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Key habitats for Egyptian mongooses in Doñana National Park, south-western Spain

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Summary

1. The habitat use by Egyptian mongooses during nocturnal and diurnal resting, foraging and walking was studied by radio-tracking between September 1987 and September 1989 in south-western Spain.

2. Mongooses always avoided open areas, and preferred those with dense vegetation during both nocturnal and diurnal resting, and when active. Vegetation types with low density of understorey and ground cover were used less than expected on the basis of availability. No significant monthly variation was observed.

3. Mongooses moved at different speeds in each type of vegetation. Foraging activities predominated in areas with the thickest ground cover and density of vegetation, while more open areas were mainly traversed.

4. Mongooses selected the areas with high densities of their main prey (rabbits) and shelters (thickets and rabbit warrens) for foraging and resting, respectively. Both requirements were provided by the same vegetation types.

5. Possible applications for the conservation and management of this species in relation to key habitats are discussed.

Key-words: *Herpestes ichneumon*, habitat use, movement speed, foraging habitats.

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Introduction

Herpestes ichneumon L. (the Egyptian mongoose) is the only member of Herpestidae (following Wozencraft 1989) with natural populations in Europe (Delibes 1982). It occurs only in the south-western quadrant of the Iberian Peninsula, although at the end of the last century mongooses were found at the north of this Peninsula (Delibes 1982). Modern techniques using the Geographical Information Systems (GIS) might help in understanding the factors influencing mongoose distribution and planning measurements for its conservation and management through its range (Haslett 1990). However, it is first necessary to identify a species' habitat requirements before this technique can be used (Koehler 1990; Schoen 1990). We studied habitat requirements for resting and activity of Egyptian mongooses in Doñana National Park, and identified the key vegetation types on which to work for the conservation and management of Egyptian mongooses in this important wildlife park and adjacent land (Valverde 1958; Rogers & Myers 1980). Additionally, the

proportion of active time spent foraging and walking in different vegetation types was studied following the method developed by Palomares & Delibes (1993a).

Study area

The study took place at Coto del Rey (Northern Doñana National Park, south-western Spain; 37°9'N 6°26'W). The general vegetation of Coto del Rey is characterized by *Pinus pinea* L. and *Eucalyptus* sp. with variably scattered undergrowth mainly of *Halimium halimifolium* L.; ash stands situated in small natural streams and near to marshes, and dominated by species of *Fraxinus*, *Populus alba* L., *Pistacia lentiscus* L., *Tamarix* sp and *Rubus* sp; and associations of *P. lentiscus* at places with a higher ground water table. Ash stands and associations of *lentiscus* were highly clumped (Palomares & Delibes 1993b). There is a portion of the area which has been maintained as an autochthonous forest with *Quercus suber* L. and undergrowth of *Pistacia lentiscus* and *Halimium halimifolium* as the more characteristic plant species. The climate is Mediterranean sub-humid, with mild, wet winters, and hot, dry summers, with an annual rainfall

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between 500 and 600 mm. More information on the area can be found in Valverde (1958), Allier, González Bernaldez & Ramírez Díaz (1974) and Rogers & Myers (1980).

Oryctolagus cuniculus L. (the European rabbit) is the main prey of mongooses in the study area (Palomares & Delibes 1991). Track count censuses through most of the study area indicated that rabbits were abundant in ash stands, autochthonous forest, lentiscus, and the borders of these areas with meadows, and rare in pine and eucalyptus afforestations (P. Ferreras, unpublished data). Other carnivore species present in the study area are *Felis pardina* Temminck (Iberian lynx), *Vulpes vulpes* L. (red fox), *Meles meles* L. (European badger), and *Genetta genetta* L. (common genet).

Methods

Twenty-four mongooses (12 adult females, 7 adult males, 2 young males, and 3 young females) were captured with box-traps between September 1987 and September 1989, and equipped with radio-collars containing tip switches (Wildlife Materials, Inc., Carbondale, Illinois, USA). Their age was estimated by body mass and tooth wear (Palomares & Delibes 1992a). Except for five individuals which were tracked for less than 1 week, mongooses were tracked for an average of 87 days (range = 24–251 days).

