

REACTION DISTANCE IN MEDITERRANEAN MOUFLON (*OVIS GMELINI MUSIMON* x *OVIS* SP.) IN THE PRESENCE OF HIKERS WITH A DOG ON THE CAROUX PLATEAU (HÉRAULT, FRANCE)

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RÉSUMÉ

Dans le cadre d'une étude relative aux dérangements liés à la fréquentation touristique que subit le Mouflon méditerranéen (*Ovis gmelini musimon* x *Ovis* sp.) dans le massif du Caroux-Espinouse (Hérault, France), nous nous sommes attachés à évaluer la sensibilité de l'espèce à la présence et au comportement d'un chien (*Canis familiaris*) accompagnant deux randonneurs. Des dérangements expérimentaux standardisés réalisés aux printemps 1996 à 1998 sur le plateau du Caroux, l'un des secteurs du massif recevant la plus forte pression touristique, ont permis de mesurer les distances de modification d'activité et de fuite de Mouflons soumis à trois sources de dérangement différentes : approches sans chien, avec un chien en laisse et avec un chien libre.

Si la distance médiane de fuite des Mouflons augmente très significativement en présence d'un chien, le fait qu'il soit tenu en laisse ou qu'il se déplace librement n'influe pas : de 70 m (N = 95) lors d'approches sans chien, elle passe à 100 m (N = 21) et 98,5 m (N = 36) lorsque les randonneurs sont respectivement accompagnés d'un chien en laisse et d'un chien libre. En outre, la présence de deux personnes avec un chien peut modifier le comportement de Mouflons se situant sur une aire d'environ 7,5 ha autour d'eux, alors que s'ils sont seuls, dans les mêmes conditions, l'aire dérangée n'est que de 3,7 ha.

Cette sensibilité accrue des Mouflons en présence d'un chien traduit un stress important qui, source de perturbation à long terme, pourrait affecter la dynamique de la population tout comme les poursuites pouvant être occasionnées par les chiens non tenus en laisse (93,6 % des cas). De ce fait et dans le cadre d'un développement écotouristique du massif, la maîtrise de ces dérangements doit être envisagée dès à présent.

SUMMARY

Within the context of a study on tourist disturbance affecting Mediterranean Mouflon (*Ovis gmelini musimon* x *Ovis* sp.) in the Caroux-Espinouse massif (Hérault, France), we assessed the sensitivity of this species towards the presence of a dog (*Canis familiaris*) taken along by two hikers. With the help of standard experimental disturbance events we measured the distance at which Mouflons spotted a source of disturbance, modified their activity and became vigilant, as well as their escape distance. Three sources of disturbance were tested in the springs of 1996 to 1998 on the Caroux plateau, one of the areas in the massif with the highest tourist pressure: approach by two hikers, approach by two hikers with a leashed dog and approach by two hikers with a dog off leash.

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If the median Mouflon escape distance increases very significantly in the presence of a dog, the fact of keeping him on leash or allowing him to run does not make much difference: from 70 m (N = 95) when the two hikers are alone, the escape distance goes up to 100 m (N = 21) and 98.5 m (N = 36) when these persons are with a leashed or unleashed dog, respectively. Besides, the presence of two people with a dog may modify the behaviour of the Mouflons in an area of about 7.5 ha around them, whereas if the two people are alone under the same conditions, the disturbed area is only of about 3.7 ha.

This increased sensitivity of Mouflons to the presence of a dog indicates a great stress, which is a long-term source of perturbation that could affect their population dynamics, like in the case of chases by dogs off leash (93.6 % of cases). Therefore, and in the context of further development of ecotourism in the massif, the control of such disturbances must henceforth be envisaged.

INTRODUCTION

In the Caroux-Espinouse mountain massif, the true “green lung” of the large urban areas in the Hérault *département* (Cugnasse *et al.*, 1997a), natural managers started an ecotouristic development notably because of the presence of a large Mediterranean Mouflon *Ovis gmelini musimon* x *Ovis* sp. population (Cugnasse, 1994). This is why controlling the numbers of visiting tourists who may deteriorate this natural heritage has become one of the major concerns, and why the characteristic traits and behaviours of the tourists frequenting the mountain massif (Cugnasse *et al.*, 1997a), as well as their possible impact on the Mouflon are investigated in our preliminary study. Our research shows the occurrence of behavioural changes in certain herds of the Mouflon population most disturbed by the flux of tourists (Cugnasse *et al.*, 1997b; Martinetto *et al.*, 1998a).

