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Pine marten (*Martes martes* L.) home ranges and activity patterns on the island of Minorca, Spain

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Abstract

The home range and activity patterns of European pine marten (*Martes martes* L.) on the island of Minorca (Spain) were studied between October 1990 and March 1991. Female home ranges ($n = 3$) were non-overlapping and averaged 47.3 ha (range = 31.5–66 ha); two male home ranges were partially exclusive, measuring 492 ha and 919 ha. Male home ranges averaged 16 times greater than females. Pine marten were primarily nocturnal, being active 53 % and 59 % of the nighttime hours during Autumn/Winter and Spring, respectively; daytime activity levels were 19 % and 14 % during each season, respectively. Diel activity for all martens averaged 34 %. Although the data are limited, they have shown that the Minorcan pine marten may have a relationship between home range size, activity, and site conditions which merits further study.

Introduction

Members of the genus *Martes* are generally considered intrasexually territorial with overlapping home ranges between sexes (HAWLEY and NEWBY 1957; POWELL 1979; BUSKIRK and MACDONALD 1989). The degree of territoriality may be affected by such factors as food availability, habitat, and sexual activity and can break down under certain conditions (LOCKIE 1966). It has been suggested that *Martes* spacing patterns may be flexible, and the degree of territoriality varies with prey population density (POWELL 1991).

The size of foods and their availability have been shown to affect North American pine martens (*M. americana*) daily activity patterns (STRICKLAND et al. 1982). For the same species, ZIELINSKI et al. (1983) found that activity was synchronized with the activity of their prey. At present, few studies of the European pine martens (*M. martes*) home range have been conducted (STORCH 1988; MARCHESI 1989; KRUGER 1990; BALHARRY 1991) and data on activity patterns are even more limited (MARCHESI 1989). In this study, I present home range and activity pattern data from an insular, terrestrial competitor-free population of pine marten in the southern extreme of the species range.

Material and methods

The island of Minorca is part of the Balearic Island group located in the western Mediterranean approximately 250 km from the Iberian Peninsula. It measures 69 000 ha and is approximately 45 km long and 15 km wide. The study took place in a 29 km² area along the islands north coast. The climate is humid mediterranean with moderate temperatures. The island vegetation is also mediterranean, consisting of Aleppo pine (*Pinus halepensis*) and holm oak (*Quercus ilex*) forests, coastal shrublands and pastureland. Typical shrub species include wild olive (*Olea europaea*), lentisc (*Pistacia lentiscus*) and tree heather (*Erica arborea*). Much of the island consists of subdivided grazing pastures used by dairy cows.

Fieldwork was conducted from October 1990 to March 1991. A total of five pine martens were captured in padded Victor 1½ "Soft-catch" leg-hold traps (Woodstream Corporation, Lititz, Penn-

sylvania, U.S.A.) baited with partial or whole chickens. Pine martens were physically immobilized with the assistance of another person and using heavily padded gloves. Ages of captured pine martens were not determined. All captured individuals were equipped with 150–152 Mhz motion-sensored radiotransmitter collars (Type P2B, AVM Instrument Co., Livermore, California, U.S.A.; A. Urmeneta, Argüedas, Navarra, Spain) and monitored with Telonics TR-2 receivers and 2-element Yagi antennas (Telonics Inc., Mesa, Arizona, U.S.A.).

Martens were located by triangulation on the direction of the radio signal from points on the ground. The observation-area curve (ODUM and KUENZLER 1955) was plotted for all pine marten home ranges to determine at what point they reached an asymptote (less than 10 % increase/10 radiolocations). Home ranges were estimated using the minimum convex polygon method (MOHR 1947) with the McPAAL PC program (M. STÜWE, Smithsonian Institution, Front Royal, Virginia, U.S.A.). Radiolocation data were divided into two seasons: Autumn/Winter = 25 October–15 February, and Spring = 16 February–1 April.

Pine marten activity was monitored by recording changes in signal modes and signal variations due to the movements of the animals (ZIELINSKI et al. 1983). Data was obtained sporadically while carrying out other field activities and by nine continuous monitoring sessions of 6–24 hour periods during which readings were taken every 15–30 minutes. Due to data limitations, daily activity was pooled into two periods for the two seasons indicated above. Time periods were determined by calculating the average hour of sunrise and sunset for each period and were as follows, Autumn/Winter: Day = 0720–1805 h, Night = 1806–0719 h; Spring: Day = 0650–1915 h, Night = 1916–0649 h. Activity was defined as the percentage of observations that indicated movement and statistical differences were assessed using Wilcoxon signed rank tests (SOKAL and ROLF 1981).

