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Habitat use of feral cats in the main environments of an Atlantic Island (La Palma, Canary Islands)

Félix M. MEDINA[1,2]* and Manuel NOGALES[2]

[1] *Unidad de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos 20, 38700 Santa Cruz de La Palma, Canary Islands, Spain; e-mail: felix.medina@cablapalma.es*

[2] *Island Ecology and Evolution Research Group (IPNA, CSIC), Astrofísico Francisco Sánchez 3, 38206 La Laguna, Tenerife, Canary Islands, Spain; e-mail: mnogales@ipna.csic.es*

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A b s t r a c t. In this study we assess the habitat use of feral cats in the five main habitats represented on La Palma Island in the Canary Islands. We determined habitat use by the presence of faeces. Faeces persistence time was significantly different between habitats, being clearly lower in the laurel forest (the wettest) than in the other habitats. This humid environment promotes the high presence of invertebrate decomposers such as Isopoda and Diplopoda. Once the effect of differential persistence times for faeces among the different habitats was controlled for, data obtained indicated that feral cats showed no differences in the use of the five main habitats present on La Palma Island. Although cats selected closed habitats more frequently than open ones, because they prefer cover for hunting, no statistical differences were found in the island habitats studied.

Key words: *Felis silvestris catus*, spatial patterns, heterogeneous oceanic environments, Canary Islands

Introduction

Feral cats (*Felis silvestris catus* L. 1758) have been introduced onto a great variety of oceanic islands in the Antarctic (J o n e s 1977), Indian (P a r r et al. 2000), Pacific (K o n e c n y 1987) and Atlantic Oceans (N o g a l e s & M e d i n a 1996). Cats show a generalist and opportunist behaviour both in island and continental habitats, and for this reason they are found in various habitats, such as semiarid woodland (E d w a r d s et al. 2002), grassland (A l t e r i o et al. 1998), forest (F i t z g e r a l d & K a r l 1976), and farms, suburban and urban habitats (L i b e r g 1980, N a t o l i 1985, B a r r a t t 1997). Most studies on the spatial pattern of feral cats have been carried out in these anthropogenic habitats. Habitat use has been studied in natural habitats in island ecosystems (van A a r d e 1979, A p p s 1986, F i t z g e r a l d & K a r l 1986, K o n e c n y 1987, A l t e r i o et al. 1998, E d w a r d s et al. 2002, H a r p e r 2007). In most of these studies, radio-tracking and direct observation were used to assess habitat use and selection, though E d w a r d s et al. (2002) used tracks to estimate density of cats in specific habitats.

In the Canary Islands, feral cats are found in all the main habitats represented in this archipelago, although only diet has been studied thus far (N o g a l e s & M e d i n a 1996). C a s a ñ a s - A c o s t a et al. (1999) studied cat distribution in different areas of the same habitat of a small islet (Alegranza, north of Lanzarote) and found a clumped distribution of feral cats. No studies have been made of habitat use by cats on a large island of the Canarian Archipelago where the five main habitats are represented. The main aim of the present contribution was to study habitat use by feral cats in a heterogeneous oceanic island (La Palma) using the number of faeces found in each habitat.

* Corresponding author

Study Area

This study was carried out during 2001–2003 on La Palma Island, one of the western-most islands of the Canarian Archipelago (Fig. 1). It is an inhabited medium-sized island (728 km^2) with areas of high altitude (2426 m a.s.l., Roque de Los Muchachos). Altitude, orientation and the influence of the humid north-east trade winds determine its climate characteristics and its highly heterogeneous environments, characterized by different bioclimatic vegetation series (del Arco et al. 1999).