Moreover, the presence of many dogs (*Canis familiaris*) taken along by tourists and/or of stray dogs was observed (Martinetto *et al.*, 1998b). Now, several studies (Progulske & Baskett, 1958; Sweeney *et al.*, 1971; Fédération Départementale des Chasseurs du Cantal, 1981; MacArthur *et al.*, 1982; Gavin *et al.*, 1984; Espmark & Langvatn, 1985; Esteve, 1987; Jeppesen, 1987; Leonard, 1987; Nelson & Woolf, 1987; Humphries *et al.*, 1989; Fuller, 1990; Cederlund & Kjellander, 1991; Gaudin, 1991; Bullock *et al.*, 1993; Mainini *et al.*, 1993; Pin & Lovari, 1997; Jakubowski & Zalewski, 2000) and certain observations made in this mountain massif (Cugnasse, 1992) have revealed that dogs may be an intrinsic or cumulative factor of an appreciable amount of disturbance, or even a cause of death.

The objective of this article is to assess the Mouflon’s sensitivity to the presence and behaviour of a dog taken along by hikers on the Caroux plateau, one of the sectors of the mountain massif with the highest tourist pressure (Cugnasse *et al.*, 1997a) and, eventually, to enact the application of preventive measures in the perspective of an increase of this type of frequentation.

The term “disturbance” will be used to define a simple interaction, a visual, auditive and/or olfactive contact between the group of Mouflons and the hikers which, at the least, produces a change in Mouflon behaviour with transformation of an activity of maintenance into an attitude of alertness followed or not by a movement and/or escape. The term “perturbation” will only be used for changes produced by certain types of disturbance which negatively affect the population’s normal behaviour (Ministère de l’Aménagement du Territoire et de l’Environnement, 1998).

MATERIAL AND METHODS

STUDY AREA

The Caroux plateau, in the Caroux-Espinouse mountain massif (43°N, 3°E), is situated in the south-western part of the Massif Central (France), north-west of the Hérault *département*. It stretches over some 380 ha at a mean altitude of 1,050 m, and is surrounded by steep rocky slopes with a vegetation of mostly holly oak (*Quercus ilex* L.) or beech (*Fagus sylvatica* L.) except in its northern part where a broom (*Cytisus purgans* and *Sarothamnus scoparius*) dominated wasteland has colonized the more gentle slopes covered by scattered beech groves. Heathlands cover 86 % of the plateau (55.4 % dominated by Ericaceae and 30.6 % by broom, *Sarothamnus scoparius*, and ferns), 2.5 % is covered by moorlands, while gramineous plants (grass meadows, wildlife feeding crops) and rocky areas each represent not more than 1 %. Woodlands, mostly heathlands with conifers, are covering 9.5 % (Auvray, 1983).

The Caroux plateau is a listed and famous site of the Regional Natural Park situated in the Haut-Languedoc region, visited by many tourists (up to 191 people per day). These are mainly attracted by the exceptional state of this natural patrimony and the many possibilities to practice outdoor activities, in particular hiking (Cugnasse *et al.*, 1997a).

The Mediterranean Mouflon, which could extend its range because of the cutback in farming activities, was introduced between 1956 and 1960 into the perimeter of the nowadays Caroux-Espinouse National Hunting and Wildlife Reserve (1 724 ha) which is a restricted area situated, as the crow flies, at a 3.3-km distance from the Caroux plateau. Since then, its population (some 1 500 individuals - ONCFS, unpublished work) has colonized the whole massif (some 12 400 ha in 1996) and is nowadays divided into socio-spatial population units among which there are relatively few exchanges (Petit *et al.*, 1997). This population has become the subject of several eco-ethological studies, and this since many years (Pfeffer & Genest, 1969; Auvray, 1983; Cugnasse *et al.*, 1985; Faliu *et al.*, 1990; Santosa *et al.*, 1990; Dubois, 1991; Bon *et al.*, 1992a and b; Dubois *et al.*, 1992; Bon *et al.*, 1993a, b and c; Cugnasse, 1993; Bon *et al.*, 1995). From September to February the Mouflons outside the Reserve are hunted, most often by still hunts (261 Mouflons according to the 1996 shooting plan). Finally, the Reserve is more and more often frequented by naturalists.

