

Behavioural ecology of island feral horses

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Summary

In a horse population on Shackleford Banks, an island off the American east coast, major changes in social organisation have occurred. Instead of typically living in harems occupying overlapping home ranges, it was found that some harems defended territories and some horses did not even live in fixed membership groups. The existence of these social variations appeared to be correlated with the unique habitat and geographical features of the island. Territories, whose boundaries ran the width of the island, only occurred where the island was narrow, the visibility unrestricted and the essential vegetation zones ran along the island's long axis. Only here were the difficulties in defending reduced and feeding and male mate-guarding opportunities increased. Where the sand dunes were high and forest dense temporary assemblages occurred and non-territorial harems occupied the patchy semi-open area with the bachelor males.

Once territories were defended many aspects of individual social relationships became altered. Territorial stallions were less likely to influence the daily activity patterns of their groups and more likely to groom their dominant females and round-up their subordinate females than were their non-territorial counterparts. In addition, interpersonal distances were likely to be greater among horses living in territorial, as opposed to non-territorial, harems.

Introduction

ISLAND biotas differ in many ways from their mainland counterparts. Perhaps the most salient features of islands are that they possess fewer species than nearby mainland areas and that, in general, large near-shore islands have more species than smaller more distant islands. But the differences in behaviour and ecology of insular populations are just as striking. These populations often show more dimorphism (Schoener 1967; Wallace 1978), forage in more foliage levels (Karr 1971) and display reduced stereotype in seed selection (Pulliam 1973) than their mainland counterparts. Even changes in social organisation have been observed. For example, the yellow faced grassquit (*Tiaris olivacea*), which is gregarious in Costa Rica, is territorial on Jamaica (Pulliam *et al* 1972). Typically, these effects are attributed to insular isolation, small size and topographic simplicity (Preston 1962; MacArthur and Wilson 1967; Lack 1976). But the way in which these factors actually alter island fauna appear to be complex and are, as yet, incompletely understood.

The work reported here was undertaken to examine whether islands affect the social behaviour of feral horses and, if so, what attributes of islands are responsible for these changes. This entailed comparing the social behaviour and patterns of social organisations of feral horses inhabiting a number of different

mainland and island habitats. Apart from the data gathered during the last 5 years on the ponies of Shackleford Island, the other data were derived from the published studies of Welsh (1973) on Sable Island, Berger (1977) in the Grand Canyon and Feist in the Pryor Mountains (Feist and McCullough 1976).

Social organisation of wild equids

A brief look at the social organisation of the living equids — the zebras, asses and horses — suggests that phylogenetic constraints will only minimally influence feral horse social organisation. Wild equids show a remarkable diversity of social organisation (Table 1). Basically, 2 categories of social organisation exist; that involving permanent groups and that involving temporary assemblages. Typically the asiatic wild horse (*Equus przewalski*) (Mohr 1971; Groves 1974) and the plains (*E burchelli*) and mountain (*E zebra*) zebras (Klingel 1974) live in small permanent groups that are composed of females, their offspring, juveniles and a dominant stallion. Adult males not possessing harems live either alone or in permanent bachelor groups. Both kinds of groups inhabit large overlapping home ranges. For plains zebra in the Serengeti, home ranges vary in size from 600 km² in the dry season to 300 km² in the wet season (Klingel 1974). Some zebra populations undertake seasonal migrations in search of suitable food and water. The Serengeti populations, for example, migrate up to 150 km to their dry season foraging ranges. The few anecdotal accounts of the ranging behaviour of the Asiatic wild horse suggest that harems have well-defined home ranges centred around water holes during the spring foaling period and summer dry season but that they wander more widely during the winter when snow and melt water are widely available (Mohr 1971).

In the case of wild asses and Grevy's zebra the pattern of social organisation is very different. According to Klingel (1977), in both the African (*E africanus*) and the Asiatic (*E hemionus*) wild asses, there are no permanent associations other than small mother-offspring groups. Nevertheless, temporary assemblages consisting of only males, only females or of both sexes do occur. During the day these small groups and solitary individuals may even coalesce into large feeding herds but by evening these herds break up. During the breeding season, however, a large proportion of the adult males establish territories. These territories are large, averaging 23 km², and are only defended against other males when a female in oestrus actually enters the territory.

Klingel's observations show that the social organisation of Grevy's zebra (*E grevyi*) is basically similar to that of the wild asses (Klingel 1974). Permanent associations among adults are rare and most of the adult males restrict their activity to territories that are only defended in the presence of females in oestrus. These territories appear to be smaller than those of the asses (6 km²) and they appear to be maintained throughout the year except during the driest years.