Climate, field characteristics and current distribution of the five main natural habitats in La Palma are shown in Fig. 1. The five main habitats of the island are briefly described as follows. The lower parts of the island are characterized by an open xerophytic shrubland (XS), most being *Euphorbia* spp. The next habitat in altitude is the thermophyle forest (TF), which has been drastically reduced by human activities and consists mainly of an open forest of *Juniperus turbinata*. The laurel forest (LF) is the most humid and dense habitat on the island, composed of more than 20 tree species, most of them belonging to the Lauraceae. The pine forest (PF) is an open-dry woodland dominated by one endemic pine species, *Pinus canariensis*. Finally, the high mountain shrubland (HM) presents dense shrubby vegetation dominated by leguminous plant species, although broad areas lack vegetation due to harsh environmental conditions and the existence of introduced herbivores. Details of vegetation, bioclimatic and phytosociological aspects of the different habitats on La Palma are reported by Santos (1983) and del Arco et al. (1999).

Material and Methods

We consider habitat use in terms of the demonstrated presence of a particular item (faeces group), following the criteria established by Morrison et al. (1998). The number of faeces present in each habitat was used as a measurement of the relative abundance of feral cats; this method provides a useful measure of the relative density of animals in different areas (Sutherland 1996) and, in general, does not represent great problems (Tellería 1986).

Feral cats have a broad home range size (Liberg & Sandell 1988) and could move between habitats without problems, concentrating their movements along tracks, nearby roads and paths (Liberg 1980, Alterio et al. 1998). Searching was performed by a single researcher, walking on paths and forestry roads in each habitat, consisting of transects of 1.5 km long and 2 m width. Although we could not control the movements of feral cats between habitats, the study was made avoiding ecotones and inhabited areas. All faeces groups were recorded, noted, and collected for subsequent analysis of diet (Medina et al. 2006). A total of 61 transects were walked, with a minimum of 10 transects per habitat (TF: 12; HM: 10; XS, PF, and LF: 13). Although the study was carried out over a long period of time, specific climatic characteristics of each habitat (Fig. 1) and some adverse conditions (e.g. snowfall in the HM during the winter) did not allow us the study of seasonal variation in habitat use. The data obtained has been pooled to test the response of feral cats to habitat (Alterio et al. 1998).

To avoid problems due to different decomposition rates of faeces in each habitat (Tellería 1986), an experiment to find out the persistence of faeces in the different habitats was performed. A total of 30 faeces groups were placed and marked in each habitat. These were followed throughout ten weeks (July–September, 2003), recording weekly the state of faeces. Faeces were obtained from 11 domestic cats which were fed with the same

