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Asiatic Wild Asses in the Literature: What Do We Need to Know Now?

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Abstract

Asiatic wild asses were once found across central Asia, but over time their range has been reduced until today all subspecies are under threat. This paper examined the literature about wild asses with an aim to illustrating gaps in our knowledge as a target for future research.

A search was made on BIOSIS ISI for the following strings: *Equus hemionus*, wild ass, khulan, kulan, kiang, khur, and onager. In total 61 relevant references were found, published between 1900 and 2005. Most of these references were published in the 1990s, with only one published between 1900 and 1970. Khur and khulan were most under-represented in the literature with only five and two citations respectively resulting from these key words. When put into subjective categories most papers published (28) were on the conservation, behaviour or ecology of Asiatic wild asses. All physiology papers dealt with captive animals, and nearly half of all genetics papers focussed on onagers. Very little was published on the habitat use of wild asses and there was almost nothing on the distribution of subspecies, or genetic differences between them. This research highlighted the importance of key words and consistent nomenclature. We need to focus more on the ecology of wild populations, in particular examining habitat use, social structure and distribution. In addition it is very important that more is published on threats to these animals so that action can be taken in time.

Keywords: wild ass, *Equus hemionus*, khulan, khur, kiang, onager, kulan

1. Introduction

The Asiatic wild ass, *Equus hemionus*, was once found throughout central Asia, from Saudi Arabia to north east of Mongolia, but now only occurs in small, geographically discrete, populations (FEH et al. 2002). The wild populations of extant subspecies of Asiatic wild ass consist of the khur (*E. h. khur*) in India, kulan (*E. h. kulan*) in Kazakhstan and Turkmenistan, onager (*E. h. onager*) in Iran, and khulan (*E. h. hemionus* and *E. h. luteus*) in Mongolia. The kiang (*E. kiang*) was previously considered an hemionid subspecies, but has now been confirmed as a separate species (*E. kiang*) (RYDER & CHEMNICK 1990), living in the Tibetan plateau. All of the wild populations are under threat, either directly through human pressure, or simply because of small population sizes, as in the case of the onager in Iran (TATIN et al. 2003). The Asiatic wild ass (*E. hemionus*) is listed as Vulnerable (VU) by the IUCN, with kulan and onager being Critically Endangered (CR) and the khur Endangered (EN) (FEH et al. 2002). The Mongolian khulan population has so far been considered relatively healthy, so both *E. h. hemionus* and *E. h. luteus* are listed as Vulnerable (VU) (FEH et al. 2002).

The threatened status of Asiatic wild asses means that research on these animals is vital to create awareness of conservation concerns and publicise their plight. All populations are considered in danger of extinction, thus research is important both so that we can learn as much about these animals as possible in the wild, and also so threats can be scientifically determined and then presented to relevant agencies or governments for action. Poaching is one of the main threats to the wild ass (READING et al. 2001, FEH et al. 2002), but other human activities are having an increasing impact either through changes in land use (e.g. GOYAL et al. 1999), or competition with livestock for pasture and water (FOX et al. 1991, READING et al. 2001). Without proper quantification of the dangers putting Asiatic wild ass populations in peril it is impossible to find ways to combat them.

Research on wild populations aids their conservation in captivity as knowledge of genetics and social structure enable the most appropriate groupings for captive breeding to be developed (OAKENFULL et al. 2000), thus increasing genetic diversity and making the most of limited resources in zoos. The IUCN Action Plan for Asiatic wild asses (FEH et al. 2002), states that although there is some data on genetics and behavioural ecology, there are gaps in our knowledge. *E. h. hemionus* and *E. h. luteus* were both recorded from Mongolia, but are described as having different morphology and occupying geographically different areas. No genetic research has been conducted to discover if there are in fact two different subspecies in Mongolia. In addition there is doubt if *E. h. onager* and *E. h. kulan* should also remain classified as two separate subspecies. These two subspecies are very closely related (OAKENFULL et al. 2000), but breeding them together in captivity could have future consequences, in particular as individuals from both subspecies have been reintroduced to Israel (SALTZ & RUBENSTEIN 1995).

