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Distances travelled by feral horses in 'outback' Australia

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Summary

Reasons for performing study: **The distance travelled by Australian feral horses in an unrestricted environment has not previously been determined. It is important to investigate horse movement in wilderness environments to establish baseline data against which the movement of domestically managed horses and wild equids can be compared.**

Objectives: **To determine the travel dynamics of 2 groups of feral horses in unrestricted but different wilderness environments.**

Methods: **Twelve feral horses living in 2 wilderness environments (2000 vs. 20,000 km^2) in outback Australia were tracked for 6.5 consecutive days using custom designed, collar mounted global positioning systems (GPS). Collars were attached after darting and immobilising the horses. The collars were recovered after a minimum of 6.5 days by re-darting the horses. Average daily distance travelled was calculated. Range use and watering patterns of horses were analysed by viewing GPS tracks overlaid on satellite photographs of the study area.**

Results: **Average distance travelled was 15.9 ± 1.9 km/day (range 8.1–28.3 km/day). Horses were recorded up to 55 km from their watering points and some horses walked for 12 h to water from feeding grounds. Mean watering frequency was 2.67 days (range 1–4 days). Central Australian horses watered less frequently and showed a different range use compared to horses from central Queensland. Central Australian horses walked for long distances in direct lines to patchy food sources whereas central Queensland horses were able to graze close to water sources and moved in a more or less circular pattern around the central water source.**

Conclusions: **The distances travelled by feral horses were far greater than those previously observed for managed domestic horses and other species of equid. Feral horses are able to travel long distances and withstand long periods without water, allowing them to survive in semi-arid conditions.**

Introduction

Movement and the distances travelled by domestic horses (*Equus caballus*) may affect general health. Domestic horses have become more sedentary since the industrial revolution, with many now kept in small paddocks and stables as land available for horse maintenance has declined. The athletic Thoroughbred racehorse, for example is typically boxed in a stable for 23 h/day and moved to the training track for a short gallop once daily (Richards *et al.* 2006). Hampson *et al.* (2010) found that horses kept in small yards travelled only 1.1 km/day and those housed in a 16 hectare paddock travelled a mean of 7.2 km/day. The psychological, physiological and musculoskeletal consequences of this relatively sedentary lifestyle are not fully understood, but the low level of mobility from an early age may adversely affect musculoskeletal health. Domestication of the horse has not only affected mobility but has been associated with an altered diet. Horses in training are routinely fed high energy diets twice daily and may have an abundance of pasture and water (Southwood *et al.* 1993). Confinement and altered feeding patterns parallel the modern human lifestyle that is thought to be responsible for endemic levels of obesity, cardiovascular disease, arthritis and diabetes (Johnson *et al.* 2004; Perkins *et al.* 2005; Richards *et al.* 2006; Lepeule *et al.* 2009).

Global positioning system (GPS) technology has been shown to be able to accurately measure horse movement, including distance travelled, range use and watering patterns of wild/feral equids. This method was used previously by the current research team in a pilot study to monitor 3 feral horses in Australia and found that the mean daily distance travelled was 17.9 km (Hampson *et al.* 2010). This was significantly further than wild asses (*E. hemionus*) (8.3 km/day; Kaczensky *et al.* 2008) and wild Przewalski horses (*E. przewalskii*) (3.5 km/day; Kaczensky *et al.* 2008) in Mongolia. However, female zebras (*E. burchelli*) were documented to walk approximately 15 km over a 12 h period between water and their feeding region, where they remained for 3–4 days before walking back to water (Brooks *et al.* 2007).

A total published sample size of 3 individual free roaming horses is not representative of the population and does not allow robust comparison of movement patterns to other equids. Since there appears to be substantial variation within and between equid species in locomotory habits, the aim of this further work was to monitor free-ranging feral horses in order to compare feral horse movement with the movement ecology of other equid species and managed domestic horses.

Materials and methods

Twelve feral horses were tracked using GPS data loggers to determine movement and watering patterns.