Why there should be 2 major types of equid social organisa-

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TABLE 1: Social groups exhibited by different equid species

	Permanent groups		Solitary males	Temporary groups All males; all females; mixed sexes	Solitary territorial males
	Harems	Bachelor groups			
Wild horses	5-6	?	?	No	No
Plains zebra	4-7	2-3	?	No	No
Mountain zebra	6-7	4-8	?	No	No
Grevy's zebra	No	No	—	2-8	Yes
Wild asses	No	No	—	2-6	Yes

Numbers reflect range of group sizes, otherwise presence or absence is indicated

tion is not obvious. What appears to be common to all equids is that in drier habitats and in areas where resources are distributed in a more patchy fashion, systems of temporary assemblages and solitary territorial males occur more frequently than systems involving harems. This relationship probably arises largely because low quality vegetation distributed in small widely scattered patches makes it uneconomical for females to form permanent fixed membership groups by intensifying intraspecific competition. Without female associations to defend, males instead defend large areas containing the resources females require. Only larger more evenly distributed patches of higher quality vegetation allow females to feed in permanent membership groups, thus fostering a harem social system.

Social organisation of mainland feral horse populations

In general, the social organisation of mainland feral horses is similar to that of the Asiatic wild horse and the plains and mountain zebras, with one exception; there appear to be no long distance seasonal migrations. However, as with the non-migrating plains zebra of Ngorongoro Crater, feral horse populations are constrained either by geological features, such as the Grand Canyon, or man-made barriers. Thus it is difficult to surmise whether feral horses would migrate if the opportunity were available.

Some details of the population characteristics and social organisation of 2 mainland populations are shown in Table 2. At the time of the surveys both populations were composed of a variety of permanent groups. Typically, most dominant stallions possessed small harems which consisted of females, their young and juveniles. The average size of these harems was about 5 horses although they ranged in size from 2 to 20. There were also bachelor groups consisting only of adult males and during the breeding season these tried to establish their own harems by stealing females from neighbouring harems. In the Pryor Mountains the average size of these bachelor groups was 1.8 horses. Occasionally solitary males were found which were thought to be older males that had lost their harems. The stability of the groups in these populations seemed pretty high; only 7.6 per cent of the Pryor Mountain adult females changed bands in a year while none changed groups during a 6-month period in the Grand Canyon. In these 2 mainland populations, groups possessed home ranges of about 20 to 25 km² but these often overlapped with those of neighbours.

Social organisation of island feral horses

The social organisation of feral horses on islands is more variable than that on mainlands. Sable Island, which lies about 100 miles east of Nova Scotia, is inhabited by a population of

feral horses which probably originated in the early 1700s. The population, which fluctuated between 150 and 300 horses, was dispersed along the island in about 50 groups. Some were typical harems which contained a dominant stallion, females, offspring, juveniles and occasionally a subordinate male. Others were bachelor groups or even groups whose composition continuously changed. Although this type of group is characteristic of asses and Grevy's zebra, it is not generally described for horses. In addition, there were a few solitary males in the population. The sizes of these groups were slightly larger than those of the mainland populations (Table 2). Furthermore, on Sable Island, which is approximately 40 km long and 1.3 km wide, the population density was greater than that of the mainland populations, while the average size of the overlapping home range was less. The age structure, however, was not too different from that of the Pryor Mountain population.

Shackleford Banks, a barrier island off the coast of North Carolina, is inhabited by approximately 100 horses whose ancestors were probably shipwrecked on the outer banks in 1565 (Anon 1975). Certain facets of the social organisation of this

TABLE 2: Population characteristics and social patterns of 4 feral horse populations

	Pryor Mountains (1970)	Grand Canyon (1974)	Sable Island (1970)	Shackleford Island (1974)
Population characteristics				
Population size	225	78	240	104
Population density	2.0/km ²	0.2/km ²	6.3/km ²	11.0/km ²
Age structure				
Adults	58%	?	64%	61%
Juveniles	28%	?	21%	21%
Infants	13%	?	15%	19%
Activity areas				
Group ranges	25 km ²	20 km ²	<7 km ²	6 km ²
Group territories	No	No	No	3 km ²
Social patterns				
Group types (\bar{N})				
Harems	5.0	4.5	6.0	12.3
Bachelors	1.8	?	<2.0	2.6
Solitary males	Yes	Yes	Yes	Yes
Temporary assemblages	No	No	Yes	Yes
Band stability				
Adult female group changes	7.6%	0.0%	?	10.8%

population were found to be very different from those of the other studies. As in other horse populations there were stallion dominated harems, bachelor groups, solitary males and even temporary assemblages containing adults of both sexes. But the population on Shackleford was unique in that two-thirds of the harems maintain well-defined, non-overlapping territories. Furthermore, these territories were permanent. During the course of this study the boundaries remained remarkably constant, shifting not more than 15 to 20 m. Even when harems were stampeded together and driven far from their territories, all the horses returned to their previous territories after human harassment had ceased.

Territorial boundaries ran the width of the island from the ocean to the back sound. Generally, these boundaries coincided with subtle geographic features such as a row of low dunes, a tidal inlet or a patch of fresh water marsh. Although large dung piles occasionally lay along the boundaries, equally large dung piles were situated throughout the territory. But even though these boundaries were not conspicuously marked, they were rarely crossed. Two reasons may account for this. First, stallions are very solicitous of females, especially during the breeding season, and when females approach the boundary stallions herd them towards the centre of the territory. Secondly, neighbouring stallions and bachelor males rarely cross these boundaries because the resident stallion defends his territory vigorously. Typically, encounters stop after a ritualised sequence of defaecations and dung sniffing. But often these encounters escalate into physical contests in which the horses kick and chase each other. During the period of this study resident stallions won all encounters. The costs of such vigorous territorial defence, however, were presumably quite high because resident stallions often received deep cuts around the mouth and jaw.