Although many papers have focussed on the behavioural ecology of wild asses, there is still uncertainty about their social structure. It is possible that different populations have different social structures, but this needs to be clarified as it will impact on critical areas for conservation and how the animals are kept in zoos. Some populations appear to be territorial, with stallions defending an area (KLINGEL 1977, SALTZ et al. 2000), whereas other populations appear to form family groups with more permanent associations between individuals (FEH et al. 1994, FEH et al. 2001). Very little is known about the ecology of Asiatic wild asses, yet this information is vital for their conservation in the wild.

Ongoing research listed in the action plan only deals with khur in India, reintroduced wild ass in Israel, and khulan in Mongolia (FEH, et al. 2002). Little research is currently being conducted on other populations. This study shows the results of a literature search examining published documents on Asiatic wild asses between 1900 and 2005 with an aim to look for any gaps in current knowledge so that future research can be conducted to fill them. Published papers were examined to see how many were relevant to wild asses, and reviewed to see where any biases in research effort had been directed.

2. Material and methods

A search was run on ISI Bioweb (BIOSIS) science citation index. All languages and all document types were selected. The time frame was between 1900 and 2005. The following strings were input separately: *Equus hemionus*, wild ass, khulan, kulan, kiang, khur, onager. Plurals were also searched for. This search produced papers where the key word appeared in the title, key words, abstract and/or article text. The resulting references were entered into Endnote programme to allow categorisations to be made. References were categorised by year, subspecies and put subjectively into the following categories:

Incidental	–	one of the key words was mentioned in passing in a paper on another subject.
General equid	–	paper about equid species in general that mention one of the key words.
Other equid	–	one of the key words mentioned in a paper about a non-relevant equid species or subspecies.
Physiology/Genetics	–	papers focussing on the physiology and/or genetics of extant Asiatic wild asses.
Conservation/Behaviour/Ecology	–	papers focussing on the conservation, behaviour and/or ecology of extant Asiatic wild asses.

Results were analysed using Chi square tests to examine trends toward particular years or subspecies, and the number of duplicate papers covering more than one key word was determined.

3. Results

In total 61 references were found that included one or more of the search key words. Most of these were published in the 1990s (52 %, N = 32), with only one paper on Asiatic wild asses published prior to 1970 (LYDEKKER 1904; fig. 1). Twenty-seven references featured the phrase '*Equus hemionus*' and 33 'wild ass', with 12 of these references featuring both phrases. Significantly few references featured the word khulan or khur compared to the other subspecies (fig. 2). Most references that contained the word 'kiang' were not relevant. Table 1 shows duplicates (i.e. where the same search word was featured in the same article as one or more others). The phrase 'wild ass' and/or '*Equus hemionus*' was featured in 79 % (N = 48) of papers about the subspecies. There was also considerable overlap within the subspecies searches. A large proportion of references (46 %, N = 28) were about conservation/behaviour/ecology of Asiatic wild asses (fig. 3). Physiology/genetics was the second most common subject.