Mongooses are diurnal in the study area, with a continuous nocturnal resting period (from 1 hour before sunset to 2 hours after sunrise on average) and one or several short resting periods or siestas interspersed with activity during the rest of the day (Palomares & Delibes 1992b). Therefore, habitat use was analysed separately for activity, siestas, and nocturnal resting following the recommendations of Palomares & Delibes (1992c).

General habitat use was studied from isolated locations to avoid statistical dependence of observations: each individual was located without disturbing it (Palomares 1990) usually daily, once during daylight and another time during the night, dusk, or dawn, using homing techniques (Mech 1983). With this technique, the error associated with triangulation (White & Garrot 1986; Kufeld, Bowden & Siperek 1987; Nams 1989) was avoided, and the accurate position of animals could be recorded. Locations from inactive individuals between 16.30 and 10.30 hours were used to analyse habitat use during nocturnal resting. All locations of inactive mongooses between 10.30 and 16.30 hours were used to analyse habitat use during siesta periods. Animals were considered active when radio-signal indicated movement (i.e. the animal was making some movement that frequently switched the pulse rate). As two or more radio-tagged mongooses were sometimes together (see Palomares & Delibes

1993b), only one location was used for analysis in these cases.

Eleven habitats or vegetation types, well delimited and easily distinguishable in the field by vegetational and understorey cover characteristics, were considered for the analyses: 1, Ash stands and small streams. 2, Autochthonous forest. 3, Lentiscus: associations of *P. lentiscus*, which were mixed with either pines or eucalyptus in some places. 4, Matorral: scrubland dominated by *Halimium halimifolium* without overstorey. 5, Pine forest. 6, Eucalyptus. 7, Rushes: associations of *Juncus* sp. 8, Pastureland: areas with meadows and isolated *Quercus suber*. 9, Marsh: flats usually flooded by winter rains. 10, Meadow. 11, Crops: vegetation cover shifted throughout the year. They have been listed in decreasing order of vegetation density and understorey cover. Throughout this paper the terms habitat or vegetation type are used interchangeably, in spite of the former having a broader meaning.

Bimonthly differences in habitat use were analysed by Friedman test. Differences between sex-age classes were not analysed since family groups were frequent (Palomares & Delibes 1993b), and any comparison would be meaningless. Diversity of habitat use during each period (activity, siesta, and nocturnal resting) was estimated by Levins (1968) index (B).

Preference or avoidance of each vegetation type was determined by the method of Neu, Byers & Peck (1974) using chi-square analysis and Bonferroni confidence intervals to control the experimental error probability at $P=0.05$. If vegetation types were used more or less ($P<0.05$) than available, they were considered preferred or avoided, respectively. Availability was the proportion of the total area contained within home ranges (delineated by minimum convex polygon method; e.g. see Macdonald, Ball & Hough 1980). Vegetation was interpreted from aerial photographs and ground inspection, and availabilities were estimated by a digital planimeter.

Vegetation types actually preferred by mongooses for foraging during the activity period can be accurately estimated using the method developed by Palomares & Delibes (1993a) for free-ranging mongooses living in the study area. This method consisted in monitoring movement speed during 15-min intervals, and to assign one behaviour (foraging or walking) to each interval depending on the movement speed. Palomares & Delibes (1993a) showed that mongooses moving equal to or less than 11 m per min undertook a high proportion of foraging and eating activities (both included in the same category), while mongooses moving equal or faster than 19 m per min were walking.