DATA COLLECTION

Controlled disturbance experiments by persons approaching in the open (Martinetto *et al.*, 1998a) were carried out on the Caroux plateau in spring (April to June) from 1996 to 1998, during the Mouflons' evening activity period. These experiments allowed to assess the degree of reactivity of these animals to the presence and behaviour of a (middle-sized Labry-type) dog walked by two observers who approached them on foot, walking on or outside the trail without noise, as well as the distances at which the Mouflons would:

1. detect the source of disturbance and cease their activity to adopt an attitude of vigilance: *i.e.* the distance of activity change (Cd). Although such change in behaviour bears a certain resemblance to a situation of "minimum" stress, it is a good indicator of disturbance (MacArthur *et al.*, 1979; MacArthur *et al.*, 1982; Pedevillano & Wright, 1987; Herbold *et al.*, 1992).

2. move away or escape: escape distance (Ed) (Hediger, 1934).

Groups of males, matriarchal and mixed groups of different sizes were approached, depending on the day by two people alone, by two people with a dog on leash or two people with a dog off leash. The dog did not make any noise and was called back when Cd's and Ed's were measured. This to avoid that in case of repeated experiments it would be recognized by the Mouflons.

Distance between the unleashed dog and the two hikers was measured every five minutes, except when the Mouflons were stalked.

DATA PROCESSING

Since the same group of Mouflons was disturbed only once during the same day, the data collected are considered to be independent.

The preliminary results showed that Mouflon group composition had an influence on escape distance (Martinetto *et al.*, 1998a). Moreover, approaching animals outside the trails, which are generally thought to be neutral grounds, is causing even more disturbance (Schultz & Bailey, 1978; Cederna & Lovari, 1986; Hamr, 1988; Humphries *et al.*, 1989; Lamerenx *et al.*, 1992; Mainini *et al.*, 1993; Pin & Lovari, 1997). This is why the homogeneity of the experimental disturbance events distribution by group composition and type of approach (on or outside the trail) was assessed by a test of mutual independence (Zar, 1996) of the different sources of disturbance (without dog, with a leashed dog, with an unleashed dog) ($\chi^2 = 20.871$; $df = 12$; $p = 0.052$) to exclude any factor of confusion. Also, since the Ungulates' reaction to disturbance could be related to the size of the group they belong to (Altmann, 1958; Hicks & Elder, 1979; Cederna & Lovari, 1986; Humphries *et al.*, 1989; Schütz *et al.*, 1995), a Kruskal-Wallis test was used to check for equality of mean sizes of the disturbed groups with respect to the three sources of disturbance ($H_c = 1.661$; $p = 0.436$).

Since the data relative to Cd and Ed did not adjust to a normal distribution (Lilliefors test: Cd: maximum deviation to the mean = 0.1137; $p < 0.01$ — Ed: maximum deviation to the mean = 0.1346; $p < 0.01$), we decided to express the results in median distances.

Because of the significant positive correlation between Cd and Ed (without dog: $r_s = 0.561$; $p = 0.001$ — with dog on leash: $r_s = 0.573$; $p = 0.010$ — with an unleashed dog: $r_s = 0.569$; $p = 0.001$), only the median Ed was tested in relation with the source of disturbance by a median comparison test followed by a Tukey type test of multiple comparisons (Zar, 1996). The factor period (April: lambing; May-June: lamb rearing) could not be tested because only 3.3 % of the experimental disturbances took place in April.

RESULTS

A total number of 152 standard experimental disturbance events were arranged on the Caroux plateau.

The obtained median Cd (Fig. 1) indicate that two hikers with a dog, whether or not kept on a leash, may modify the behaviour of Mouflons being within a radius of 154.5 ± 0.5 m around them, *i.e.* an area of some 7.5 ha. For two hikers alone, this area is 3.7 ha.