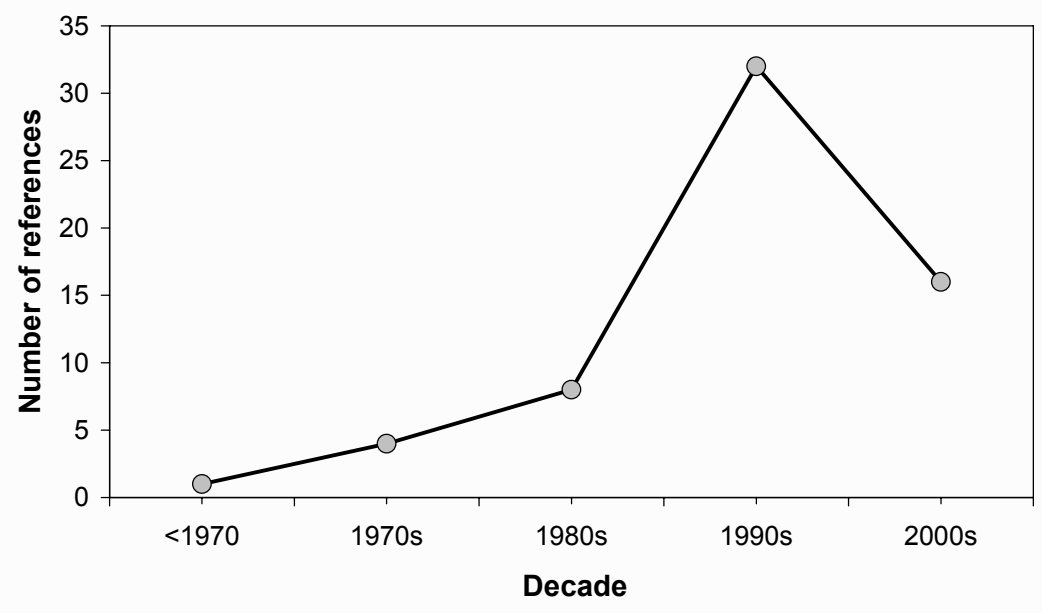

Fig. 1: References featuring Asiatic wild ass species names since 1900. More papers were published in the 1990s than any other decade to date (X^2 = 51.26, df = 4, P = < 0.01).

Table 1: Number of duplicate references (where the same search word was featured in the same article as one or more others)

	N	Khur	Kiang	Kulan	Khulan	Onager
Wild ass	33	2	5	1	0	1
E. hemionus	27	3	2	3	2	4
Khur	5		0	1	0	0
Kiang	12			3	0	4
Kulan	10				0	3
Khulan	2					0
Onager	18					

Incidental references

There were five references where one of the search strings was included in a paper about another subject. These papers covered subjects such as encephalitis associated with equine herpesvirus 1 in a Thomson's gazelle (*Gazella thomsoni*) (KENNEDY et al. 1996) and prehistoric fauna of Eurasia (VERESHCHAGIN & BARYSHNIKOV 1991). There were also three papers from research in Israel in an area where onager have been reintroduced, describing a long term vegetation study (WARD et al. 2000), the use of remote sensing to assess vegetation status (SALTZ et al. 1999), and the space use of reintroduced Persian fallow deer (*Dama mesopotamica;* DOLEV et al. 2002).

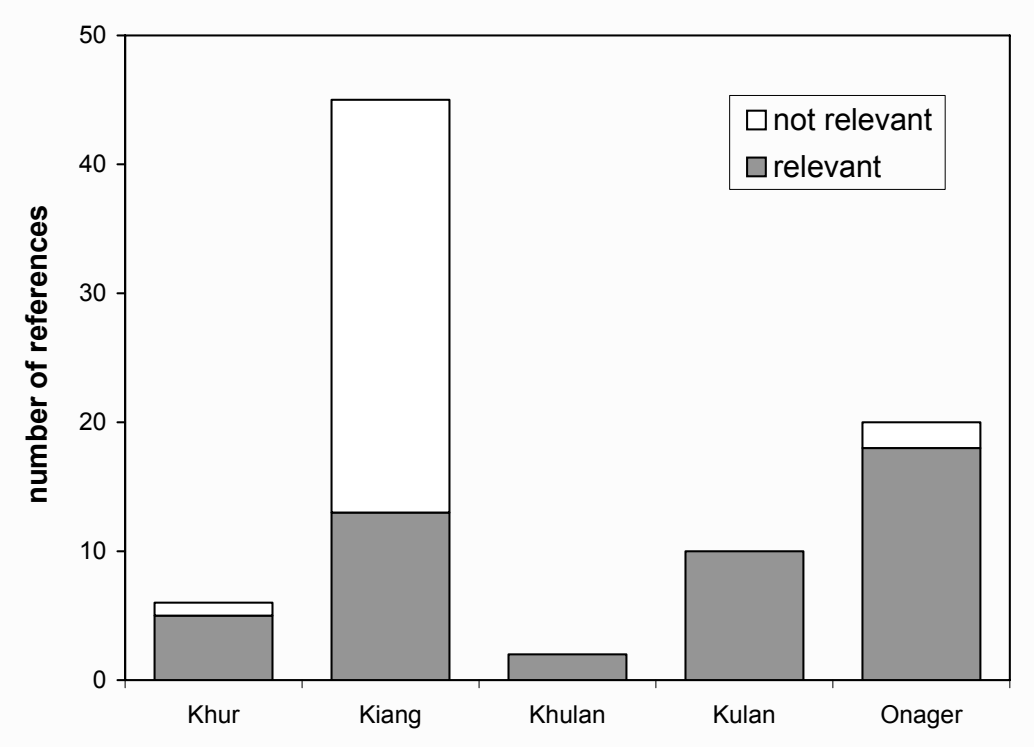

Fig. 2: Number of references on each of the individual key words. Filled bars indicate relevant articles, number of non-relevant articles is represented by unfilled parts of the bar. There were fewer references on khur and khulan than the other subspecies (X^2 = 17.54, df = 5, P = < 0.01).