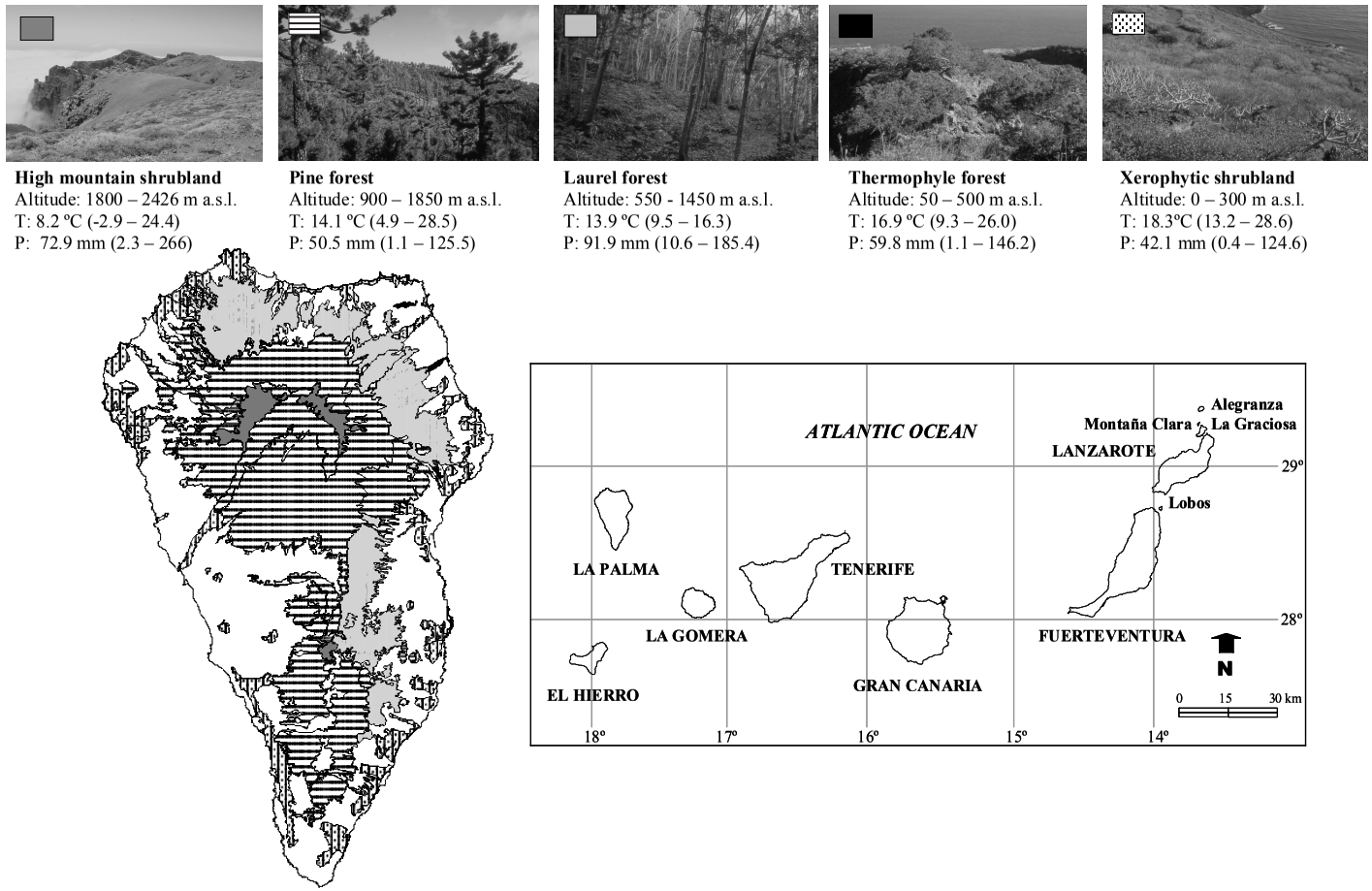

Fig. 1. The Canary Islands showing the location of La Palma Island and map of the Island with its main habitats and their respective: altitudes, temperature (T), and precipitation (P). Ranges of temperature and precipitation are given in brackets. Blank areas correspond to human settlements and cultivation.

type of food stuffs in order to homogenise faeces content and age, and avoid problems with different defecation rates and dropping contents. Disappearance causes such as the presence of decomposers or of falling leaves, were specifically noted.

To calculate differences in persistence of faeces between habitats, a Kaplan-Meier survival time analysis was used (K r e b s 1999) comparing the number of failures (faeces groups disappeared). We used values of faeces persistence as a correction factor for faeces groups counted in transects. We divided the number of faeces found in each habitat by their persistence time. Habitat use was compared by applying a Kruskal-Wallis test, using a correction factor of number of faeces found in the different habitats.

Results and Discussion

Faeces persistence time was significantly different between habitats (G = 127.78, df = 4, $P < 0.001$), being clearly lower in the LF (mean ± s.e., 0.93 ± 0.32) than in the other habitats (Fig. 2). Persistence time of faeces was also lower in the TF (8.63 ± 0.51) with respect to XS (10 ± 0.0), PF (9.70 ± 0.30) and HM (10 ± 0.0) (G = 19.51, df = 3, $P < 0.001$). The LF is the wettest habitat on La Palma, with an annual mean precipitation of about 2000 mm (M a r z o l - J a é n 1984). These humid environmental characteristics promote the highest presence of decomposers such as *Armadillium vulgare* (Isopoda), *Ommatoiulus moreletti* (Diplopoda) and *Polydesmus coriaceus* (Diplopoda) (R. G a r c í a , pers. comm.). Nevertheless decomposers were responsible for the complete disappearance of 83.3% of faeces sited in the LF, while in the TF only 16.6% of faeces disappeared as a result of decomposers action. In the other habitats, these biological agents had no effect on disintegration of faeces.

