

SHORT NOTES

Interspecific behaviour in temperate ungulates: an alien adult male associates with a group of non-conspecifics

Marisa Sicilia*, María Miranda & Jorge Cassinello

Instituto de Investigación en Recursos Cinegéticos (IREC), CSIC-UCLM-JCCM Ronda de Toledo s/n, 13071 Ciudad Real, Spain

*Corresponding author: marisa.sicilia@uclm.es

KEY WORDS: *Ammotragus lervia*, antipredator advantage, foraging efficiency, game management, interspecific association, *Ovis orientalis musimon*, social advantage

Group associations between two or more species have been described across a wide range of taxa in the wild, especially in birds and fishes. However, they have also been documented in many species of mammals, mainly primates and cetaceans, but rarely in ungulates – see review in (1) –. Interspecific mammal groups are usually formed by several individuals of different species (e.g., 2; 3; 4). Nevertheless, on rare occasions a single animal of a given species has been reported to associate with a group of non-conspecifics, in cetaceans (5) and in ungulates (6; 7).

We report here for the first time, an instance of group association between the aoudad *Ammotragus lervia* (Pallas, 1777) and the European mouflon *Ovis orientalis musimon* (Gmelin, 1774), where a mixed group (adult males and females, and on some occasions subadults) of mouflons associated with a solitary adult aoudad male. Both species are exotic in the study area.

The study site is a private rangeland (7.24km²) located in central Spain (38°55'N 0°36'E; 660-820m above sea level), where three species of large herbivores live in sympatry: red deer *Cervus elaphus* (Linnaeus, 1758), aoudads and European mouflons. We followed a routine of observing their behaviour, distinguishing different groups according to sex and age classes: mixed groups (adult males/females and subadults), single male groups and female groups (including subadults). Sampling routine involved regular visits to the study site: four days a week, two months per season, during 1.5 years. We focused our efforts at dawn and sunset hours, when peaks of animal activity take place. During our visits, we witnessed for several days an association of an adult aoudad male and a variable group of mouflons. Sex-age structure and size of the mouflon group varied, although in all cases it was mixed (see Table 1). The aoudad registered was always the same individual, an adult male over six years old (sensu 8). There was only one small aoudad group of around 20 individuals in the study area, so that it was easy to recognize conspicuous animals, such as this large male. We registered this association seven times on five sampling days in October 2006 (Table 1).

TABLE 1

Sightings of the mouflon group when in the company of the adult aoudad male.

Date	Adults		Subadults	Total	Main group behaviour	Individual behaviours
	males	females				
16 Oct 2006	5	3	0	8	feeding	–
16 Oct 2006	?	?	?	14	moving	Aoudad: chasing and flehmen towards mouflon female. 2 mouflon males: chasing the latter mouflon female.
17 Oct 2006	4	8	0	12	moving	–
17 Oct 2006	?	?	0	25	escaping	–
18 Oct 2006	5	2	1	8	feeding	–
25 Oct 2006	7	3	1	11	moving	–
26 Oct 2006	4	2	2	8	guarding	Aoudad: guiding mouflon group. Chasing a mouflon female (see Video 2)

The aoudad and mouflons were usually seen feeding, moving or guarding together. However, in some instances the aoudad male was observed guiding the whole group (see Video 1). We also recorded this male following a mouflon female on two occasions: on 16 October 2006,

the aoudad chased and displayed flehmen behaviour towards an adult mouflon female, which was also pursued by two mouflon males at the same time; on 26 October 2006, the aoudad chased another mouflon female (Video 2). Finally, on 26 October 2006, after the solitary

aoudad had been observed in company with the mouflon group for one and a half hours, a nursery aoudad group joined them to form a new multispecific group devoted to resting and foraging together (Video 3).

Before discussing possible causes for this association, we should point out the relatively small size of the private rangeland where the study was undertaken, which may promote a high frequency of encounters of individuals of different species. In this context, we do not consider a single observed association of an aoudad group, made up of adult females and youngsters, with the aoudad male-mouflon herd on October 26 to be a mixed group, because it appeared to be a random association without a functional purpose (9).

Several factors have been described as possible causes for non-random mixed-species associations to occur. **Antipredator advantage** appears to be the most common explanation in different kinds of mammals and especially in ungulates (2; 7; 10; 11; 12). Thus, ungulate species can reduce predation risk by remaining together for mutual protection and forming multispecific herds. This protection against predation can be attained by a given ungulate species through different mechanisms, such as joining species that are preferred prey for carnivores (2), or improving predator detection by associating with species having different antipredator abilities (7; 11). The association may result in improved foraging behaviour since shared vigilance behaviour increases available feeding time (7).

Old aoudad males, such as the one observed, tend to abandon their conspecific herd and show solitary behaviour (13). Solitude could carry an increased predation risk because of the lack of group help in vigilance behaviour, which might explain this association with mouflons. However, the “oddity effect” (14; 15; 16) predicts a higher risk of attack and capture of individuals that differ in size or colour from other group members, through reduced ‘confusion effect’ (17). Hence, the aoudad’s visibility to predators and therefore its vulnerability to predation would increase because of lack of conspecifics in the group.