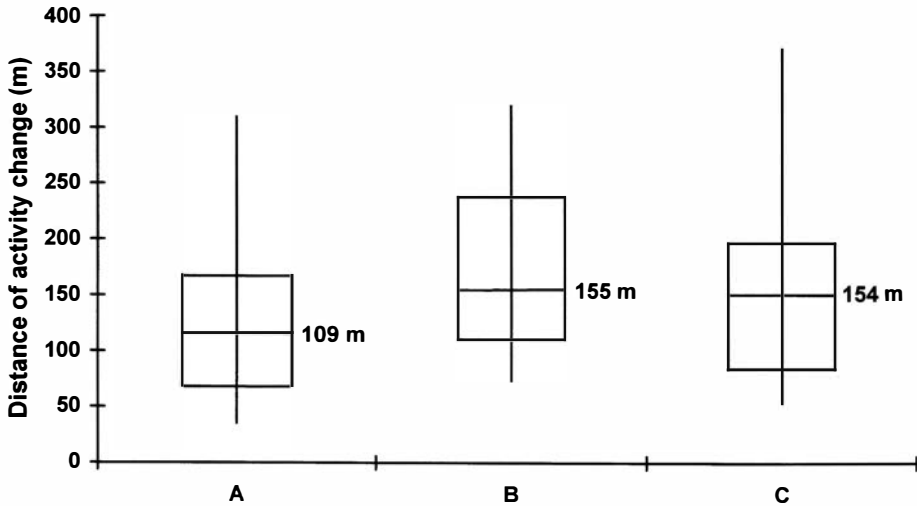


Figure 1. — Distance of activity change of Mediterranean Mouflons (*Ovis gmelini musimon* x *Ovis* sp.) approached by two hikers A: without a dog (N = 95), B: with a dog on leash (N = 21) and C: with a dog off leash (N = 36) on the Caroux plateau (Hérault, France) in the springs of 1996 to 1998. Median, first and third quartile, minimum and maximum.

According to the source of disturbance, there is a highly significant variation in the Mouflons' median Ed ($\chi^2 = 13.182$; $df = 2$; $p = 0.001$) (Fig. 2): while their escape distance is 70 m when the Mouflons are in the presence of two hikers, it is significantly longer when these are with a dog, whether kept on a leash (100 m: $q = 7.085$; $p < 0.001$) or not (98.5 m: $q = 4.723$; $p < 0.005$). No significant difference appeared between the median Ed of the groups approached whether with a leashed or unleashed dog ($q = 2.362$; $p > 0.05$), since the latter had kept a mean distance of 23.3 ± 19.6 m (N = 82) between it and the two hikers.

DISCUSSION

Tourists are frequenting the Caroux plateau at a regular rate between spring and autumn (Martinetto *et al.*, 1998a). Among them 16.2 % are groups of tourists (*i.e.* 1 person out of 26) with their dogs (93.6 % of which are not on a leash — Cugnasse *et al.*, 1997a), a percentage which is almost four times less than the estimate for the whole French population [1 person out of 7 among which 1 out of 2 is a country-dweller (Freymy & Freymy, 1996), a figure that confirms its urban character (Cugnasse *et al.*, 1997a)] but higher than indicated for other places (11 % of the groups in the High Vosges area for example, Schaal & Boillot, 1992).

Because of the predictable increase in the number of tourists in the massif and since the presence of dogs, regarded as predators by the wild fauna (Bullock *et al.*, 1993; Mainini *et al.*, 1993; Sime, 1999) is increasing in proportion (Martinetto & Cugnasse, unpublished data), monitoring the troubles they are causing should be considered right now. Indeed, according to what has already been shown in several

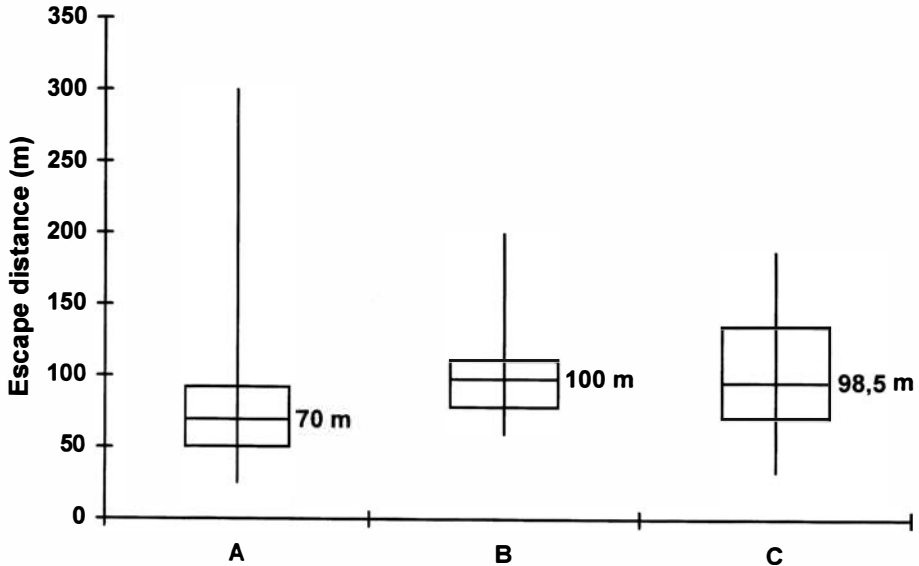


Figure 2. — Escape distance of Mediterranean Mouflons (*Ovis gmelini musimon* x *Ovis* sp.) approached by two hikers A: without a dog (N = 95), B: with a dog on leash (N = 21) and C: with a dog off leash (N = 36) on the Caroux plateau (Hérault, France) in the springs of 1996 to 1998. Median, first and third quartile, minimum and maximum.