The feral horse populations on Sable and Shackleford Islands had similar age structures, population densities and ranging areas (Table 2). Shackleford had significantly larger harems and smaller ranges than some of the other populations but these characteristics might just as likely be the consequences of territoriality as its cause. Furthermore, band stability, as measured by the percentage of adult female movements, was not much lower than that found in the Pryor Mountain population.

Advantages of territoriality

Why then did the population on Shackleford Island exhibit such a different pattern of social organisation? There appears to be an absolute correspondence between particular habitats and the types of groups that inhabit them and it is therefore proposed that a number of features concerning the topography and habitat structure of Shackleford were responsible for the pattern of social organisation. Shackleford Banks is a long, narrow island approximately 17 km long and 1 km wide. The eastern half of the island is virtually flat and is composed of 3 major vegetation zones, each running parallel with the long axis of the island. Running inwards from the ocean (Fig 1) there is a sandy beach about 10 m wide followed by a narrow zone of low dunes that are predominantly covered with sea oats (*Uniola paniculata*). The dunes are rarely higher than 5 m but they do provide the centre of the island with some protection from ocean waves and salt spray. There is an extremely wide flat swale that is dominated by salt-meadow cordgrass (*Spartina patens*), the rush (*Juncus roemerianus*) and other grasses and sedges. The distribution of species is often patchy and in places the ground cover is fairly sparse. In this zone there are both permanent and temporary pools of fresh and brackish water. Finally, there is a salt marsh bordering the sound in which saltwater cordgrass (*Spartina alterniflora*) and glasswort (*Salicornia virginica*) are dominant. It was only on this flat, eastern half of the island that territorial harems were found.

The western end of the island has a strikingly different profile. There are virtually no flat open areas (Fig 2). Along the beach there are tall dunes reaching 10 to 15 m in height. These dunes stretch across the width of the island and eventually slope into dense maritime forest. Occasionally, there are small flat areas among the dunes and these are covered by typical swale vegetation. Intruding into the forest from the rear are pockets of fresh marsh which support a rich and varied flora. In this topographically complex area horses were often found alone, in bachelor groups or in temporary assemblages. At this end of the island animals of both sexes mingled freely but when groups formed their composition continuously changed.

Between the eastern and western end of the island there is a small flat area which is punctuated by 2 small stands of

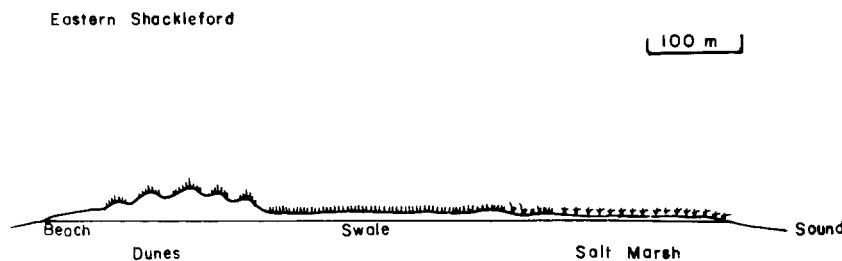


Fig 1. Cross-section of the eastern end of Shackleford Island

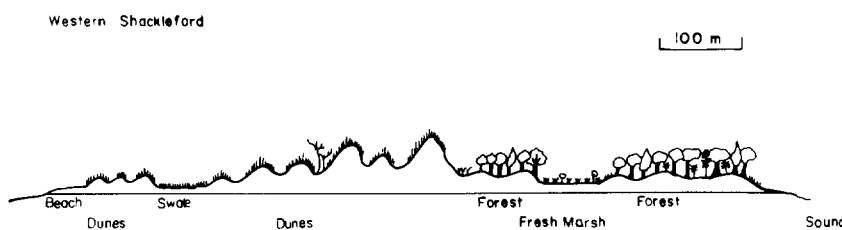


Fig 2. Cross-section of the western end of Shackleford Island

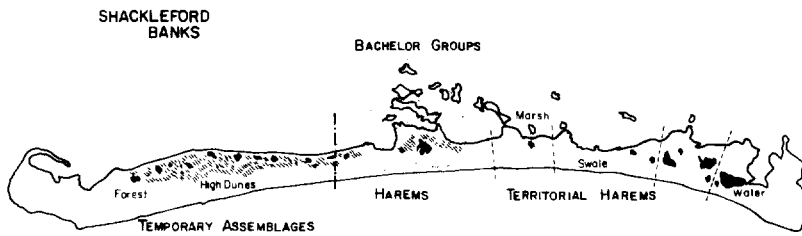


Fig 3. Map of Shackleford Island showing the location of the major environmental features and the location of the territorial harems, non-territorial harems which overlap with the bachelor groups, and the location of the temporary assemblages

maritime forest (Fig 3). In the centre of this area were situated several small groups of bachelor males and on the fringes of the forest were located 2 harem groups. The ranges of the harems were not exclusive and they did overlap almost completely with the ranges of the bachelor males. As a result they were not considered to be true territorial harems. The location of the various habitat areas and the arrangement of the types of groups inhabiting them is depicted in Fig 3. Note the fairly even distribution of fresh or brackish water along the back side of the island.