In the study site no natural predators are present. Human hunting activity is mainly focused on a specific season (autumn and early winter), so that, as “predator” pressure is relatively low, it does not appear to be a plausible factor shaping ungulate grouping (1; 18).

Some studies conducted in other mammal orders have shown two other potential advantages of non-random interspecific associations that may explain the aoudad-mouflon association we observed: social advantage and increased foraging efficiency.

Associating with a species of higher resource detection ability or one that facilitates resource access may increase **foraging efficiency** of the herd mates (12). SINCLAIR (2) and STENSLAND et al. (1) considered that since grazers and browsers eat widely dispersed food they would not obtain any food detection benefit by associating with herds of other species. However, in accord with studies on herbivore diet, a hierarchical selection of resources has been reported for herbivores (19; 20; 21). Foraging behaviour is a hierarchical process where plant selection is optimized at the landscape level, patches at the community

level and individual and plant parts at the bite scale (19; 22). Such hierarchical resource selection takes place not only at the herbivore individual level but also at the group level (19; 23; 24). Hence, vegetal resources are actually distributed in differential palatability patches and different animals may have different abilities in their detection. Association between aoudads and mouflons may well respond to the greater ability of either species in food searching. Nutritional analyses made on comparative diet composition between aoudads, mouflons and red deer showed a seasonal-dependent foraging efficiency (25). In autumn, when the aoudad-mouflon association was observed, mouflon were significantly more efficient than the other two species in obtaining plants of high nutritional value (25). This may advantage aoudads associating with mouflons (as seen on Video 3), although we did observe the male aoudad apparently in a leading role (Video 1).

The **social advantage** hypothesis could also apply to our study case. The behaviour we filmed took place in autumn, the rutting season for both mouflons (26) and aoudads (27). Sexual behaviour of the aoudad male towards a mouflon female was observed on two occasions (see Table 1). Interspecific sexual behaviour and resulting hybridization have often been documented in domestic ungulates (e.g., 28) and sporadically between domestic and free-ranging wild species (e.g., 29) or between free-living ungulates (30; 31). Two different situations have been reported as possible catalysts for this unusual behaviour: 1) when access to conspecifics is denied and 2) where breeding groups of allopatric species are artificially in contact with one another. The latter explanation appears to be more plausible in the case of our study since the two species are naturally allopatric but have been brought into artificial contact. Moreover, the genera *Ammotragus* and *Ovis* are phylogenetically close, with similar behavioural patterns (32) although according to GEIST (33), hybridization would not be feasible because of reproductive barriers between the two species.

Finally, it is worth pointing out that in the study site the aoudad and mouflon populations share space and resources with a much larger population of red deer. It is postulated that between these three species in sympatry, the mouflon is subordinate in access to resources, due to their smaller body size and lower competitive abilities (SICILIA et al., unpublished data). Thus, there may be an advantage in associating with aoudad individuals. However, this hypothesis needs further study.

From our limited number of observations, we cannot identify the dominant factor causing mouflon and aoudad to associate. However, we suggest that under the particular conditions of resource availability, hunting regime and density of the different ungulate species in the study area, the association may have conferred social advantages and feeding improvements.

ACKNOWLEDGEMENT

We are very grateful to Yolanda Fierro for allowing us access to her private hunting rangeland and facilitating our fieldwork at all times. MM and MS are currently enjoying predoctoral fellowships from the Junta de Comunidades de Castilla-La Mancha

(JCCM), and the Spanish National Research Council (CSIC, I3P grant), respectively. Our research has been supported by projects PAI08-0264-1987, PREG-07-21 (both granted by JCCM) and CGL2007-63707/BOS (granted by Ministerio de Educación y Ciencia and cofunded by FEDER).