ungulates (Jacobsen, 1979; MacArthur *et al.*, 1982; Humphries *et al.*, 1989; Bullock *et al.*, 1993; Pin & Lovari, 1997) as well as in the Alpine Marmot *Marmota marmota* (Mainini *et al.*, 1993; Louis, 1999) in mammals, and in the Golden Plover *Pluvialis apricaria* (Yalden & Yalden, 1990) in birds, our observations confirm that the Mediterranean Mouflon presents an increased sensitivity to disturbance when there is a dog around.

The median escape distances of this species measured by us in the Caroux, cannot systematically be extrapolated to other Ungulates because of the inter-specific variability in behaviour (Hediger, 1934). Nor can it be extrapolated to other Mouflon populations if the environmental factors are not the same (for example, the presence of a natural predator in the area used by an Ungulate population greatly conditions the latter's reactions, Hamr, 1988; Lovary, 1988). In spite of that, these are minimal data managers may use as a data source. In fact, we arranged experimental disturbance events in a sector where Mouflons had reduced their mean escape distance in response to repeated exposures to humans (Martinetto *et al.*, 1998a). Moreover, the largest tourist groups are causing the greatest disturbance (Hamr, 1988; Humphries *et al.*, 1989), especially when they are noisy (Jacobsen, 1979, Cederna & Lovari, 1983). An experiment with more observers (54.0 % of the groups observed on Caroux are made up of more than 2 people, Cugnasse *et al.*, 1997a) with several noisy people (30.1 % of the groups, Cugnasse *et al.*, 1997a) would probably have yielded still higher escape distances. It would certainly have been the same if we had used a barking dog (Espmark &

Langvatn, 1985), as are 21.2 % of the dogs observed on the massif (Cugnasse *et al.*, 1997a), or a dog with a spontaneous predatory behaviour (being on the scent, tracking, Sweeney *et al.*, 1971) which would have triggered even much stronger reactions. Moreover, our observations were made in the evening when the animals' attention is centered on their quest for food after a day of almost total fasting and during which their behaviour reactions are minimal (Schaal & Boillot, 1992). This is especially so because the predominance of open habitats makes it easier to detect potential sources of disturbance (Lagory, 1987; Humphries *et al.*, 1989) and the many possibilities to escape and take refuge in rocky or densely vegetated areas (Hicks & Elder, 1979; MacArthur *et al.*, 1982; Jeppesen, 1984; Jeppesen, 1987; Hamr, 1988; Gaudin, 1991; Schaal & Boillot, 1992; Petrak, 1996) also contribute to make the Mouflons that are using the plateau feel safe. Finally, Ungulates are showing a greater sensitivity to the presence of man and/or a dog during the hunting period (Altmann, 1958; Behrend & Lubeck, 1968; Douglas, 1971; Schultz & Bailey, 1978; Root *et al.*, 1988; Deblinger & Alldredge, 1989; Punga, 1990; Hamann *et al.*, 1991; Reimers & Kolle, 1991). Preliminary observations (ONCFS, unpublished work) seem to confirm this for the Mouflon even if still hunting of the species in this mountain massif seems to disturb them less than other hunting practices, probably because it may also be disturbed by the wild boar beat hunts.

Contrary to the Alpine Marmot (Mainini *et al.*, 1993), the mere presence of a dog taken along by two hikers had an influence on the Mouflons' reaction. This reaction may in turn be affected by the type of dog taken along (*e.g.* a sheepdog that will not stalk game) and by the dog's behaviour when unleashed (docile, silent, always keeping itself at a mean distance of less than 25 m from the observers and not chasing after the spotted Mouflons). On the other hand, the process of familiarization of the Caroux plateau Mouflons could be rather difficult because of their fright of dogs, which is often reinforced by their frequent contacts with other mostly free-running dogs taken along by hikers and with hunter hounds which are showing a predatory behaviour (Humphries *et al.*, 1989; Bullock *et al.*, 1993).