Results

During the five months of fieldwork reported here, data were collected from five pine martens (2 males, 3 females) for a total of 255 marten/days. Individual pine martens were monitored for an average of 51 days (range = 5–152, SD = 59 days); during Autumn/Winter and Spring the radiomarked martens consisted of 1 male and 2 females. One of the females (F2) was radiotracked both seasons.

The home range area asymptote was obtained by female pine marten F2 during both Autumn/Winter and Spring (Fig. 1). The home ranges of males M3 and M4 appeared to be reaching asymptote as they did not increase more than 10 % in the final eight and nine radiolocations, respectively. Female pine martens F1 and F5 did not reach maximum home range size during the study period; however, because the former was nearing asymptote it was included in the calculations. I opted to not include F5 in the calculations as only five radiolocations were obtained but her home range was plotted as its spatial relation to the other female martens was noteworthy.

A total of 92 radiolocations were used in estimating all pine marten home ranges; 49 during Autumn/Winter and 43 in Spring. The average time between successive radiolocations was 2.3 ± 0.4 (\pm SE) days. There was great discrepancy between male and female home ranges. The Autumn/Winter home ranges of two females measured 31.5 and 66.5 ha ($n = 20$ and 12 radiolocations, respectively) while the one male used 492 ha ($n = 17$

Average percentage of time pine martens were active during daytime, nighttime, and total periods by season in Minorca, Spain

Total number of activity readings are given in parentheses

	Day Male/Female/Total	Night Male/Female/Total	Total Male/Female/Total
Autumn/Winter	25.0/17.4/18.9 (104)(270)(374)	41.5/58.8/53.1 (53)(107)(160)	29.2/29.1/29.2 (157)(378)(534)
Spring	13.3/14.8/14.1 (127)(128)(255)	53.0/64.1/59.0 (90)(117)(207)	29.9/38.3/34.4 (217)(245)(462)

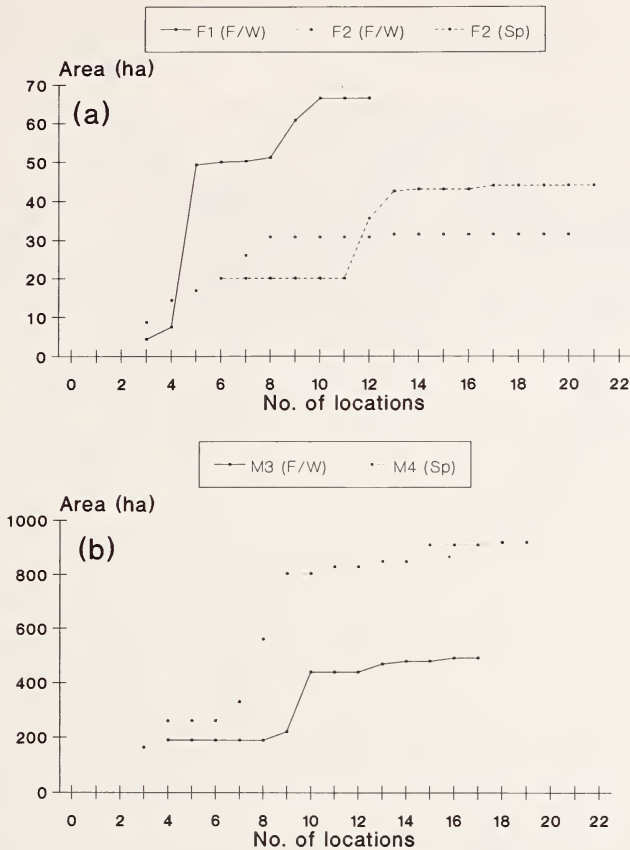


Fig. 1. Asymptote home range sizes of female (a) and male (b) pine martens radiotracked on the island of Minorca, Spain, 1990–1991

locations) (Fig. 2). Likewise during Spring, one female had a home range of 44 ha ($n = 21$ locations) and that of a male measured 919.5 ha ($n = 19$ locations). For the 5-month period, female home range estimates averaged 47.3 ha (range = 31.5–66.5 ha, $n = 3$) and males 705.7 ha (range = 492–919.5 ha, $n = 2$). Female home ranges did not overlap, and the two male ranges did so only slightly. Male home ranges averaged 16 times greater than females (range = 7–29 times) and each included the range of at least one of the radiomarked females.