It is suggested that territoriality would exist in all horse populations if the costs associated with maintaining it were offset by large enough benefits. Only on the eastern end of Shackleford, however, did it appear that the benefits of exclusive access to a variety of seasonal food types and of increased control over females in oestrus exceeded the costs of excluding competitors. This favourable benefit/cost relationship might have arisen because:

- (1) The island is narrow;
- (2) the habitat is open and visibility is excellent;
- (3) each of the 3 essential feeding zones runs lengthwise along the island;
- (4) water is fairly evenly distributed along the length of the island.

Two facts suggested that foraging considerations were important and that having territories might provide horses with increased feeding advantages. First, the horses spent an average of 75 per cent of their time foraging. Fig 4 shows that there were daily and seasonal effects but time spent feeding made up a considerable part of a horse's daily time budget. Secondly, despite this large proportion of time spent feeding, the overall

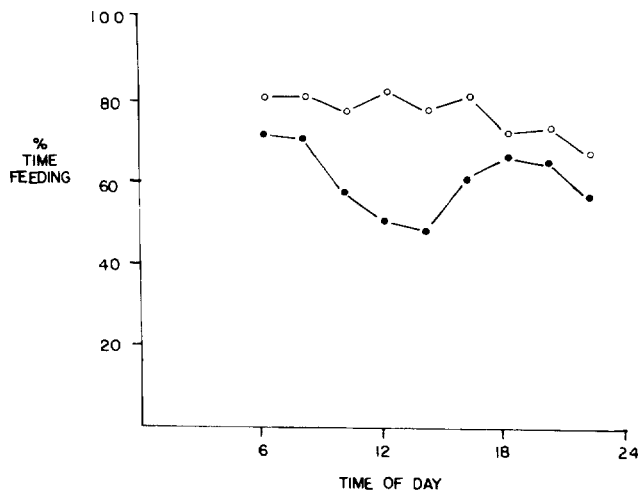


Fig 4. Seasonal changes in the daily pattern of time spent foraging. ●—● summer; ○—○ winter

condition and health of the animals remained low (Fig 5). Ribs could be seen through the coat year round and most deaths occurred just before the foaling season when the nutrient and energy content of the sparse forage was lowest.

On Shackleford the abundance of forage types varies seasonally and the grazing behaviour of the horses reflected this changing availability. Typically, horses spent most of their time feeding on the saltmarsh and the swale during the summer but during the winter they switched their activity patterns and concentrated feeding on the swale and on the dunes. These seasonal feeding patterns are shown in Fig 6 for horses living in territorial harems but the pattern also applied to horses living in non-territorial harems and bachelor groups. Apparently horses needed to forage in all 3 vegetation zones in order to survive.

Since home ranges traversing the island from ocean to sound would secure access to each of the 3 major zones, why did some horses establish territories and maintain exclusive access to this forage? This was done possibly to derive 2 additional feeding benefits. First, home ranges had large areas of overlap (Fig 3) and this might have temporarily prevented individuals in a group from obtaining a particular resource at a particular time. Obviously establishing a territory, even if more costly in terms of time and energy expenditure, would alleviate this problem. Secondly, exclusive use of an area might have enabled individuals to use the forage more efficiently. By regularly rotating grazing patches in a particular zone, each horse could continuously harvest the highly nutritious new vegetative growth. Preliminary analyses showed that territorial harems seemed to alternate consistently among regenerating patches. Although there was much variation, the time from abandoning a patch to recommencing feeding in that patch was longer within territories (10 to 14 days) than in areas of overlapping home ranges (less than 7 days). As a result, the grass was longer in territorial as opposed to non-territorial areas. Even if difficult at



Fig 5. A Shackleford pony grazing on submerged saltwater cordgrass (*Spartina alterniflora*) and drinking sea water. This individual typifies the poor body condition of horses as the new vegetation begins to grow in March