Number of faeces collected per sample unit varied significantly between habitats (Kruskal-Wallis test: $\chi^2 = 18.91$, df = 4, $P = 0.001$), with fewer being found in the LF (Fig. 3A). Nevertheless, once the effect of differential persistence times of faeces was accounted

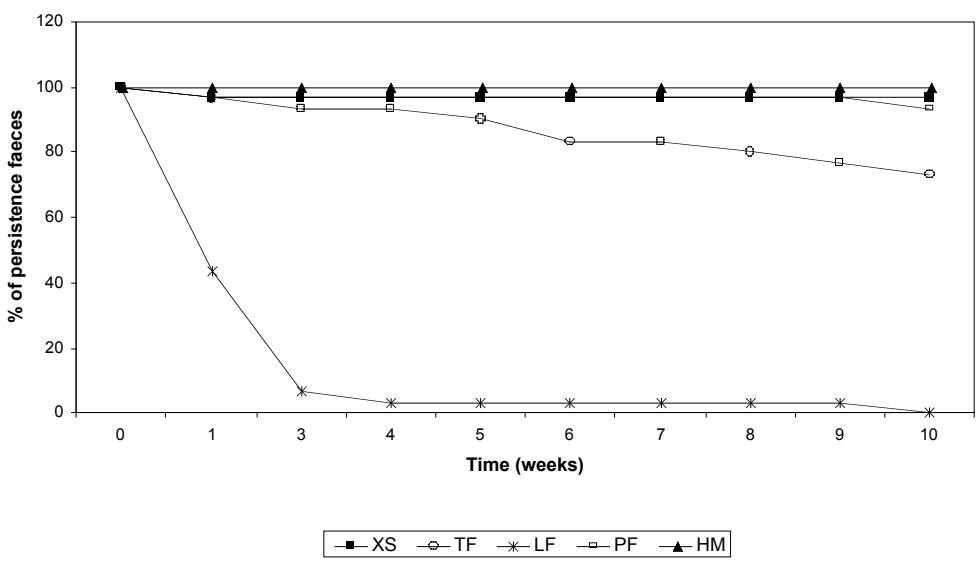

Fig. 2. Persistence of feral cat faeces in the main habitats of La Palma Island: xerophytic shrubland (XS), thermophyle forest (TF), laurel forest (LF), pine forest (PF) and high mountain shrubland (HM).