Thirty-one periods of intensive radio-tracking during the daily activity period of 8 adult females, 1 adult male, and 2 young (from 06.00 to 19.00 h

GMT; Palomares & Delibes 1992b) were done on foot and at a short distance (30–100 m) from the animals, not disturbing them (Palomares 1990). We split each tracking day into 15-min intervals, estimating for each one the travelled distance and how long the animal was active (from which movement speed was obtained). Activity time was obtained by listening to the changes in pulse rate as the tip switch in the radio-collar was affected by the animal movement, and distance travelled was measured as the shortest distance between two consecutive locations separated by 15 min. For the analyses, the 15-min intervals with less than 5 min of net active time, and those when mongooses moved through different vegetation types were excluded. Differences of movement speed among vegetation types were tested by Kruskal-Wallis (H) test, using the day as the sampling unit to avoid pseudoreplication. In total, 630 15-min intervals were analysed.

Results

General habitat use

The mongooses were never located on meadows or marsh, and only twice on pastureland and four times on crops during the isolated locations. Intensive tracking revealed that these areas were used to cross between others when the distance was short. Therefore, these areas were considered as avoided by mongooses.

Ash stands were the vegetation type where mongooses were located most frequently in any period (Table 1). This vegetation type was also the only one used significantly more than its availability during all the activity, siestas or nocturnal resting periods. Lentiscus during the activity, and rushes during the activity and nocturnal resting periods,

were used significantly more than their availability (Table 1). By contrast, pine forests were used significantly less than their availability during all activity, siestas and nocturnal resting, autochthonous forest during activity and nocturnal resting, and matorral during nocturnal resting (Table 1). Diversity of habitat use was higher during siestas ($B = 1.74$), followed by activity ($B = 1.68$) and nocturnal resting ($B = 1.37$).

The three vegetation types most used (ash stands, lentiscus and pine forests; Table 1) were selected with significantly different frequency during activity and siesta than during nocturnal resting ($\chi^2 = 15.91$ and 10.50 , $P < 0.001$ and 0.005 , respectively). Differences between activity and siestas were not significant ($\chi^2 = 0.66$, $P = 0.7110$). Pine forests and lentiscus were used significantly more during activity and siestas than during nocturnal resting ($P < 0.05$).

Seasonal habitat preferences

Mongooses used each habitat similarly throughout the year both during activity ($\chi^2 = 2.937$, $df = 5$, $P = 0.7098$, Friedman test) and nocturnal resting ($\chi^2 = 3.500$, $df = 5$, $P = 0.6234$) (siestas were not analysed because of small sample size). Ash stands were always the most used, followed by lentiscus, except in November–December during activity, and May–June and November–December during nocturnal resting, when there was a higher use of pine forests, autochthonous forest and pine forests, respectively (Fig. 1).

Foraging vs. walking habitat use

Mongooses moved with significantly different mean speed in each vegetation type used during activity (Table 2; $H = 22.35$, $P = 0.001$). In ash stands,

Table 1. Availability of each habitat inside home ranges (by minimum convex polygon method) of mongooses, and percentage of use of each habitat during the activity, siesta and nocturnal resting of mongooses: ‘+’ and ‘–’ indicate if habitat was used significantly more or less than expected with regard to its availability following the method of Neu *et al.* (1974). The number of isolated locations used for each activity period is given in parentheses

Habitat type	Availability (%)	Use (%)		
		Activity ($n = 742$)	Siesta ($n = 150$)	Nocturnal ($n = 697$)
Pine forest	50.1	–10.5***	–12.6***	–7.3***
Eucalyptus	5.0	–2.7*	–2.0 NS	–0.9***
Ash stands	10.8	+59.2***	+55.6***	+69.2***
Lentiscus	12.3	+18.3**	19.9 NS	13.2 NS
Aut. forest	10.7	–5.5***	5.3 NS	–5.7***
Rushes	0.5	+2.4*	2.6 NS	+3.0**
Matorral	2.8	1.1 NS	0.7 NS	–0.4**
Others [†]	7.7	0.3	1.4	0.3

* $P < 0.05/2k$; ** $P < 0.01/2k$; *** $P < 0.001/2k$; NS, not significant; $k = 7$ (number of compared habitats).

[†] This includes meadows, pastureland, marsh and crops. These habitats were directly considered as avoided by mongooses.