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GPS data logger

The University of Queensland Equine GPS data logger was constructed from a Wintec G-Rays GPS unit (G-Rays 2 WBT-201data logger)[1]. The store-on-board GPS unit was modified by the addition of a circuit board which controlled the power input from an additional 3 AA battery pack. The total weight of the GPS, battery, collar and a very high frequency (VHF) location beacon was 700 g. The GPS unit was mounted on a neck collar with a full sky view, counterweighted by the battery pack and VHF beacon, which hung under the horse's neck. The 130,000 position storage capacity of the unit and the life of a single battery power source (6.5 days) allowed data logging at the rate of one position every 5 s (Hampson *et al*. 2010).

Data defining both horizontal and vertical positions were downloaded via Google Earth Plus[2]. The Wintec software was used to perform distance calculations from the raw GPS positional data. The pattern of travel was also superimposed on Google Earth satellite photographs of the study area and checked for plausibility and data error. In a previous study (Hampson *et al*. 2010) the same GPS unit was determined to be sufficiently accurate to measure domestic horse movement in small paddocks and feral horse movements in large paddocks with no 'outlier' data points.

Subjects

Twelve mature feral horses, from different family bands (8 mares, 4 stallions), living in 2 different wilderness environments, were tracked for 6.5 consecutive days. Four mares and 4 stallions were tracked at one location, which was semi-arid country on a large cattle property (Babbiloora) in central Queensland (latitude –25.18, longitude 147.49). The area receives a mean annual rainfall of 528.5 mm, and 157 mm had fallen in the 6 months prior to data collection (Bureau of Meteorology, Australia). The area had a large body of feed in all areas of the paddock accessed by the horses. Four mares were tracked at the second location, which was a semi-arid environment near Kings Canyon in central Australia (latitude –24.50, longitude 132.10). This 20,000 km^2 area consists of a valley system bordered by high prominent escarpments and is surrounded by vegetated and nonvegetated sand dunes measuring 15 m in height. Mean annual rainfall is 335 mm and rainfall was 331 mm in the 6 months prior to data collection (Bureau of Meteorology, Australia). There was high competition for feed resources in this area between feral cattle, horses and camels. Vegetation was scarce within 15 km of the single permanent water hole. All other semi-permanent waterholes in the area were dry at the time of the study as confirmed by the local indigenous people and stockmen. Ground and aerial searches from helicopter also confirmed that all animal tracks converged at this single waterhole. Feral horses have inhabited both areas for in excess of 140 years (Berman 1991) and experience very little pressure from human intervention. The breed origins of the horses were uniform with influence from early Thoroughbred, Arab and station hack horses.

GPS collar placement

In order to apply the collars, horses were darted i.m. with 0.7 ml etorphine hydrochloride (Imobilon)[3] when they approached water. When the horse became laterally recumbent, the collar was attached to the upper neck and the immobilising agent reversed using 1.4 ml diprenorphine hydrochloride (Revivon)[3] injected i.v. Horses returned to their usual band within 15 min of darting and appeared unaffected by the neck collar and the initial human contact. After a minimum of 6.5 days, the same feral horses were relocated using the VHF beacon on their collar and again immobilised by darting. The collars were removed, the immobilising agent reversed and the horses released.

Watering frequency

Both study locations had only one watering point available to the horses at the time of the study. Watering frequency was determined by the frequency that horses approximated the position of the water point on the Google Earth satellite photograph of the study area.

Statistical analysis

Distances travelled were compared between groups depending on sex and location of the horses using a nonparametric Wilcoxon *t* test. Statistical significance was set at 0.05. All values are presented as mean ± s.e.

The project was approved by the University of Queensland Animal Ethics Committee (AEC-PCA) monitoring compliance with the Animal Welfare Act (2001) and The Code of Practice for the care and use of animals for scientific purposes (approval number SVS/393/07/AHF).