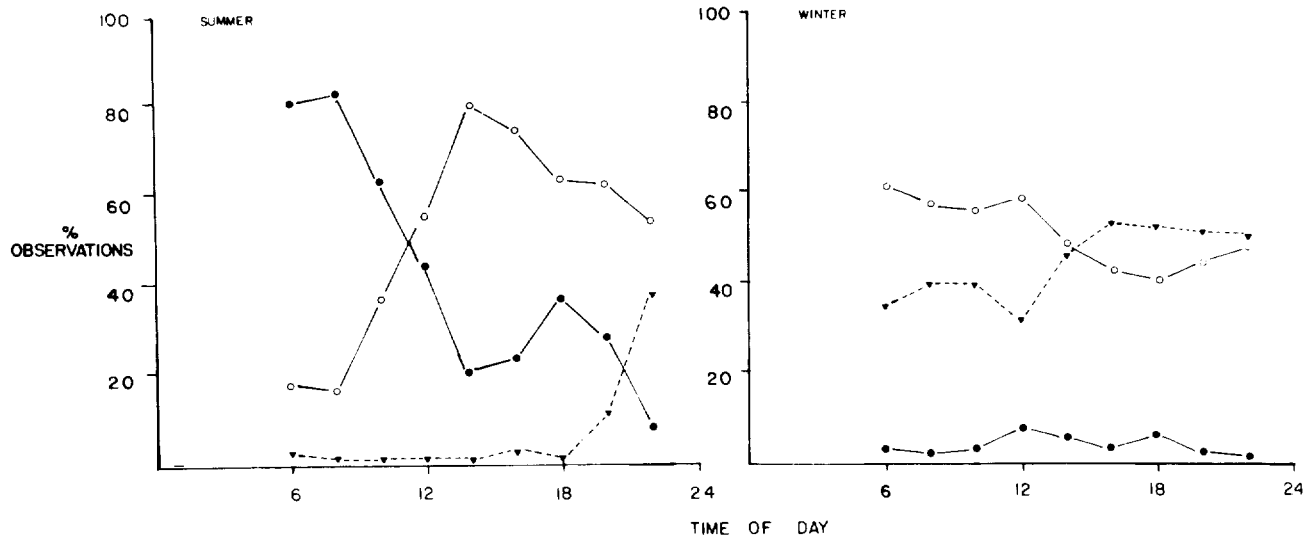


Fig 6. Daily pattern of habitat use for different seasons. ●—● marsh; ○—○ swale; ▼—▼ dunes

present to explain why individuals did not cheat and crop the forage prematurely, it would appear that individuals in groups that had exclusive access to resources were deriving increased feeding benefits.

Because stallions performed all the territorial defence, it was possible that they could increase the number of females in their harems and increase the likelihood that they actually fathered their offspring by maintaining a territory. Two observations suggested that the reproductive success of territorial males may indeed be higher than that of non-territorial males. First, it was found that male-male contacts were more likely to occur further away from the harem when a male had a territory than when he did not. Thus, the risk of a female being stolen by a neighbouring stallion was lower for territorial stallions than for non-territorial stallions. Secondly, territorial harems consisted of more adult females than non-territorial harems and, more importantly, territorial harems tended to increase in size, whereas non-territorial harems either did so more slowly or decreased in size.

Costs of territoriality

On Shackleford, guaranteed access to fresh water and to the 3 essential vegetation zones seemed to provide all horses, regardless of sex, with some additional feeding benefits. Also, males appeared to derive additional mating benefits. But what about the costs associated with this unique occurrence of equid territorial behaviour? During the study, it was not possible to estimate the costs associated with territoriality but normally the costs of excluding other individuals from an area were high (Gill and Wolf 1975; Carpenter and MacMillan 1976; Rubenstein 1981). On the eastern end of Shackleford Banks, however, these costs may in fact have been quite low because first, visibility was high and stallions could monitor their boundaries with a minimum of lost time and energy and secondly, half the perimeter, on average, of a territory running the width of such a narrow island was bounded by water and thus devoid of potential competitors. Therefore, even if the additional costs to ungulates of being territorial were usually high, the habitat structure on the eastern end of Shackleford kept them low, making "affordable" the small feeding and mating advantages associated with territorial behaviour.

Circumstantial evidence lends support to this hypothesis. In the mainland populations water was not evenly distributed

about the habitats and as a result bands shared watering holes and had overlapping home ranges. The same situation seemed to exist on Sable Island (Welsh 1973). Even on Shackleford, where water was less uniformly distributed, the visibility poorer and the island wider, territoriality did not occur. In the transition zone where there was only one large centrally located pool, forests and accessible islands almost touching the sound side of the island, both harems and bachelor groups maintained overlapping ranges. Although in this area groups sometimes drank simultaneously from this pool, one group usually waited in the forest until the drinking group had left. Furthermore, Hoffman (1980, personal communication) noted that on an island less than 2 miles from Shackleford, with similar vegetation but with different spatial arrangements and with centrally located water holes, the horses lived in harems that did not possess territories. So it appeared that the dispersion of forage and water played an important role in determining whether harems will have overlapping home ranges or territories.

Consequences of territoriality

Once territories were formed subsequent changes in other aspects of social behaviour were possible. For example, the reduced likelihood of interference from neighbours probably enabled a stallion to control his harem and prevent raiding males from stealing his females, with less effort. Therefore, it was not surprising that during and immediately before the breeding season the individual distance among members of territorial harems was significantly larger than among members of harems that did not have exclusive home ranges (Fig 7).