Fig. 1. Bimonthly habitat use by mongooses during (a) activity and (b) nocturnal resting. Sample sizes (from Jan–Feb to Nov–Dec) for activity were 106, 150, 85, 65, 161 and 175 locations, and for nocturnal resting 113, 178, 103, 49, 126 and 128 locations. PI, pine forest; EU, eucalyptus; AS, ash stand; LE, lentiscus; AF, autochthonous forest; RU, rushes; MA, matorral.

lentiscus, autochthonous forest, matorral and rushes, foraging activities greatly predominated over walking, while walking predominated in eucalyptus. In pine forests there was no predominant activity (Fig. 2).

Habitat use by mongooses as estimated from the locations of the 31 periods of intensive tracking used to obtain the previous information did not differ significantly from the pattern of habitat use estimated from the isolated locations ($\chi^2 = 10.4$, $df = 6$, $P = 0.1099$).

Discussion

In our study area, mongooses avoided the use of open areas, and preferred to use the habitats with higher density of understorey vegetation (mainly ash stands and lentiscus) and rabbits, their main prey (Palomares & Delibes 1991), both during ac-

tivity and resting. Habitats with higher density of understorey vegetation were also preferred during the winter by three adult females in another part of the Doñana National Park (the Doñana Biological Reserve; Palomares & Delibes 1990), in spite of the general characteristics of vegetation in the latter area being different to those of the Coto del Rey area (Allier *et al.* 1974; Palomares & Delibes 1990). Since mongooses are diurnal (Palomares & Delibes 1992b), and can be killed by dogs, *Canis familiaris*, Iberian lynxes, and big raptors (Ben-Yaacov & Yom-Tov 1983; Palomares & Delibes 1992a; Delibes & Palomares, in press), the use of dense vegetation close to the ground during the activity protects them against potential predators and disturbance by man. On the other hand, mongooses mainly choose to rest in rabbit warrens and thickets (Palomares & Delibes 1993c), which are also more abundant in these habitats. The small variation for both activity

Table 2. Mean movement speed (m min^{-1}) of mongooses as measured at 15-min intervals during periods of intensive tracking for each habitat used during the activity

Habitat	n (N° cases) [†]	Mean	SE	Range
Pine forest	12 (76)	21.1	3.4	6.3–37.1
Eucalyptus	2 (20)	21.8	2.8	19.1–24.6
Ash stand	25 (405)	9.4	1.4	0.5–21.6
Lentiscus	9 (62)	8.6	1.4	1.0–14.8
Auto. forest	6 (49)	15.2	2.9	9.4–25.5
Rushes	2 (9)	10.3	5.2	5.1–15.5
Matorral	5 (9)	1.2	1.2	0.0–4.7

[†] n denotes the number of days of intensive tracking when movements in a given habitat were detected for one 15-min interval at least; N° cases denotes the total number of 15-min intervals.

Fig. 2. Percentage of 15-min intervals where activities of eating–foraging or walking in each habitat during intensive tracking periods of mongooses in Coto del Rey were inferred by movement speed. The number of 15-min intervals for each habitat are given over each pair of columns. Abbreviations as in Fig. 1.

and resting of bimonthly habitat use was expected since rabbits were always the main prey of mongoose throughout the year (Palomares & Delibes 1991).

Ash stands and lentiscus were the vegetation types most used by mongooses for foraging, while others with less rabbit density and understorey cover, such as pine forests and eucalyptus, were used both for foraging and travelling. In pine forests and eucalyptus, mongooses could look for alternative prey such as small mammals, reptiles, and insects (Palomares & Delibes 1991). Eating–foraging activities in autochthonous forest, matorral and rushes suggested that these vegetation types also provided food for mongooses; however, they were scarcely used (Table 1). Generally, matorral and rushes have little vegetation and cover, and mongooses might be exposed to predation when foraging there. So the low use by mongooses of these areas would be justified, especially if they could select other denser and more productive habitats. However, the autochthonous forest has a greater understorey and rabbit density, and therefore should have been more

used by mongooses. This vegetation type was the only one used by lynxes in the area (P. Ferreras, unpublished data), and the risk of predation explained the observed pattern (F. Palomares & M. Delibes, unpublished).