Results

GPS analysis of travel distance

Mean daily distances travelled by all horses over the 6.5 day period of GPS tracking are presented in Figure 1. There was a large range of mean daily distances (8.1–28.3 km) covered by the horses. The mean daily distance travelled by all horses combined was 15.9 ± 1.9 km. During the period of tracking, stallions (18.2 ± 2.91 km/day) tended to travelled further on average than mares (14.8 ± 2.5 km/day) but this difference was not significant due to the small sample size. Mean daily distance travelled was 16.8 ± 1.71 km by central Queensland horses and 14.7 ± 4.17 km for central Australian horses. The mean daily distance travelled, regardless of gender was not significantly affected by location. However, central Queensland horses tended to travel a similar distance each day and

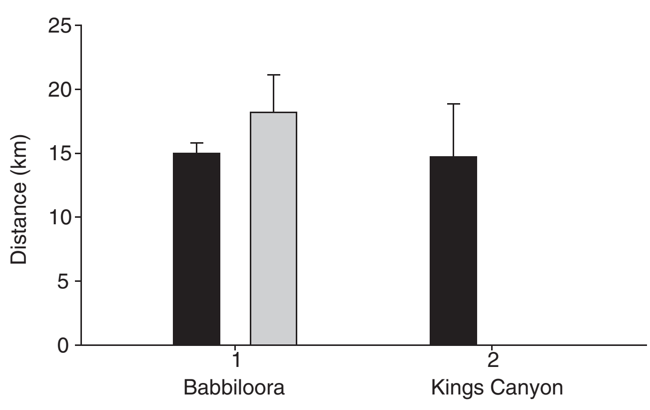

Fig 1: Mean ± s.e. daily distance (km) travelled by female (■) and male (□) feral horses in 2 inland Australian locations, Babbiloora (central Queensland) and Kings Canyon (central Australia). Distances travelled were measured by GPS tracking collar. Stallions did not travel significantly further than mares.

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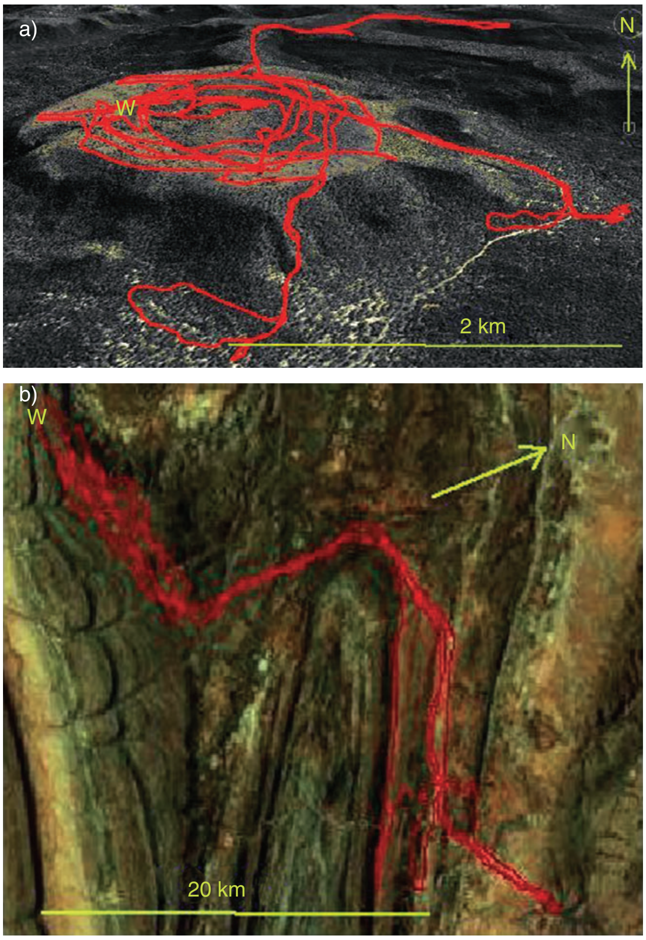

Fig 2: Comparison of typical ranges of horses in the 2 different environments. a) Shows the GPS path of a band stallion in prime grazing country. Each daily travel distance is consistent and within 3.5 km of a central waterhole (W). b) Shows the GPS path of a desert mare with a young foal at foot. Water (W) is at one end of the path and the preferred feeding ground is a distance of 22.5 km from water. True North is shown by 'N'. The end of the path is around 40 km in a straight line from the marked water.

never more than approximately 8 km from water. Central Australian horses travelled significantly greater single day distances when travelling to and from water and were frequently recorded at distances of 15–55 km from water. Long distance travelling days (mini-migrations), to and from water, were followed by short travelling days within good feeding locations (Fig 2).