Therefore, keeping dogs on leash, notably during certain critical periods (snow, gestation, lambing, presence of young, Progulske & Baskett, 1958; Prior, 1984; Rigaud, 1985; Jeppesen, 1987; Hamr, 1988), even if such measure has only a limited impact, should contribute to avoid first of all certain mortalities from the consequences of pursuits: captures, bites, falls (Pfeffer, 1967; Fédération Départementale des Chasseurs du Cantal, 1981; Rigaud, 1985; D'Herbomez, 1985; Esteve, 1987; Cugnasse, 1992) while in the middle and long term it may reduce certain perturbations: higher energy costs (Jeppesen, 1984; Freddy *et al.*, 1986; Hüppop, 1995), early separation of mother and young in Roe Deer *Capreolus capreolus* (Cederlund & Kjellander, 1991), temporarily or permanent displacements away from their home range in cervids (Progulske & Baskett, 1958; Sweeney *et al.*, 1971; Jeppesen, 1987; Gaudin, 1991), greater use of refuge areas which are often wooded, or rocky and steeply sloping (Sweeney *et al.*, 1971; Hicks & Elder, 1979; Jeppesen, 1987; Hamr, 1988; Kufeld *et al.*, 1988; Gaudin, 1991; Schaal & Boillot, 1992; Schnidrig *et al.*, 1991; Schnidrig-Petrig & Ingold, 1995; Petrak, 1996; Hamann *et al.*, 1997) sometimes not so good because of less available food resources which may affect survival rate (Mc Namara, 1982), and/or breeding success (Robinette *et al.*, 1955).

On the other hand, there could be some less visible or indirect effects like retreating to areas with a remarkable and/or vulnerable biodiversity which are then

used intensively. Moreover, the time spent watching, fighting and recuperating (30 minutes for a Fallow Deer which has been chased by a dog for three minutes, Humphries *et al.*, 1989) will not be spent on maintenance activities like feeding and resting (Mc Namara, 1982; Humphries *et al.*, 1989; Gossow *et al.*, 1991; Schaal & Boillot, 1992; Hüppop, 1995; Reimers & Kolle, 1991).

If one takes account of the increase in the median distance of activity change and, subsequently, of the enlargement of the disturbed area (from 3.7 ha to 7.5 ha), with respect to the occurrence of groups of tourists with dogs, the distances these are covering (10 km-long hikes on average, Cugnasse *et al.*, 1997a) and the high penetrability of the Caroux-Espinouse mountain massif (more than 750 km of trails and tracks suitable for cars, Martinetto *et al.*, unpublished data), it is now a recognized fact that according to the sector in which it is situated, but also at certain times of the year, the type of area susceptible to be disturbed could be rather large. Beyond the example of the Mouflon, other even more vulnerable wild species are concerned, like a minimum of 38 bird species which are nesting on the ground (notably the Hen Harrier *Circus cyaneus* and the Montagu's Harrier *Circus pygargus*) or at low heights, and 28 species of mammals which are inhabiting the mountain massif (Cugnasse, 1990), mainly in spring (period of settlement, of reproduction and rearing of young) and summer (period of rearing of young).

In spite of that, it is not unthinkable that in the mean and/or long term the Mouflons will "accept" the presence of a dog on leash that cannot reach them. Monitoring the hikers' change in behaviour and its impact would also give precious information on the Mouflons' ability to integrate changes of the environment (Geist, 1971), and this could usefully be applied to manage the natural areas which are open to the public.

ACKNOWLEDGEMENTS

The authors would like to thank Y. Tachker, Director of Research and Development (ONC), M. Catusse, head of the CNERA Mountain Fauna (ONCFS), M. Alliès, president of the Caroux-Espinouse Group of Cynegetic Interest and J. Mendes, president of S.I.V.O.M. responsible for the management of Caroux-Espinouse, for their support on several other accounts, and the ONCFS Board of Directors for their interest shown in our study. We also thank the director of the Caroux-Espinouse National Hunting and Wildlife Reserve. We shall neither forget the trainees and volunteers for the Environment who actively assisted in the collection of field data. We gratefully acknowledge the remarks of M. Catusse and the referees (J.-M. Gaillard and an anonymous referee) following their constructive readings. We would also like to thank E. Taran for the translation of the manuscript into English. This study was carried out under the study and research conventions between the Office National de la Chasse on the one hand, and the Caroux-Espinouse Group of Cynegetic Interest (1996-97) and S.I.V.O.M. responsible for the management of Caroux-Espinouse financially supported by the Languedoc-Roussillon Region (1998), on the other hand.

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