Our results indicated that ash stands and lentiscus provided both food and shelter, whereas matorral, rushes, and autochthonous forest might also be suitable for foraging. The latter could also provide safe shelter as rabbits warrens (one of the most often used resting sites; Palomares & Delibes 1993c) were abundant (personal observation). Hence, ash stands, lentiscus and autochthonous forest should be the vegetation types mainly considered when investigating potential distribution and abundance of mongooses based on GIS applications. Other areas with similar structural vegetational characteristics, as shown by Palomares & Delibes (1990), should also be considered. Nevertheless, caution should be shown when considering areas also used by potential predators (e.g. lynxes), where mongooses might reach lower densities than expected from habitat

quality, and an interactive model including inter-specific competition should be applied.

Because of the restricted and specialized habitat use of mongooses, investigations should be made to see whether population density can be managed by changing the proportions of the different vegetation types. Ecological habitat selection theory specifies conditions under which population densities indicate habitat quality (see, e.g. Rosenzweig 1981; Parker & Sutherland 1986), so that consequences of habitat change can be projected directly from use and availability data (e.g. see Fagen (1988) for *Odocoileus hemionus* Rafinesque). Nevertheless, the population dynamics and the social status of individuals have also to be carefully considered before developing habitat evaluation systems for a given species (Van Horne 1983; Hobbs & Hanley 1990).

Finally, the conservation of mongooses in Doñana National Park area can be threatened in the future due to their highly specialized use of places mainly associated with small streams and areas with a higher ground water table (e.g. ash stands and lentiscus in this study). Such places can disappear as a consequence of ground water extraction activities around the Park (Llamas 1988). Measurements directed to the maintenance of ground water level and, therefore, the conservation of damp places should be started to guarantee the conservation of mongooses and other species which live in or greatly use these places in Doñana National Park (see, e.g. Rogers & Myers 1980).