Watering frequency

The mean watering frequency of central Queensland horses was 2.1 ± 0.9 days (range 1–3 days). Central Australian horses watered less frequently and this difference was significant ($P<0.05$). Their mean watering frequency was 3.2 ± 0.8 days (range 2–4 days).

Discussion

There is a large variability of range use ecology within the Equid family. There have been several previous studies reporting the home range size of feral horses determined by repeated sightings during ground based observations. The accuracy of observation vs. GPS data logging has not been established but observation has previously been the gold standard for animal ecologists (Linklater *et al*. 2000). Since the introduction of accurate and reliable GPS, animal ecologists are now able to monitor animals regularly for long periods without risk of interference. Linklater *et al*. (2000) reported a home range size for Kaimanawa feral horses of 0.96–17.7 km^2 for 48 horse bands (horse groups). Kaimanawa horses have a similar breed origin to the Australian feral horses (Halkett 1996). Linklater *et al*. (2000) found that all band home ranges overlapped with others and were located within an area of approximately 7 × 4 km. Similar spatial organisation of feral horses was reported by Klingel (1975), Salter and Hudson (1979) and Feist and McCouough (1975) in feral horse populations confined in small ranges. However, the study of arid and semi-arid habitat horses in Nevada (Berger 1986), western Alberta (Salter and Hudson 1982) and Wyoming (Miller 1983), have reported larger home ranges. These studies relate the increased size of the home ranges to resource demand. Kaczensky *et al*. (2008) were the first to report equid movement and home range size using GPS technology. Over a 4 year period in Mongolia, wild Przewalski horses had ranges of 152–826 km^2, significantly larger than reported for feral horses elsewhere. Over this 4 year period Przewalski horses travelled approximately 60 km from one end of their range to the other but the mean daily distance was 3.5 ± 0.9 km. On average, Przewalski horses ventured only 9 ± 2.9 km from the nearest water. The same study reported home ranges of 4449–6835 km^2 with a mean daily distance of 8.3 ± 0.7 km for Asiatic wild asses. Asses ventured a mean of 13.5 ± 0.9 km away from water. Other *Equidae* studied include the plains zebras which were recorded using GPS trackers walking up to 15 km away from water to feed and returning to water at 3–4 day intervals (Brooks *et al*. 2007). The current study used GPS technology to determine feral horse movement and watering patterns. We found that central Australian and central Queensland feral horses travelled larger mean daily distances than other equids reported previously. Central Australian horses, in particular, travelled up to 55 km from water and had large interwatering intervals.

The current study found that even though the average daily distance did not vary significantly between the 2 populations from contrasting habitats, the day by day routine of the horses was quite different and appeared to be dependent on resource location. In central Queensland, there was little requirement for horses to travel large distances between food and water. Pasture was widespread and pasture quantity close to water was similar to that at a distance away from water. However, in central Australia, resource distribution was scarce and patchy. Feed tended to grow solely along gully floors and low lying areas where water may have pooled and soaked the ground for several days following infrequent rain. Berman (1991) studied the ecology of feral horses in the same study area in the mid 1980s and measured the herb cover at distance intervals from the same permanent water source used by horses in the current study. Herb cover increased relative to the distance away from water (Fig 3), indicating the large competition for food resources close to water. Berman (1991) found evidence of horses 65 km away from the only available water source.

The current study located horses 55 km from Berman's (1991) water point. In consideration of the long walks the horses must make to access water from distant feed grounds it is not surprising that watering frequencies were as low as every fourth day. Scheibe *et al*. (1998) found that Przewalski horses drank less frequently than domestic horses and drank a higher volume of water relative to body size. They suggested that drinking frequency was not as