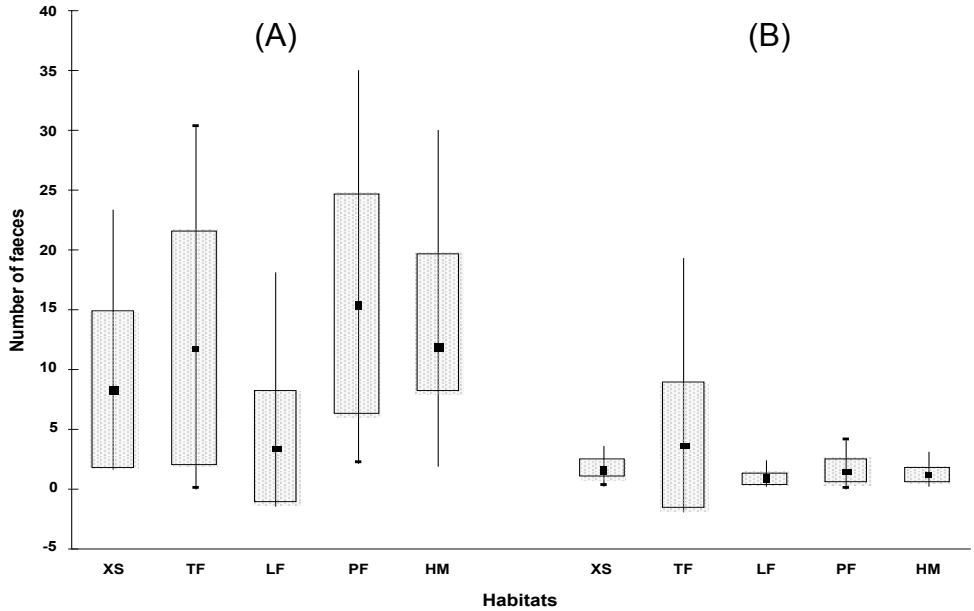

Fig. 3. (A) Mean, standard deviation and range of feral cat faeces found in transects in the main habitats of La Palma Island; (B) values of habitat use (mean, standard deviation and range of number of feral cat faeces) after applying the correction factor. Xerophytic shrubland (XS), thermophyle forest (TF), laurel forest (LF), pine forest (PF) and high mountain shrubland (HM).

for, feral cats showed no differences in their use of the five main habitats (Kruskal-Wallis test: $\chi^2 = 5.42$, df = 4, $P = 0.246$) (Fig. 3B). Although cats select closed habitats more frequently than open ones, preferring covered for hunting (Edwards et al. 2002), when we compared the use of the two open habitats (TF and PF) to those with the most vegetation cover (XS, LF and HM), no statistical differences were found (Mann-Whitney test: U = 395.50, $P = 0.424$).

Feral cats are a top predator introduced into the Canary Islands (Nogales & Medina 1996). A lack of competitors and the availability of vacant ecological niches have favoured the establishment and successful colonisation of non-native mammal species on oceanic islands (van Aarde & Skinner 1981). The low number of faeces collected in the LF could be related to its wet and cold climate, influencing habitat selection by feral cats (Harper 2007). Nevertheless, the action of decomposers on faeces persistence is an important factor to consider.

On the other hand, density and spatial patterns of feral cats are affected by distribution and abundance of their prey species (Liberg 1980). Populations of exotic mammal species, such us rabbits (*Oryctolagus cuniculus*), rats (*Rattus* spp.) and mice (*Mus domesticus*), are differentially well distributed, and preyed on by feral cats, in all of the main habitats of La Palma Island (Medina et al. 2006). Although prey type varies considerably between the different habitats on the Island, their abundance is relatively high in all of them: rabbits in all habitats except in the LF (Cabrera-Rodríguez 1997), rats in the LF (Nogales et al. 2006), and mice in the HM (Medina et al. 2006). In this respect, absolute food abundance is one of the most important characteristic that determines the density of feral cats in a particular habitat (Liberg & Sandell 1988).

Predator-prey interactions based on different introduced species (C o u r c h a m p et al. 2000) make possible viable populations of feral cats in all habitats of the Canary Islands.

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L I T E R A T U R E

Apps P.J. 1986: Home ranges of feral cats on Dassen Island. *J. Mamm. 67: 199–200.*

Alterio N., Moller H. & Ratz H. 1998: Movements and habitat use of feral house cats *Felis catus*, stoats *Mustela erminea* and ferrets *Mustela furo*, in grassland surrounding yellow-eyed penguin *Megadyptes antipodes* breeding areas in spring. *Biol. Conserv. 83: 187–194.*

Barratt D.G. 1997: Home range size, habitat utilisation and movement patterns of suburban and farm cats *Felis catus*. *Ecography 20: 271–280.*

Cabrera-Rodríguez F. 1997: Variaciones en la abundancia del conejo (*Oryctolagus cuniculus* Linneo, 1758) en La Palma, islas Canarias (Lagomorpha, Leporidae). *Vieraea 26: 133–137.*

Casañas-Acosta N., Yebra-Mora L. & Medina F.M. 1999: Distribución y variación temporal de la dieta del gato cimarrón (*Felis catus* Linnaeus, 1758) en Alegranza, islas Canarias (Mammalia, Carnivora). *Vieraea 27: 165–172.*

Courchamp F., Langlais M. & Sugihara G. 2000: Rabbits killing birds: modelling the hyperpredation process. *J. Anim. Ecol. 69: 154–164.*

del Arco M., Acebes J.R., Pérez De Paz P.L. & Marrero M.C. 1999: Bioclimatology and climatophilus vegetation of Hierro (part 2) and La Palma (Canary Islands). *Phytocoenologia 29: 253–290.*