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References

- Allier, C., González Bernaldez, F. & Ramírez Díaz, L. (1974) *Mapa ecológico de la Reserva Biológica de Doñana*. CSIC, Estación Biológica de Doñana, Sevilla.
- Ben-Yaacov, R. & Yom-Tov, Y. (1983) On the biology of the Egyptian Mongoose, *Herpestes ichneumon*, in Israel. *Zeitschrift für Säugetierkunde*, **48**, 34–45.
- Delibes, M. (1982) Notas sobre la distribución pasada y actual del meloncillo *Herpestes ichneumon* (L.) en la Península Ibérica. *Doñana, Acta Vertebrata*, **9**, 341–352.
- Delibes, M. & Palomares, F. (in press) *Herpestes ichneumon*. Manguste. *Handbuch der Säugetiere Europas*. AULA Verlag GmbH, Wiesbaden, 5.
- Fagen, R. (1988) Population effects of habitat change: a quantitative assessment. *Journal of Wildlife Management*, **52**, 41–46.
- Haslett, J.R. (1990) Geographic Information Systems: a new approach to habitat definition and the study of distributions. *TREE*, **5**, 214–218.
- Hobbs, N.T. & Hanley, T.A. (1990) Habitat evaluation: do use/availability data reflect carrying capacity? *Journal of Wildlife Management*, **54**, 515–522.
- Koehler, G.M. (1990) Population and habitat characteristics of lynx and snowshoe hares in north central Washington. *Canadian Journal of Zoology*, **68**, 845–851.
- Kufeld, R.C., Bowden, D.C. & Siperek, Jr, J.M. (1987) Evaluation of a telemetry system for measuring habitat usage in mountainous terrain. *Northwest Science*, **61**, 249–256.
- Levins, R. (1968) *Evolution in Changing Environments*. Princeton, Princeton University Press, New Jersey.
- Llamas, M.R. (1988) Conflicts between wetland conservation and groundwater exploitation: two case histories in Spain. *Environment Geological Water Sciences*, **11**, 241–251.
- Macdonald, D.W., Ball, F.G. & Hough, N.G. (1980) The evaluation of home range size and configuration using radio tracking data. *A Handbook on Biotelemetry and Radio Tracking* (eds C.J. Amlaner & D.W. Macdonald), pp. 405–424. Pergamon Press, Oxford.
- Mech, L.D. (1983) *Handbook of Animal Radio-Tracking*. University of Minnesota Press, Minneapolis.
- Nams, V.O. (1989) Effects of radiotelemetry error on sample size and bias when testing for habitat selection. *Canadian Journal of Zoology*, **67**, 1631–1636.
- Neu, C.W., Byers, C.R. & Peck, J.M. (1974) A technique for analysis of utilization-availability data. *Journal of Wildlife Management*, **38**, 541–545.
- Palomares, F. (1990) *Ecología y organización social del meloncillo, Herpestes ichneumon* L., en el Parque Nacional de Doñana. PhD thesis, University of Granada, Granada.
- Palomares, F. & Delibes, M. (1990) Habitat preference of large grey mongoose, *Herpestes ichneumon*, in Spain. *Acta Theriologica*, **35**, 1–6.
- Palomares, F. & Delibes, M. (1991) Dieta del meloncillo, *Herpestes ichneumon*, en Coto del Rey, Norte del Parque Nacional de Doñana. *Doñana, Acta Vertebrata*, **18**, 187–194.
- Palomares, F. & Delibes, M. (1992a) Some physical and population characteristics of Egyptian mongooses *Herpestes ichneumon* (L. 1758) in south-western Spain. *Zeitschrift für Säugetierkunde*, **57**, 94–99.
- Palomares, F. & Delibes, M. (1992b) Circadian activity patterns of free-ranging large gray mongooses, *Herpestes ichneumon*, in south-western Spain. *Journal of Mammalogy*, **73**, 173–177.
- Palomares, F. & Delibes, M. (1992c) Data analysis design and potential bias in radio-tracking studies of animal habitat use. *Acta Oecologica*, **13**, 221–226.
- Palomares, F. & Delibes, M. (1993a) Determining types of activity and time budget from movement speed in radio-tracked mongooses. *Journal of Wildlife Management*, **57**, 164–167.
- Palomares, F. & Delibes, M. (1993b) Social organization of the Egyptian mongoose: group size, spatial behaviour, and interindividual contacts in adults. *Animal Behaviour*, **45**, 917–925.
- Palomares, F. & Delibes, M. (in press) Resting ecology and behaviour of Egyptian mongooses in south-western Spain. *Journal of Zoology, London*, **230**, 557–566.
- Parker, G.A. & Sutherland, W.J. (1986) Ideal free distribution when individuals differ in competitive ability: phenotype-limited ideal free models. *Animal Behaviour*, **34**, 1222–1242.
- Rogers, P.M. & Myers, K. (1980) Animal distribution,

- landscape classification and wildlife management, Coto Doñana, Spain. *Journal of Applied Ecology*, **17**, 545–565.
- Rosenzweig, M.L. (1981) A theory of habitat selection. *Ecology*, **62**, 327–335.
- Schoen, J.W. (1990) Bear habitat management: a review and future perspective. *International Conference on Bear Research and Management*, **8**, 143–154.
- Valverde, J.A. (1958) An ecological sketch of the Coto Doñana. *British Birds*, **51**, 1–23.
- Van Horne, B. (1983) Density as a misleading indicator of habitat quality. *Journal of Wildlife Management*, **47**, 893–901.
- White, G.C. & Garrott, R.A. (1986) Effects of biotelemetry triangulation error on detecting habitat selection. *Journal of Wildlife Management*, **50**, 509–513.
- Wozencraft, W.C. (1989) The phylogeny of the recent Carnivora. *Carnivore Behavior, Ecology, and Evolution* (ed. J.L. Gittleman), pp. 495–535. Chapman and Hall, London.

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