Territorial stallions were also less likely than non-territorial stallions to direct or influence many daily activities such as choosing feeding areas, determining the duration of feeding episodes, leading local or short distance movements and intervening in intragroup conflicts. Only when initiating and directing long distance movements and when herding widely dispersed females did territorial and non-territorial stallions behave in a similar fashion.

Dominance relationships within a harem were also affected by the territorial nature of the group. Although harem stallions dominated all their females, females differed in their ability to dominate each other. By recording how often females threatened each other (eg, headshakes, ear lay backs, neck extensions, rump turns and kicks) it was possible to rank

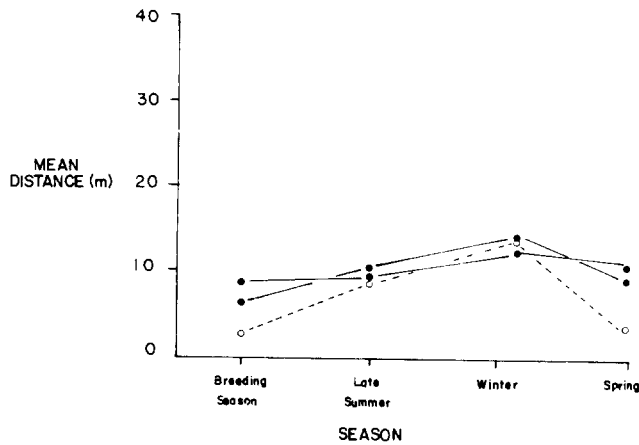


Fig 7. Seasonal changes in the mean distance among group members. ●—● territorial groups; ○—○ non-territorial groups. Differences significant during breeding season ($t_{25} = 2.81$; $P < 0.01$) and spring ($t_{31} = 3.02$; $P < 0.005$)

females. Both territorial and non-territorial harems exhibited nearly linear female dominance hierarchies. Typically, adult females ranked above yearlings and yearlings ranked above 2 year olds, regardless of harem type (Fig 8). But territorial and non-territorial stallions threatened their females differently, especially during round-ups. Territorial males tended to round-up lower ranking females disproportionately more than they did higher ranking females, whereas non-territorial males tended to round-up females more equally, regardless of rank (Table 3).

Territoriality also seemed to affect the grooming relationship between stallions and their females. Among horses living in territorial harems a correlation was found between the extent to

TABLE 3: Number of times territorial and non-territorial stallions rounded-up high and low ranking females in their harems

Type of stallion	Female rank	
	Upper 50%	Lower 50%
Territorial harem	12	71
Non-territorial harem	9	12

Statistical test: chi = 12.5; significance level P-squared <0.001.

which females were groomed by the stallion and their rank. The male groomed higher ranking females more than lower ranking females. Among horses living in non-territorial harems, however, the stallion appeared to groom all his adult females equally (Fig 8).

From these few examples it appeared that the relationship between a stallion and his females depended on whether he had established a territory. With respect to "bonding" behaviours, as measured in terms of interpersonal distance, and grooming and round-up behaviour, territorial males responded differently to females depending on their relative rank than did non-territorial males. It seemed likely that such differences were the consequences of the different risks of mating failure suffered by each type of stallion.

The linear arrangement of territories also had consequences for inbreeding and kin relations. Adult and, to a lesser extent, juvenile females moved only short distances when they left a band, whereas juvenile males usually moved longer distances to the western end of the island or to the bachelor groups in the