A total of 996 readings were used in the analysis of activity patterns. There was no significant difference in seasonal activity patterns ($P > 0.10$) as all pine martens were primarily nocturnal during both seasons. During Autumn/Winter they were 19 % daytime active vs. 53 % nighttime, and in Spring 14 % daytime active vs. 59 % nighttime (Table). Pine martens were active 29 % of the time during Autumn/Winter; the one male was slightly more diurnal than the two females (25 % vs. 17 %). Females showed more activity during the nighttime hours (58 % vs. 41 %). During Spring, activity did not differ significantly from the previous season ($P > 0.10$). Total pine marten activity averaged 34 %, both females being more active than the male (38 % vs. 30 %). There was no difference between daytime activity levels of the pine martens; however nocturnal activity was greater for the two females than for the male (64 % vs. 53 %).

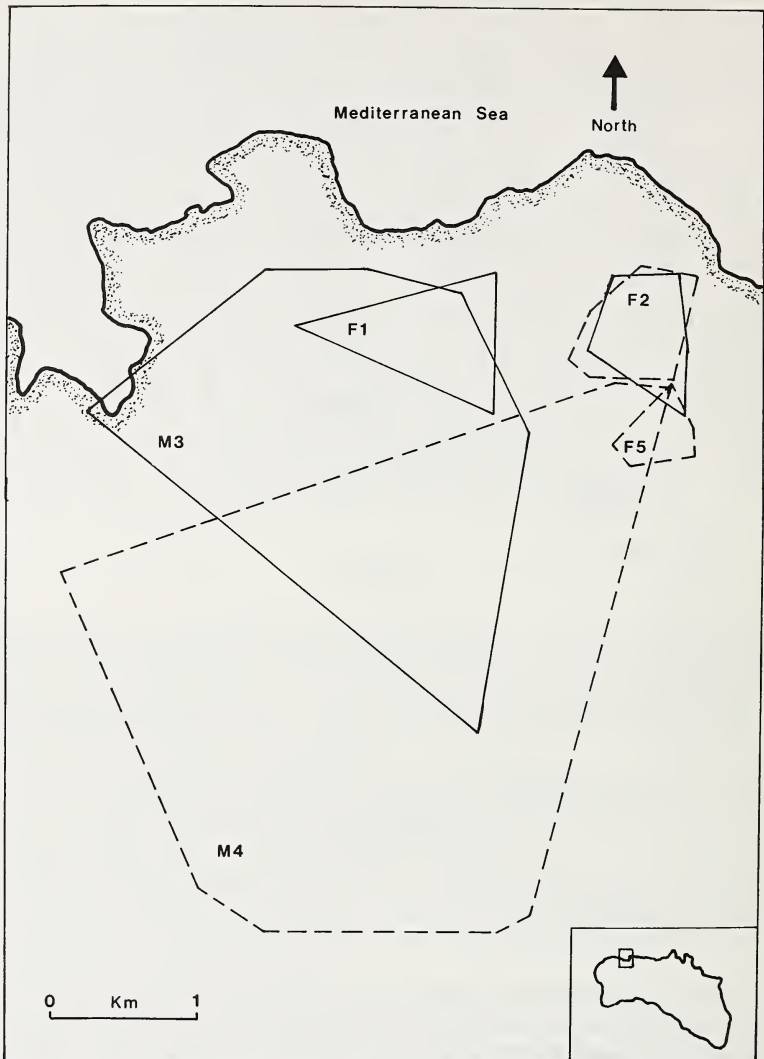


Fig. 2. Home ranges of three female (F) and two male (M) pine martens on the island of Minorca, Spain, 1990–1991. Solid line = Autumn/Winter and broken line = Spring

Discussion

The radiomonitored pine martens in Minorca appeared to be intrasexually territorial, with overlap of home ranges between sexes as reported in other European studies (STORCH 1988; MARCHESI 1989; KRUGER 1990; BALHARRY 1991). The two male home ranges were shown to overlap slightly; however most of the shared area is open pastureland, and it is unlikely that it is regularly used. All but one of M3's radiolocations were located on the mountainous north side of the study area while M4 concentrated his activities on the south side of La Vall. Since both male martens were monitored during separate periods, their true spatial relationship may not be accurately shown here.

Female pine martens home ranges did not overlap and occupied a relatively small size. The home range of F5 is probably underestimated, as only five radiolocations were used in the calculation.