Edwards G.P., De Preu N., Crealy I.V. & Shakeshaft B.J. 2002: Habitat selection by feral cats and dingoes in a semi-arid woodland environment in central Australia. *Austral Ecol. 27: 26–31.*

Fitzgerald B.M. & Karl B.J. 1979: Food of feral house cats (*Felis catus* L.) in forest of the Orongorongo Valley, Wellington, New Zealand. *J. Zool., Lond. 6: 107–126.*

Fitzgerald B.M. & Karl B.J. 1986. Home range of feral house cats (*Felis catus* L.) in forest of the Orongorongo Valley, Wellington, New Zealand. *New Zeal. J. Ecol. 9: 71–81.*

Harper G. A. 2007. Habitat selection of feral cats (*Felis catus*) on a temperate forested island. *Austral Ecol. 32: 305–314.*

Jones E. 1977: Ecology of the feral cat, *Felis catus* (L.), (Carnivora: Felidae) on Macquarie Island. *Aust. Wildl. Res. 4: 249–262.*

Konecny M. J. 1987: Home range and activity patterns of feral house cats in the Galápagos Islands. *Oikos 50: 17–23.*

Konecny M. J. 1987: Food habits and energetics of feral house cats in the Galapagos Islands. *Oikos 50: 24–32.*

Krebs C.J. 1999: Ecological methodology. *Addison Westley Longman, Inc. Menlo Park, California.*

Liberg O. 1980: Spacing patterns in a population of rural free roaming domestic cat. *Oikos 35: 336–349.*

Liberg O. & Sandell M. 1988: Spatial organisation and reproductive tactics in the domestic cat and other felids. In: Turner D.C. & Bateson P. (eds), The domestic cat: the biology of its behaviour. *Cambridge University Press, Cambridge: 83–98.*

Marzol-Jaén V. 1984: El clima de Canarias. In: Afonso L. (ed.), Geografía de Canarias I. *Editorial Interinsular Canaria, Santa Cruz de Tenerife: 157–202.*

Medina F.M., García R. & Nogales M. 2006: Feeding ecology of feral cats on a heterogeneous subtropical oceanic island (La Palma, Canarian Archipelago). *Acta Theriol. 51: 75–83.*

Morrison M.L., Marcot B.G. & Mannan R.W. 1998: Wildlife-habitat relationships: concepts and applications, 2nd edition. *The University of Wisconsin Press, Madison, Wisconsin.*

Natoli E. 1985: Spacing pattern in a colony of urban stray cats (*Felis catus* L.) in the historic centre of Rome. *Appl. Anim. Behav. Sci. 14: 289–304*.

Nogales M. & Medina F.M. 1996: A review of the diet of feral domestic cats *(Felis silvestris* f. *catus*) on the Canary Islands, with new data from the laurel forest of La Gomera. *Z. Säugetierkd. 61: 1–6*.

Nogales M., Rodríguez-Luengo J. L. & Marrero P. 2006: Ecological effects and distribution of invasive non-native mammals on the Canary Islands. *Mammal Rev. 36: 49–65*.

Parr S.J., Hill M.J., Nevill J., Merton D.V. & Shah J. 2000: Alien species case study: eradication of introduced mammals in Seychelles in 2000. *World Conservation Union, Gland*.

Santos A. 1983: Flora y vegetación de La Palma. *Editorial Interinsular Canaria, Santa Cruz de Tenerife*.

Sutherland W.J. 1996: Ecological census techniques: a handbook. *Cambridge University Press, Cambridge*.

Tellería J.L. 1986: Manual para el censo de los vertebrados terrestres. *Editorial Raíces, Madrid*.

van Aarde R.J. 1979: Distribution and density of the feral house cat *Felis catus* on Marion Island. *S. Afr. T. Antarkt. Nav. 9: 14–19*.

van Aarde R.J. & Skinner J.D. 1981: The feral cat population at Marion Island: characteristics, colonization and control. *C.N.F.R.A. 51: 281–288*.