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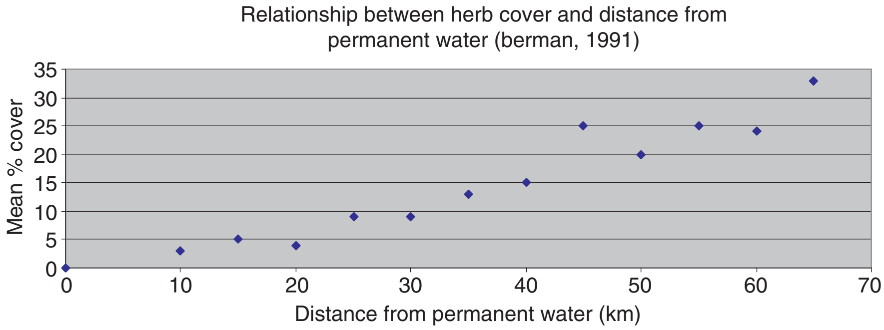

Fig 3: The relationship between herb cover and distance from permanent water in the desert horse habitat recorded by Berman (1991). Horses had to travel long distances from water to access feeding grounds. Feed within a range of 20 km from water was minimal. A similar situation existed in this location during the present study. This graph was drawn from data from Berman (1991) with permission from the author.

important to wild horses as the amount of water consumed. Horses that drank less frequently also ingested larger volumes of water. These authors, as well as Bouman and Bouman (1994) and Sneddon *et al*. (1991) all suggested that desert-dwelling horses are genetically adapted to hot and dry climates as part of the evolutionary strategy of the species. Other equid species have apparently also adapted to arid conditions. Maloiy (1970) subjected Somali donkeys (*E. asinus*) to heat stress and dehydration. Donkeys survived water loss equivalent to 30% of their original bodyweight in temperatures up to 40°C and survived up to 12 days without water. Donkeys were able to drink enough water (24–30 l) in 2–5 min to restore the deficit. Maloiy (1970) concluded that these observations represented a thermal and metabolic adaptation of desert mammals to heat and aridity. This adaptation did not totally eliminate the need to drink water, but permitted a considerable degree of dehydration. Donkeys are capable of living and reproducing in arid habitats similarly to camels in the Middle East, northern and eastern Africa and central Asia.

Central Australian horses may also be genetically adapted to arid conditions. The population of feral horses in the semi-arid areas of central Australia can be reduced by up to 75% in times of severe drought (Berman 1991). The ability to travel up to 65 km from water to access feed (Berman 1991) and survive for at least 4 days without water (present study) may represent a physiological adaptation of the original domestic horse stock that were the founders of the feral horses over 140 years ago. The strong pressure of the frequent severe droughts in central Australia for natural selection may have driven a genetic change. In contrast, domestic horses travel very small distances compared to their feral relatives (Hampson *et al*. 2010), generally have free access to water and have been documented to drink several times daily (Scheibe *et al*. 1998). Scheibe *et al*. (1998) suggested that the high water consumption of domestic horses may be a learned behaviour acquired under conditions of abundance.

The current study determined the range of 12 adult feral horses in 2 different wilderness environments over a 6.5 day period. Mean distance travelled was 15.9 ± 1.9 km/day (range 8.1–28.3 km/day). Horses in the central Queensland habitat, with plentiful pasture, tended to remain close to water (maximum 8 km from water). Central Australan horses were recorded up to 55 km from water and some horses walked for 12 h to reach water. Feed was scarce within a range of 15 km from the water point in the central Australian habitat due to competitive grazing by large numbers of feral horses, feral cattle and feral camels. These horses watered less frequently (3.2 ± 0.8 days; range 2–4 days) than central Queensland horses. Central Australian feral horses travelled longer mean daily distances and recorded longer watering intervals than other wild equids (Rubenstein 1989; Berman 1991; Scheibe *et al*. 1998; Adriansen and Nielson 2005; Brooks *et al*. 2007; Kaczensky *et al*. 2008). The unique ecology of the central Australian horse, as shown by this study, warrants further study.

The ability to survive the extreme environment of central Australia may be within the phenotype of all horses and simply a testament to the versatility of *E. caballus* as a species. On the other hand the central Australian population, subjected to the extreme selection pressure of the harsh environment, may have already inherited traits that set them apart from their domestically managed cousins.

Conflicts of interest

The authors have declared no potential conflicts.

Manufacturers' addresses

[1]Wintec Wireless Electronics, Taiwan.
[2]Google Earth Plus, google.com.
[3]Novartis SA (Pty) Ltd. Base, Switzerland.

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