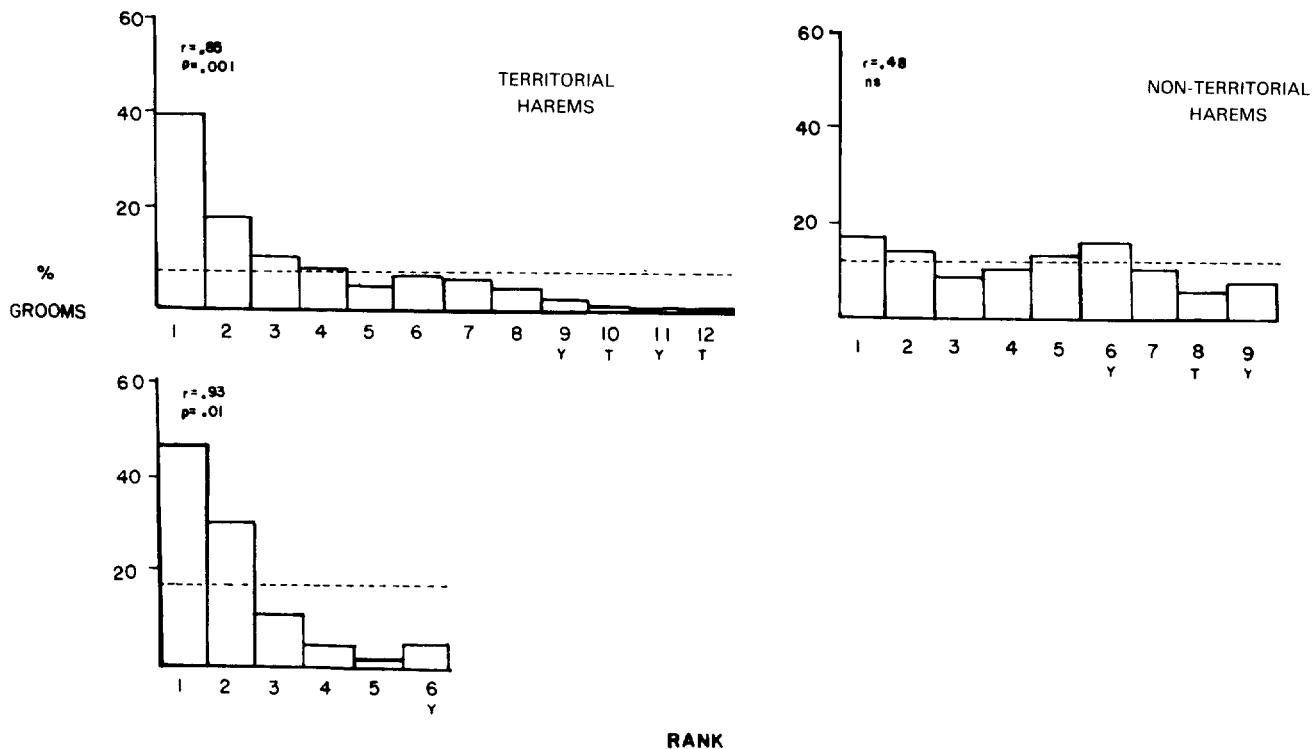


Fig 8. Relationship between a female's rank and the frequency of male grooming contacts. Dashed line shows the expected level if all females were groomed equally frequently by the male. The correlation coefficient (r) and level of significance (P) reveal the magnitude and significance of the relationship. ns Not statistically significant at $P < 0.05$. Y = Yearling, T = Two-year-old

transition areas. Some never seemed to leave their natal territory. However, larger samples are needed before the ramifications of these different sex-related dispersal patterns on group dynamics can be completely unravelled.

Conclusions

These comparisons reveal that horses have a typical pattern of social organisation but that variations can arise under unusual environmental conditions. On Shackleford Banks the types of groups that formed, relationships between groups and the social cohesion within groups were largely controlled by the habitat structure of the island, which in turn was influenced by the size and shape of the island. But does Shackleford Bank represent a topographically and vegetationally unique situation? Or are there other areas that might provide novel arrangements of habitats or unusual environmental pressures? It would not be surprising to find that most islands, because of their peculiar shapes, limited floral diversity, ruggedness, fluctuating fresh water levels and extreme climates, are areas that are most likely to provide habitats that must be adapted to in novel ways. The spectacular variety of endemic bird species on islands certainly suggests that forceful selection pressures are operating.

But even on mainlands, a species' range is comprised of a variety of environments. And as 2 recent and continuing studies of mainland horse populations demonstrated, some of these differences also influence equid sociality. In the New Forest where the adult sex ratio was highly skewed and females greatly outnumbered males, males appeared to possess harems and exclusive non-overlapping home ranges (Pollock 1980, personal communication). But unlike the Shackleford horses, a proportion of females appeared to live apart from harems. Some lived in harems only during the breeding season, leaving the group during the winter as the forage abundance and quality declined. Others never attached themselves to harems, wandering among harems regardless of season. In a Camargue horse population another social variant occurs. In a population consisting of 42 adult horses, 36 lived in a cohesive large group comprising many harems. Duncan and Vigne (1979) were able to demonstrate that individuals in larger groups were parasitised by fewer biting flies. They argued that the debilitating effects on condition associated with blood loss were a major factor in affecting this social arrangement.

These studies on feral horse populations demonstrate that a species such as the horse may exhibit a "typical" social system under "normal" conditions. However, the social system is likely to alter when changes occur in ecological factors, such as habitat structure, the distribution of forage and water and the diversity and quality of the vegetation, as well as demographic factors such as size, sex ratio and age structure. In addition, because islands differ quite markedly from the ideal or normal environment, populations living on them will most likely exhibit novel and exciting social variations.

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Résumé

Dans la population équine de l'île de Shackleford Banks au large de la côte est USA, des changements majeurs de l'organisation sociale sont apparus. Au lieu de vivre classiquement en harems occupant des territoires se "chevauchant", on s'est rendu compte que certains harems défendaient leur territoire et même que certains chevaux n'appartenaient même pas à des groupes fixes. L'existence de ces variations sociales semble être due à l'habitat et aux caractéristiques géographiques uniques de l'île. Les territoires, dont les limites couraient le long de l'île, n'existaient que là où celle-ci est étroite, la visibilité non obstruée et où les principales zones de végétation courent le long de l'axe principal de l'île. Ce n'est qu'à ces endroits que les difficultés de défense étaient réduites et les possibilités de se nourrir et d'assurer la garde pour les mâles étaient supérieures. Dans les zones de hautes dunes de sable et de forêt épaisse, des assemblages provisoires ont été observés et des harems sans territoire fixe occupaient les zones semi-ouvertes accidentées avec des mâles célibataires.