REFERENCES

- STENSLAND E, ANGERBJORN A & BERGGREN P (2003). Mixed species groups in mammals. *Mammal Review*, 33:205-223.
- SINCLAIR ARE (1985). Does interspecific competition or predation shape the African ungulate community? *Journal of Animal Ecology*, 54:899-918.
- KOKSHUNOVA LE, GAVRILENKO VS, TREUS MY & SMAGOL VA (2005). Interrelations of saiga (*Saiga tatarica tatarica*) with wild and domestic ungulates. *Journal of Evolutionary Biochemistry and Physiology*, 41:710-713.
- TEELEN S (2007). Influence of chimpanzee predation on associations between red colobus and red-tailed monkeys at Ngogo, Kibale National Park, Uganda. *International Journal of Primatology*, 28:593-606.
- BARAFF LS & ASMUTIS-SILVIA RA (1998). Long-term association of an individual long-finned pilot whale and Atlantic white-sided dolphins. *Marine Mammal Science*, 14:155-161.
- GOSLING LM (1980). Defence guilds of savannah ungulates as a context for scent communication. *Symposia of the Zoological Society of London*, 45:195-212.
- FITZGIBBON CD (1990). Mixed-species grouping in Thomson's and Grant's gazelles: the antipredator benefits. *Animal Behaviour*, 39:1116-1126.
- CASSINELLO J (1997). Identificación del sexo y clases de edad en las poblaciones españolas de arrui (*Ammotragus lervia*). Relación con el manejo de poblaciones en libertad. *Boletín del Instituto de Estudios Almerienses, Ciencias*, 14:171-178.
- WASER PM (1982). Primate polyspecific associations: do they occur by chance? *Animal Behaviour*, 30:1-8.
- KEAST A (1965). Interrelationships of two zebra species in an overlap zone. *Journal of Mammalogy*, 46:53-66.
- DIAMOND JM (1981). Mixed-species foraging groups. *Nature*, 292:408-409.
- DEBOER WF & PRINS HHT (1990). Large herbivores that strive mightily but eat and drink as friends. *Oecologia*, 82:264-274.
- GRAY GG & SIMPSON CD (1982). Group dynamics of free-ranging Barbary sheep in Texas. *Journal of Wildlife Management*, 46:1096-1101.
- MUELLER HC (1971). Oddity and specific searching image more important than conspicuousness in prey selection. *Nature*, 233:345-346.
- LANDEAU L & TERBORGH J (1986). Oddity and the 'confusion effect' in predation. *Animal Behaviour*, 34:1372-1380.
- KRAUSE J & RUXTON G (2002). *Living in groups*. Oxford University Press, Oxford.
- BERTRAM BCR (1978). *Living in groups: predators and prey*. In: KREBS JR & DAVIES NB (eds), *Behavioural ecology: An evolutionary approach*, Blackwell Scientific Publications, Oxford: 64-96.
- TERBORGH J (1990). Mixed flocks and polyspecific associations: costs and benefits of mixed species groups to birds and monkeys. *American Journal of Primatology*, 21:87-100.
- SENFRT RL, COUGHENOUR MB, BAILEY DW, RITTENHOUSE LR, SALA OE & SWIFT DM (1987) Large herbivore foraging and ecological hierarchies. *Bioscience*, 37:789-799.
- HJÁLTÉN J, DANELL K & LUNDBERG P (1993). Herbivore avoidance by association: vole and hare utilization of woody plants. *Oikos*, 68:125-131.
- MIRANDA M, DIAZ L, SICILIA M, CRISTOBAL I & CASSINELLO J (2011). Seasonality and edge effect determine herbivory risk according to different plant association models. *Plant Biology*, 13:160-168.
- BAILEY DW, GROSS JE, LACA EA, RITTENHOUSE LR, COUGHENOUR MB, SWIFT DM & SIMS PL (1996). Mechanisms that result in large herbivore grazing distribution patterns. *Journal of Range Management*, 49:386-400.
- BERGVALL UA, RAUTIO P, KESTI K, TUOMI J & LEIMAR O (2006). Associational effects of plant defences in relation to within- and between-patch food choice by a mammalian herbivore: neighbour contrast susceptibility and defence. *Oecologia*, 147:253-260.
- PÉREZ-BARBERÍA FJ, WALKERI DM & MARONI G (2007). Maximizing intake under challenging foraging conditions at two spatial scales in Soay sheep. *Animal Behaviour*, 73:339-348.
- MIRANDA M (2010). Comportamiento trófico de ungulados nativos y exóticos en simpatria en un ambiente mediterráneo: estrategias de herbivoría y efectos sobre la flora autóctona. PhD Thesis. Universidad de Castilla-La Mancha, Ciudad Real [chapters in English].
- PFEFFER P (1967). Le Mouflon de Corse (*Ovis ammon musimon* Schreber 1782); position systématique, écologie et éthologie comparées. *Mammalia*, 31 (Suppl.):1-262.
- OGREN H (1965). Barbary sheep. *New Mexico Department of Game and Fish Bulletin*, 13, Santa Fe.
- MINE OM, KEDIKILWE K, NDEBELE RT & NSOSO SJ (2000). Sheep-goat hybrid born under natural conditions. *Small Ruminant Research*, 37:141-145.
- GIACOMETTI M, ROGANTI R, DE TANN D, STAHLBERGER-SAITBEKOVA N & OBEXER-RUFF G (2004). Alpine ibex *Capra ibex ibex* x domestic goat *C. aegagrus domestica* hybrids in a restricted area of southern Switzerland. *Wildlife Biology*, 10:137-143.
- STUBBLEFIELD SS, WARREN RJ & MURPHY BR (1986). Hybridization of free-ranging white-tailed and mule deer in Texas. *Journal of Wildlife Management*, 50:688-690.
- ROBINSON TJ, TRIFONOV V, ESPIE I & HARLEY EH (2005). Interspecific hybridisation in rhinoceroses: Confirmation of a Black x White rhinoceros hybrid by karyotype, fluorescence in situ hybridisation (FISH) and microsatellite analysis. *Conservation Genetics*, 6:141-145.
- CASSINELLO J (1998). *Ammotragus lervia*: a review on systematics, biology, ecology and distribution. *Annales Zoologici Fennici*, 35:149-162.
- GEIST V (1971). *Mountain sheep. A study in behaviour and evolution*. The University of Chicago Press, Chicago.

Received: December 2, 2009

Accepted: February 15, 2011

Branch editor: Pereboom Zjef