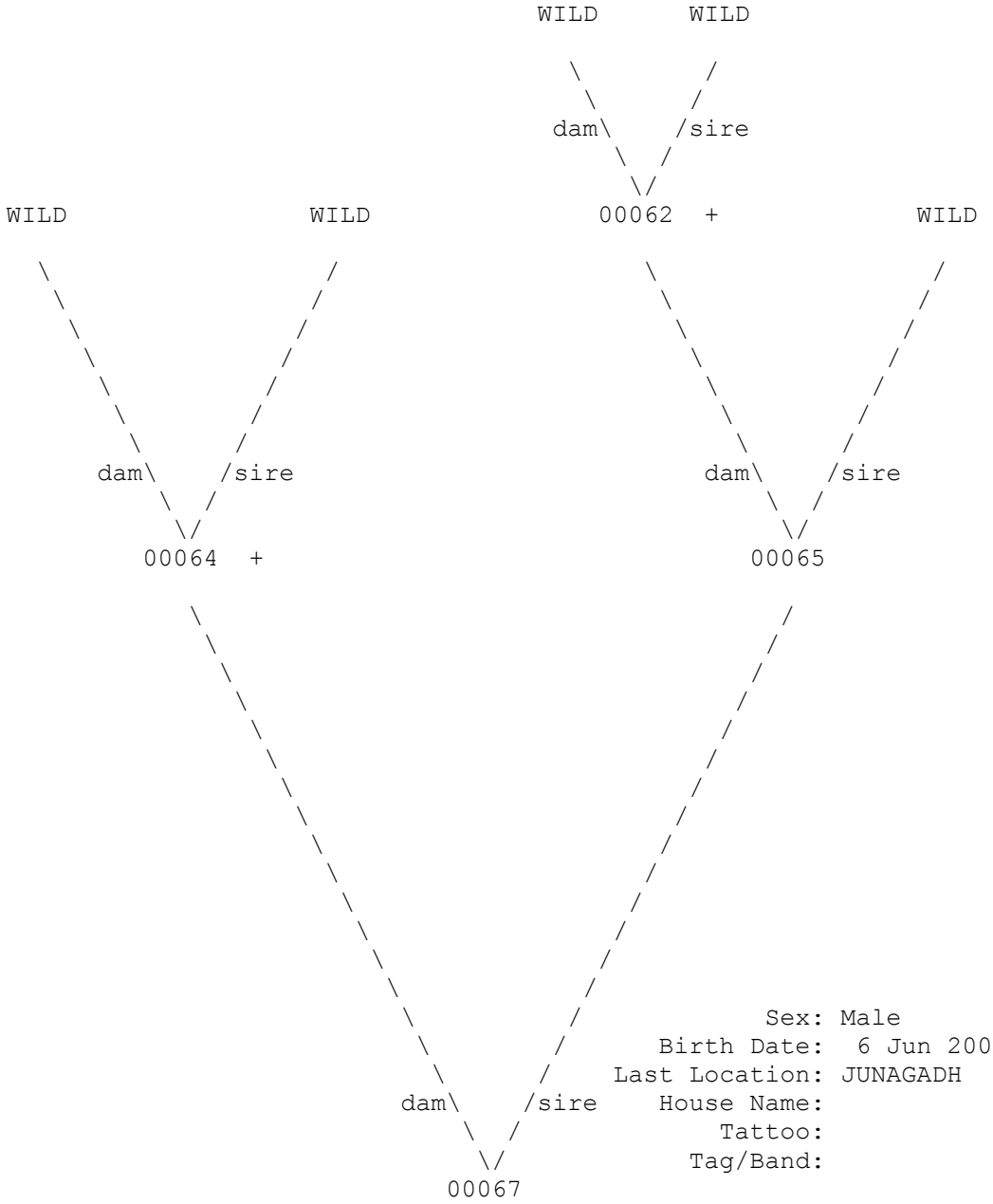
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00066



Sex: Male
Birth Date: 12 Nov 2005
Last Location: JUNAGADH
House Name:
Tattoo:
Tag/Band:

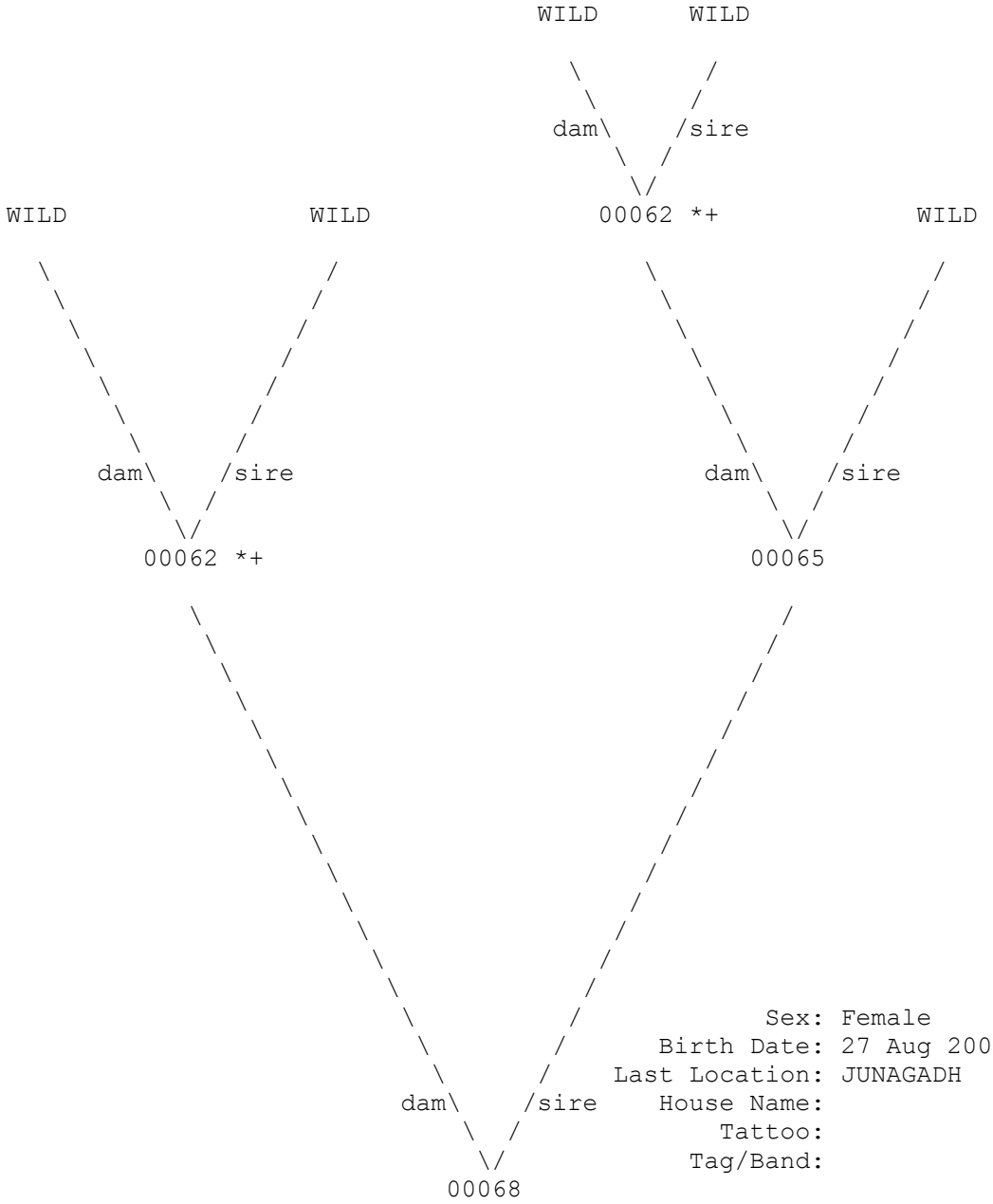
+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00067



+ Wild-caught...