General equid references

Five papers mentioned wild asses as part of research on equid species in general. All of these papers dealt with equine genetics. One of these papers looked at the genetics of herpesviruses, including equine herpesvirus in zoo Perissodactyls (tapir, zebra and wild ass) (EHLERS et al. 1999); another paper examined species-specific esterases of three equids (KAMINSKI et al. 1978). Two papers examined polymorphism. MYKA et al. (2003a) found the same level of chromosomal polymorphism in five equid species (including onager, kulan and kiang), despite their being separated by three million years of evolution, due to either a common ancestor or independent polymorphism in each species. BROWN et al. (2004) examined the equine lymphocyte antigen DRA locus to find the extent of polymorphism and establish the allele frequency distribution. Although their samples were mostly from domestic horses they also included other

equid species, including onager. They found that alleles tended to be species-specific, with the high level of polymorphism at the DRA locus being unique to the genus *Equus*. KRUGER et al. (2005) conducted a phylogenetic analysis of equid species using microsatellite data, finding that *E. h. onager* and *E. h. kulan* were distinct subspecies.

Other equid references

Asiatic wild asses were mentioned in ten papers that were focussed on other equid species. Four of these papers were on African wild asses: MOEHLMAN et al.'s (1998) paper on the conservation of wild asses in the Horn of Africa; the genetics of Somali wild ass (*E. africanus somaliensis*) (HOUCK et al. 1995, HOUCK et al. 1998) and large mammals (including wild ass) of Jordan (HATOUGHBOURAN & DISI 1991). There were two papers on the behaviour of feral asses, one in the Caribbean (RUDMAN 1998) and one in Death Valley, USA (MOEHLMAN 1998). Two papers were on zebras: herpesvirus infection of a captive Grévy's (*E. grevyi*) stallion (BLUNDEN et al. 1998) and historic range of *E. africanus, E. grevyi* and *E. burchelli* (BAUER et al. 1994). In addition there was a paper on Przewalski's horse (*E. ferus przewalskii*) red blood cell amino acid transport activity (FINCHAM et al. 1992) and discovery of an *E. h. hemippus* skull (EISENMANN & TRANIER 1985).