Une fois les territoires défendus, de nombreux aspects des relations sociales individuelles changent. Les étalons à territoire ont moins tendance à influencer les activités quotidiennes de leurs groupes et plus à s'occuper de leurs femelles dominantes et à regrouper leurs femelles subordonnées que les étalons sans territoire. De plus, les distances individuelles sont généralement plus grandes entre animaux vivant dans des harems territoriaux par opposition à des harems non territoriaux.

Zusammenfassung

Bei einer Pferdepopulation auf Shacklesford Banks, einer Insel vor der amerikanischen Ostküste, haben sich größere soziale Organisationsveränderungen ereignet. Anstatt in den typischen Harems in sich überschneidenden Heimatgebieten zu leben, wurde festgestellt, daß einige Harems ihre Territorien verteidigten und einige Pferde noch nicht einmal in festen Gruppen lebten. Das Bestehen dieser sozialen Variationen schien mit dem einzigartigen Lebensraum und den

geographischen Besonderheiten der Insel in Zusammenhang zu stehen. Territorien, deren Grenzen über die ganze Breite der Insel verliefen, gab es nur an den Stellen, wo die Insel schmal und die Sicht unbegrenzt war und wo die Vegetationszonen entlang der Längsachse der Insel verliefen. Nur hier waren die Schwierigkeiten der Verteidigung reduziert und die Ernährung sowie die Möglichkeit der männlichen Partnerbewachung besser. Wo die Sanddünen hoch und die Wälder dicht waren, fanden zeitweise Zusammenschlüsse statt, und nicht-territoriale Harems bewohnten zusammen mit den weibchenlosen Männchen die uneinheitliche, halboffene Landschaft. Mit dem Beginn der Territoriumsverteidigung veränderten sich auch zahlreiche Aspekte der individuellen sozialen Verhältnisse. Territoriale Hengste neigten weniger dazu, das tägliche Aktivitätsmuster ihrer Gruppe zu beeinflussen, und tendierten eher dazu, ihre dominanten Weibchen zu versorgen und zu pflegen und ihre untergeordneten Weibchen zusammenzutreiben als ihre nicht-territorialen Gegenstücke. Bei territorialen Harems wurden auch größere Abstände zwischen den einzelnen Tieren beobachtet als bei nicht-territorialen.

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ABSTRACTS

Digestive system and diseases

Mesodiverticular bands as a cause of small intestinal strangulation and volvulus in the horse

FEEEMAN, D. E., KOCH, D. B. and BOLES, C. L. (1979) *J. Am. vet. med. Ass.* **175**, 1089-1094.

MECKEL'S diverticulum and persistent vitello-umbilical bands are already documented as causes of intestinal obstruction in horses and cattle respectively. A third and distinct developmental anomaly, described as a mesodiverticular band, was responsible for bowel strangulation and secondary volvulus in the 3 cases reported in this paper. The band derives from a persistent vitelline artery and extends from one side of the mesentery to the antimesenteric surface of the bowel, usually along the jejunum as in these animals. The resultant double fold of mesentery thus forms a pouch into which intestines may migrate and become incarcerated. An interesting pathological feature in these cases was strangulation of the bowel, not within the pouch itself but through a tear in the jejunal mesentery close to the hernial opening, which is thought to develop as a result of increased tension caused by incarceration. The presence of ramifications of the vitelline artery may render the anomalous mesenteric band stronger than the normal jejunal mesentery. Fixation of bowel within the pouch also led to volvulus as an additional complication. Mesodiverticular bands may be present without causing pathological changes. A further case is reported in which 2 such bands were incidental findings at post mortem examination.

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Neoplasia

Treatment of bovine and equine ocular squamous cell carcinoma by radiofrequency hyperthermia

GRIER, R. L., BREWER, W. G., PAUL, S. R. and THEILEN, G. H. (1980) *J. Am. vet. med. Ass.* **177**, 55-61.

THE treatment of ocular squamous cell carcinomas in cattle and horses using radiofrequency (RF) hyperthermia is described. The efficacy of the treatment in destroying tumours is ascribed to the apparent greater sensitivity of malignant cells to non-coagulating temperatures of between 41°C and 45°C. The tissue hyperthermia was created by passing a RF (2MHz) electric current for approximately 30 secs between 2 electrodes placed on the tumour surface or within the tumour mass. Most of the animals were treated under topical anaesthesia and sedation, without resort to general anaesthesia. Total treatment time ranged from 30 secs to 15 mins depending on the size and number of tumours. Forty-five ocular squamous cell carcinomas in 17 cattle and 8 horses were treated. In cattle 88 per cent of tumours receiving a single treatment regressed completely while there was 67 per cent complete regression in those tumours which received 2 or more treatments. In horses there was 75 per cent complete regression in the 8 tumours treated. The conclusion is that hyperthermia is an effective and easily applied treatment for ocular squamous cell carcinoma in cattle and horses when the tumour mass is small, less than 5cm diameter, and there is no deep eyelid or conjunctival penetration.

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