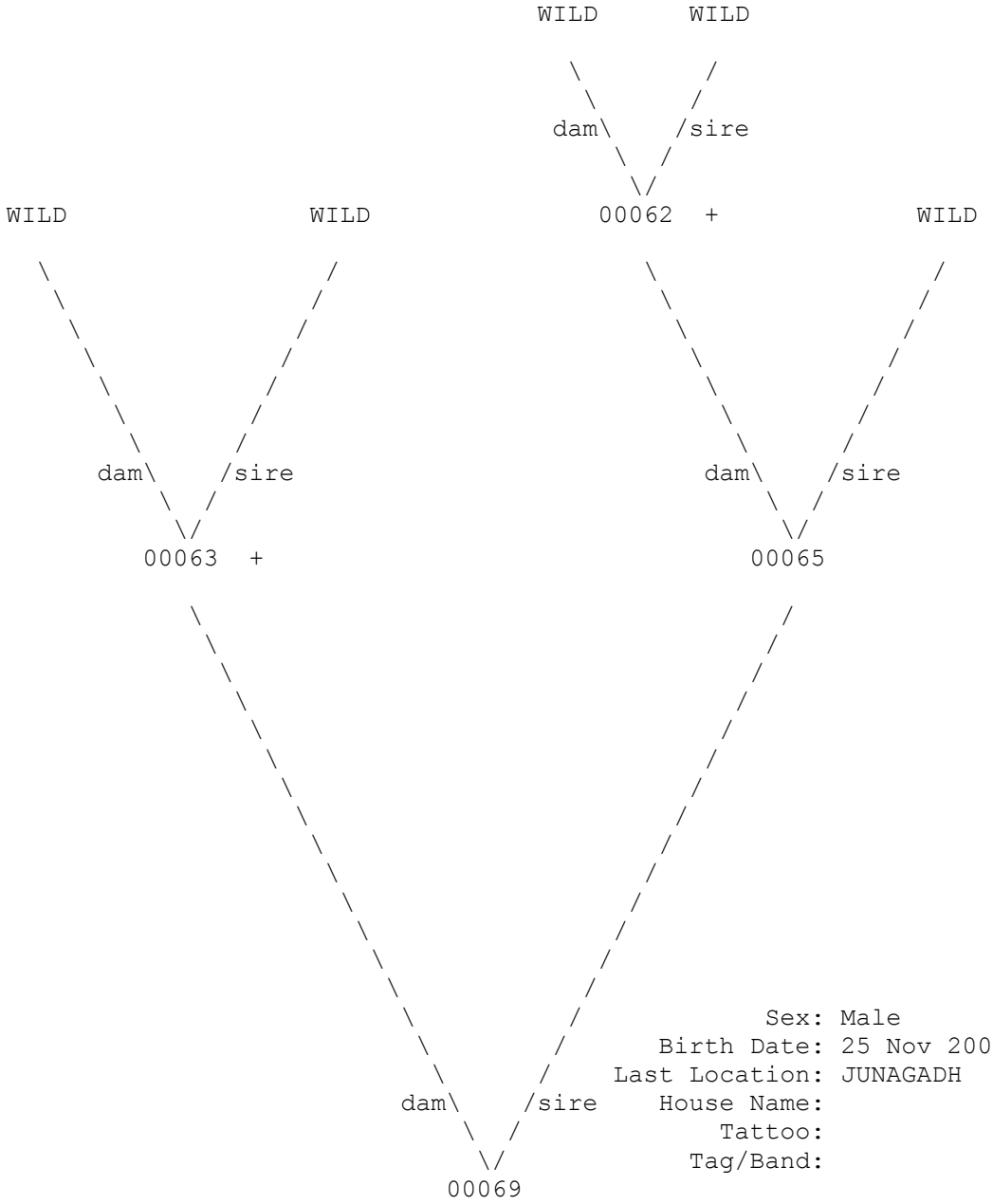
Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00068



Sex: Female
Birth Date: 27 Aug 2006
Last Location: JUNAGADH
House Name:
Tattoo:
Tag/Band:

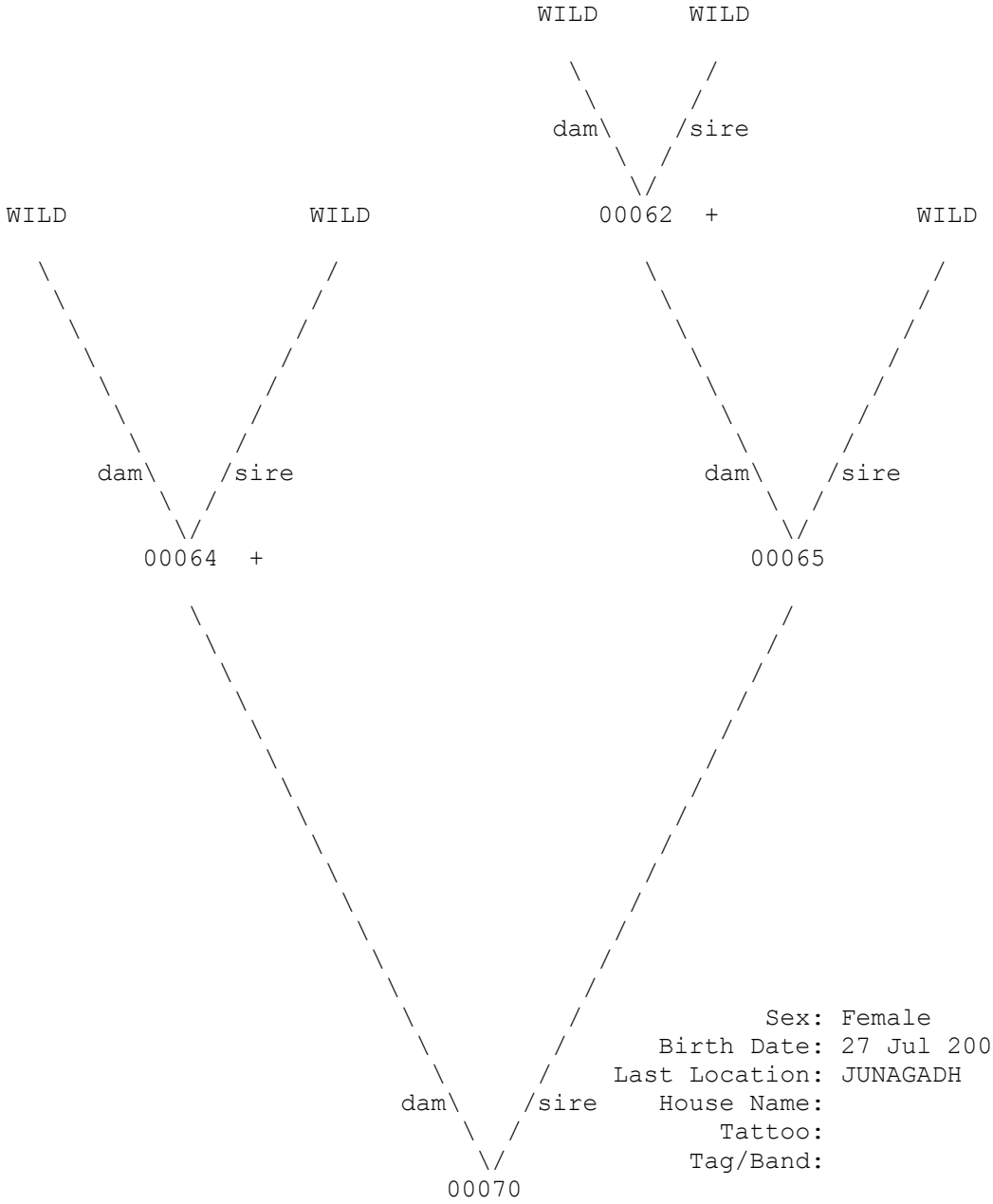
+ Wild-caught... * Appear more than once...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00069



+ Wild-caught...

Taxon Name: EQUUS HEMIONUS KHUR Studbook Number: 00070



Sex: Female
Birth Date: 27 Jul 2007
Last Location: JUNAGADH
House Name:
Tattoo:
Tag/Band:

+ Wild-caught...

Compiled by: Anupam Srivastav thru Wildlife Institute of India
Data current thru: 31 Aug 2008 Indian Regional
Printed on 15 Jul 2010 using Sparks v1.54