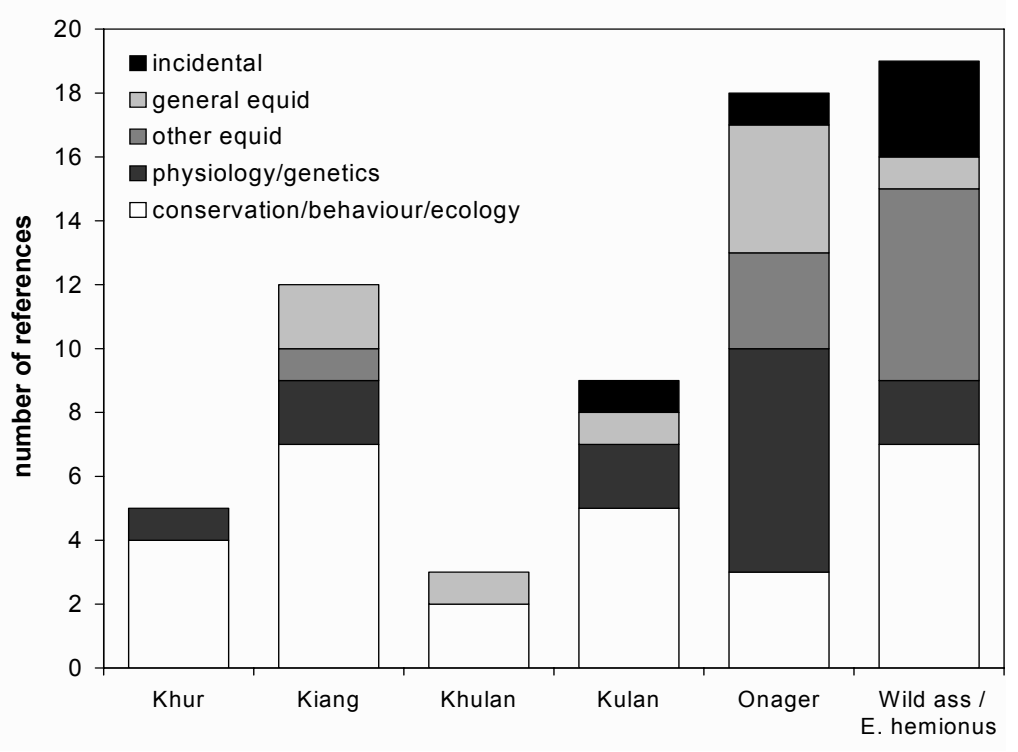

Fig. 3: Subject of Asiatic wild ass references by subspecies. Duplicate papers are included in each key word that they were referenced in. Wild ass and *Equus hemionus* papers were lumped here, thereby excluding duplicates.

Physiology/Genetics

All 13 physiology and genetics papers were the results of research on captive animals. Four papers described different aspects of wild ass parasites. Forty two species of helminth, including 34 strongylids, were found in 24 kulan from Askania-Nova and Badkhyz (DVOINOS et al. 1992). Endoparasitic infuzorians in the intestine of *E. h. onager* from Barskal'mes island, Russia

were examined, with most parasites, up to 785,400 per ml, found in the dorsal part of the colon (KORNILOVA 1991). Occurrence of bot fly larvae on wild ass (RAO et al. 1990) and use of onager grazing in zoos to control parasites (DAGLEISH et al. 2004) were also examined. One paper classified here as a genetics paper simply described a case of a donkey (*E. asinus*) - khur hybrid (JOSHI et al. 2001), and another looked at wild ass hemoglobin sequences (MAZUR & BRAUNITZER 1982). Research for three of the seven genetics papers was conducted on onagers: MYKA et al. (2003b) explored chromosome changes between domestic horses (*E. caballus*) and onagers, GADI & RYDER (1983) analysed onager DNA, and KAMINSKI (1972) examined onager serum esterases. RYDER (1978) examined chromosomal polymorphism in *E. hemionus* and RYDER & CHEMNICK (1990) did a chromosomal study of kiang, coming to the conclusion that it is a species in its own right (*E. kiang*) and not an hemionid subspecies.

Conservation/Behaviour/Ecology

There were 28 papers on conservation, behaviour or ecology of Asiatic wild asses. It should be noted that some papers assigned to this category could not be obtained and reviewed here, however from the abstract it was apparent that they contain information on distribution and ecology of the wild ass. These papers were LYDEKKER (1904), LOBANOV (1982), CHU et al. (1985), and PAKLINA & VAN ORDEN (2003).

Social structure of Asiatic wild asses has only been described for a few populations: *E. hemionus* sp. in Turkmenistan (KLINGEL 1977) and reintroduced to Israel (SALTZ & RUBENSTEIN 1995, SALTZ et al. 2000), onager in Iran (TATIN et al. 2003) and khulan in Mongolia (FEH et al. 1994, FEH et al. 2001). In all wild populations there appears to be formation of large groups: Turkmenistan 1 – 135 (KLINGEL 1977), Mongolia 1 - 850 (FEH et al. 2001) and Iran 2 - 74 animals in a group (TATIN et al. 2003). However most animals were seen in smaller groups by KLINGEL (1977; 2 - 6 individuals), FEH et al. (2001; 1 - 10 individuals), READING et al. (1999; mean group size = 4.31 $\pm$ 0.64 animals/group) and READING et al. (2001; 3 - 18 in south-east Gobi to 4 - 35 per group in south-west Gobi, Mongolia).

There is mixed evidence on the social structure of wild asses, possibly depending on the subspecies or even the population. KLINGEL (1977) did not observe during the breeding season, but found no permanent associations between animals. Among captive kulan mares no clear-cut rank differences were observed, and there were few agonistic interactions (GANSLOSSER & DELLERT 1997), also suggesting less association among animals. SALTZ et al. (2000) observed strong territoriality by stallions and no permanent associations, but FEH at al. (2001) saw no evidence of areas being defended and found family groups of 1+ stallions with at least two females and their offspring. TATIN et al. (2003) also reported seeing family groups of onager with no aggressive interactions between stallions at the same water hole, but this was reported from only one observation. Although the group of kulan in Bukhara Reserve, Uzbekistan was artificially controlled it appears to have more of a harem structure, with a stallion remaining with mares in a 'reproductive group' (BAHLOUL et al. 2001). BERGER (1981) described fights between onager stallions, but did not report in detail on the social structure.