The male and female pine marten home range estimates in Minorca were much smaller than those reported for the species throughout the rest of Europe. However, the results presented come from a small sample size, a limited amount of data, and caution must be taken in interpreting them. In Germany, KRUGER (1990) reported two female pine martens with home ranges of 760 and 960 ha, while a male covered 1500 ha. In two different areas in Scotland, male pine marten home ranges varied from 400–600 ha ($n = 5$) to 2000–3000 ha ($n = 6$) (BALHARRY 1991). Other studies have described female ranges as being 200–1000 ha, and male ranges as 900–2000 ha (STORCH 1988; MARCHESI 1989). Because home range data from island mammal populations are scarce, more will be needed for comparing with mainland data to determine whether this may be a general phenomenon.

The use of space has been proposed as being a good indicator of habitat quality (LINDSTEDT et al. 1986; BUSKIRK and MACDONALD 1989; ZIELINSKI 1991). Highly productive and dense populations of pine martens, should be found in high quality habitats and should therefore have small home ranges. In Minorca, pine martens have no competitors for the seasonally abundant foods which constitute their diet (CLEVINGER 1992), which may explain the small home ranges reported in this study.

The most surprising result was the reduced female home ranges in comparison with male home ranges on the island. A male pine marten in Germany used an area 1.5 and 1.9 times greater than did two females respectively (KRUGER 1990). In seven North American pine marten home range studies, male home ranges averaged 2.4 times (range = 1.1–3.4 times) greater than those of females (HAWLEY and NEWBY 1957; FRANCIS and STEPHENSON 1972; CLARK and CAMPBELL 1977; WYNNE and SHERBURNE 1984; LINDSTEDT et al. 1986; BAKER 1991; LATOUR et al. 1991). In Minorca, male home range estimates were not substantially smaller than those of other *Martes* populations cited above. Because female home ranges are dependent on food abundance and distribution, these data suggest that the island prey populations may be less dispersed than in areas occupied by other marten populations, and that the Minorcan pine marten lives in a high quality habitat. Male home range size therefore does not appear to be influenced by food abundance and distribution but may likely be determined by the maximum number of females a male marten can include within its home range.

European pine martens have been described as being normally nocturnal or crepuscular (LABRID 1986), but quantitative data are lacking. For pine martens, factors such as temperature, amount of human activity, size and abundance of prey items are believed to affect activity behaviour. Unlike in other parts of its' range, temperature is not a stress factor in the Balearic Islands. Human activity is extremely low in the study area. Therefore, the types of food that marten may be consuming and the foraging strategies used to obtain them, may be important factors regulating activity in Minorca.

Principal foods in Autumn/Winter are fleshy fruits, insects and small mammals, whereas during spring small mammals and birds are favored (CLEVINGER 1992). It also has been suggested that, where these foods are abundant and not widely distributed, martens should have low activity levels (THOMPSON 1987; ZIELINSKI 1991; see also HUTTO 1990). If this is true, it does not entirely agree with home range habitat quality relationship mentioned earlier, since the nighttime activity levels reported herein appear to be high compared with those of *M. americana* (ZIELINSKI 1983). The high nighttime activity might be explained by the Minorcan martens focusing on nocturnal prey (small mammals), being relatively inefficient predators, or their having higher than normal energy requirements due to this race's exceptionally large size (ALCOVER et al. 1986).

Evidently more study is needed on the foraging behaviour and activity patterns of Minorcan pine marten with respect to their prey in order to help clarify some of the

hypotheses regarding pine marten utilization of space and time as an indicator of habitat quality. Given that in Minorca pine martens have no terrestrial competitors, and temperature and human activity can be discounted as significant factors increasing their metabolic demands, this island situation may serve as an opportune area in which to delve further into these questions.

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Zusammenfassung

Streifgebiete und Aktivitätsmuster der Baummarder (Martes martes L.) auf der Insel Minorca, Spanien

Auf der Insel Minorca, Balearen, wurden von Oktober 1990 bis März 1991 die Streifgebiete und die Aktivität von fünf mit Radiosendern markierten Baummardern (3 ♀, 2 ♂) untersucht. Die Streifgebiete der Weibchen waren 47,3 ha (31,5–66 ha) groß und überschnitten sich nicht; die zweier Männchen waren 492 ha und 919 ha groß und überschnitten sich zum Teil. Die Gebiete der Männchen waren im Mittel 16mal größer als die der Weibchen. Die Baummarder waren im Untersuchungszeitraum überwiegend nachtaktiv; in den Perioden Herbst/Winter und Frühjahr waren sie 53 % bzw. 59 % der Nachtstunden und 19 % bzw. 14 % der Tagstunden aktiv. Die tägliche Gesamtaktivität betrug 34 %. Die vorliegenden Beobachtungen weisen einige interessante Aspekte auf, die ein vertieftes Studium der Marder Minorcas wünschenswert erscheinen lassen.

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