Reproduction of *E. hemionus* sp. was low during the first five years after release in Israel, but after this increased to 0.5 - 1 foal/female/year (SALTZ & RUBENSTEIN 1995). In Mongolia, reproduction rate was 15%, with 50% survival of foals over the first year (FEH et al. 2001). In Iran, 16.7 % - 18.5 % of the populations seen was made up of foals (TATIN et al. 2003).

Only distribution of kiang, khulan, onager and khur has been described, and none of the descriptions covered the entire range of the subspecies, except for khur as their range is so small. Kiang populations were examined in the Tibetan plateau of Yeniugou, China (HARRIS et al. 1999, HARRIS & LOGGERS 2004), Aru Basin, Tibet (SCHALLER & GU 1994) and Ladakh, India (FOX et al. 1991, MALLON 1991). In Yeniugou, populations appeared stable or declining (HARRIS & LOGGERS 2004), with 843 seen in 1991, 100 in 1992 and 418 seen in 1997 (HARRIS et al. 1999). Group sizes and locations found were similar between years, but methods used to estimate the population sizes differed (HARRIS, et al. 1999). In Tibet, SCHALLER

& GU (1994) reported 2100 individuals of various ungulate species using 1150 km^2 of habitat, with less than 32 % of these animals being made up by kiang. The kiang population is sparse in Ladakh, with 1500 animals over 6000 km^2 (FOX et al. 1991). The numbers in this region were reduced during the war with China in 1962, but between 1987 and 1988 there was an increase in the population (FOX et al. 1991). Kiang were seen in broad valleys and gravel flats between 4400 m and 4700 m elevation, in areas dominated by *Caragana* spp. and *Kraschenninikovia ceratoides* vegetation (MALLON 1991). They avoided mesic sedge habitats, selecting *Stipa* spp. instead (HARRIS & MILLER 1995). Using remote sensing data, SHARMA et al. (2004) examined potential habitat for kiang in Surkhang, Nepal. Suitable habitat was defined as being between 4650 m and 6000 m in altitude (with 4650 m to 5340 m being prime habitat), < 15° slope, grass and shrub vegetation plus bare ground for breeding, and less than 5 km to the nearest community. Within these parameters only 71 km^2 (9.12 % of the total area) was suitable habitat, although this primary habitat was spread out over 340.43 km^2 with patches of less suitable habitat in-between.

FEH et al. (2001) and READING et al. (1999, 2001) examined khulan distribution in Mongolia. In south-western Mongolia, FEH et al. (2001) observed 1445, 1595 and 1506 animals in 1994, 1995 and 1996 respectively, noting annual fluctuations of 10 % without an obvious trend. In the same area in 1997, READING et al. (1999) estimated a population of 1674 $\pm$ 506 wild ass, with a density of 4.20 $\pm$ 1.27 animals/100 km^2. Throughout Mongolia 33,000 – 63,000 wild ass were estimated with a density of 4.2 $\pm$ 1.3 to 19.1 $\pm$ 3.2 animals/100km^2 (READING et al. 2001). Khulan were distributed throughout the Gobi region and were possibly expanding their range north and east (READING et al. 2001).

There are only two populations of onager remaining in Iran: 471 animals in Touran Protected Area and 96 in Bahram-e-Goor Reserve (TATIN et al. 2003). This shows a reduction from the 600 – 770 animals recorded in the 1970s (TATIN et al. 2003). Onager and kulan were reintroduced to Israel beginning in 1981 (PERLMAN 1987) with a population of over 100 animals in 1997 (SALTZ et al. 2000). These animals have had no apparent impact on the vegetation structure (WARD et al. 1999).

The last remaining population of khur is in the 4900 km^2 Wild Ass Sanctuary in the Little Rann of Kutch, India (GOYAL et al. 1999), after the population in Baluchistan became extinct over the past 40 years (DANIEL 1991). Monsoon waters flood the land, leaving only islands, the largest of which is about 3km wide and 12 km long, further restricting the range of this population (DANIEL 1991). Recently the resources on these islands have been depleted by livestock, but important habitats for khur include Rann habitat, saline grassland and *Prosopis* spp. habitats (GOYAL et al. 1999). The population was 3000 – 5000 in 1946, then went down to a low of only 362 in 1967; there was an increase to 720 animals in 1976 and then to about 2072 by 1990 (DANIEL 1991, GOYAL et al. 1999).

The onager in Iran and khur in India are at very small population sizes, but are officially protected. However changes in land use and habitat loss have impacted the range and population sizes of these animals (DANIEL 1991, GOYAL et al. 1999). In particular khur are impacted by the increase in irrigated fields, which have led them into conflict with local people as they predate crops (PRASAD et al. 1994). The kiang and khulan are both currently under threat from poaching for meat, hides or medicine and competition with local people for livestock grazing and water sources (FOX et al. 1991, READING et al. 1999, READING et al. 2001).

Conclusions

Compared with horses, very little has been published on Asiatic wild asses. For example when a BIOSIS search was run for 'Przewalski horse' (including plurals) 100 papers were returned for this species alone. Khur and khulan were particularly under-represented, with only five and two papers respectively published with these animals as a key word over the past 100 years. Obviously the search done here does not represent the entirety of what is known or even published about these

animals, but does reflect what literature is easily available, and so what will be found by students or government agencies when enforcement of conservation of these animals is sought. It is therefore very important for research done on these animals to be published, and not to simply remain in the grey literature where it is relatively inaccessible. The importance of key words also became apparent. Several papers did not include either the Latin or the common name in the key words, and this would result in the paper not appearing in a search. Agreed nomenclature is a key issue for the subspecies of wild ass. This not only affects literature searches, but also creates confusion even among scientists about what species is under discussion. In this paper the word 'khulan' has been used to describe the Mongolian wild ass *E. h. hemionus* and *E. h. luteus*. However in some literature this was also spelt kulan, and has also been referred to as hulan, dziggetai, chigettai and other spellings as the Cyrillic script is translated into Roman.

Of the papers dealing specifically with Asiatic wild asses, most were on behaviour, conservation or ecology. However very little was published on population sizes and distribution of animals, with most papers on this subject focussing on the kiang. Habitat use of any of these animals has barely been described. A large number of the behavioural ecology papers were on captive or reintroduced animals, with very little being known about wild populations. This was also true of the physiology and genetics papers, all of which were the results of research on captive populations. Most of the physiology papers dealt with parasites of zoo animals, and most genetics papers were using onager material.

So what do we need to know now? According to the IUCN Action Plan for the Asiatic wild ass (FEH et al. 2002), we particularly need to know about the distribution and status of the wild ass in China, and increase our knowledge of the basic behaviour and ecology of onager and kulan. Genetic studies are needed to classify the subspecies status of *E. h. kulan* and *E. h. onager*, and to differentiate the *E. h. hemionus* and *E. h. luteus* subspecies.

It is essential that more research be done on wild populations for their conservation. In particular more needs to be researched on wild populations of onager in Iran and khur in India, as these were particularly under-represented. We desperately need to know about the habitat use of wild ass, both so that it is known which areas need to be preserved, and also so that scientists can refer to figures when discussing competition of land with livestock. Threats to wild ass populations were only briefly mentioned in a few of the papers reviewed here. It is important that threats to populations are researched and publicised so that the relevant agencies or governments can take action, or at least so that the public is aware. Exact locations and sizes of extant populations need to be closely examined and monitored, so that changes can be seen and the correct reaction made.

More behavioural research is needed, in particular into the social structure of wild asses. The social structure of horse and zebra populations has been well documented (e.g. LINKLATER 2000), but the results presented here appear less clear. The social structure of animals has strong implications for their conservation, so it is important that we know more about this for each hemionid. The genetics of Asiatic wild asses need to be looked at in more detail, with modern methods, as it has great implications for the conservation of animals in zoos. One paper has already listed kiang as a separate species, rather than a subspecies (RYDER & CHEMNICK 1990), and we now need to refine our knowledge on the differentiation of *E. h. onager* and *E. h. kulan*, as well as the two Mongolian subspecies (FEH et al. 2002).

Good research has been conducted on Asiatic wild asses with most of it being done with an eye to conservation of wild populations. However this study has highlighted the importance of publishing results in peer reviewed journals where it can get the widest readership possible. In this way hopefully the remaining populations of Asiatic wild ass can remain and prosper in the wild.

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