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HABITAT SELECTION BY WILD BOAR *Sus scrofa* L. IN ALENTEJO, PORTUGAL

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ABSTRACT

This study was conducted in agricultural fields that are interspersed with woods. Two wild boars, an adult female and a juvenile male, were fitted with collars radio-transmitters with sensors that record activity. The female was radio-tracked for about 2 years and the male was tracked for 4 months in spring and summer. Survey routes of about 1km/100 ha were travelled once a month in one year to record signs of feeding activity, with the objective of analysing habitat use by the population. The home ranges of the radio-tagged animals confirmed that the wild boar is a sedentary species. We did detect changes throughout the year in the size and shape of home ranges, which clearly showed a seasonal pattern of space use. The wild boar population did not use the habitat randomly; rather it exhibitedg strong selectivity among the available biotopes, and a seasonal variation in habitat selectivity was observed. The wild boars behaved according to the *food exploitation hypothesis*, whereby the wild boars fed mainly on acorns in autumn and winter and in spring and summer strongly preferred agricultural fields. Our results appear to contradict those found in another Portuguese environment, which reflects the behavioural flexibility of the wild boar.

Key words: Alentejo, habitat use, Portugal, *Sus scrofa*, wild boar.

INTRODUCTION

The first telemetry studies of space use by wild boar *Sus scrofa* Linnaeus were very much focused on the characterization of daily and seasonal home ranges (Janeau and Spitz 1984). Those studies showed that the activities of adult animals are generally restricted to well-defined areas of a few thousands hectares or less. Later, the identification of the factors affecting the home range became a subject of research. It was shown that age, sex, food availability, and hunting disturbance are factors that strongly influence a wild boar’s home range (Spitz and Janeau 1990, Jullien et al. 1991, Boitani et al. 1994, Maillard and Fournier 1994, Massei et al. 1997, Brandt et al. 1998). Meriggi and Sacchi (2001) analysed habitat selection by wild boar at three different levels: macro-habitat, medium habitat, and micro-habitat. Their results were consistent, taking into account the different levels of analysis, and showed seasonal differences in habitat selection with feeding and antipredatory functions.

In this paper, we analyse the selectivity of radio-tagged animals occupying farmland interspersed with woods. The availability of each cover type is compared with its degree of use, either as a diurnal refuge biotope or as a food biotope. The individual space use strategies are then compared to population spatial ecology strategies, evaluated by the analysis of feeding activity. In that way, we cross auto and sinecology to get a broader view of the ecoethology of the species.

MATERIAL AND METHODS

Study Area

The study was conducted in Alentejo, Portugal. Biogeographically, the study area belongs to the Mediterranean Iberoatlantic Province and is situated in the Mariánico-Monchiquense Sector of the Luso-Extremadurenian Subprovince (Rivas-Martínez and Loidi 1999). The study area (38º 22' - 38º 35 N; 7º 35' - 7º 43' W) rises about 200-300 m asl, the average annual rainfall is between 400 and 500 mm, of which only about 4% occurs in summer, the average low temperature in the winter is about 4.7º C and the average maximum temperature in summer is about 35º C. Nevertheless, drinking water is abundant throughout the year, and is provided by a dam, two rivers, and several well spread streams.

It is a strongly humanised landscape dominated by fairly intensive agricultural systems. In the flat lands, the main crops are oats *Avena spp*. and wheat *Triticum spp.* in autumn and winter, and sunflower *Helianthus spp*. and maize *Zea mays* Linnaeus in spring and summer. In undulating zones, where a *montado* landscape prevails, some cereals and pastures are grown under the scattered trees, mainly holm-oak *Quercus rotundifolia* Lamarch and cork-oak *Quercus suber* Linnaeus. Sheep are present in large numbers and grazing strongly reduces acorn availability in winter. In the more rugged hilly grounds, small relict woods of the former natural forest are present. The availability of each cover type corresponds to its expected use and is presented in Tables 1, 2 and in the Appendix.

The total number of animals shot per shooting area (actually, game driven area) is about 0.1 per ha, which is considerably higher than the median for the entire Alentejo region (0.06 per ha). The wild boar hunting season is from November to February and the shooting method is described by Fernández-Llario et al. (2003).

Trapping and radio-tracking

Two hexagonal cages similar to the one described by Vassant and Brandt (1995) and one throw down net, depicted by Jullien et al. (1987), were used to catch wild boars. To immobilise the animals while attaching the radio collars, we used Zoletil. The intramuscular injection of Zoletil was done with a dart and a blowpipe, following the procedures developed by Fournier et al. (1995).

The animals were fitted with collars carrying the radio transmitters, which were equipped with activity sensors. For night tracking, hand-raised masts mounted on four-wheel drive vehicles were used to carry the antennas.

Radiolocations were obtained by taking bearings from sites previously tested, in order to ensure the necessary accuracy. At least two cross bearings were taken to triangulate the animal's position. We have considered only the angles, between two bearings, either greater than 55º or less than 125º. To locate a moving animal, the bearings were taken simultaneously.

Home ranges were calculated as the minimum convex polygon (MCP), which is the area included within a line linking outermost radiolocations during a certain period of time. Daily, seasonal and total period of study home ranges were calculated.

Resting, moving and feeding activities were determined by interpreting the radio signals. Regular audio and visual contact with the radio-tagged animals confirmed the reliability of the radio-tracking data.

A first approach in habitat use analysis used the following index (Duncan 1983):

$$P2i = \log (Ui/Ai + 1)$$

where Ui is the percentage of localizations in the biotope i for a given tracked wild boar, among the total localizations in the surveyed period for the individual, and Ai is the percentage of area covered by that biotope within the total area used by the individual in the study period.

A second approach to evaluate habitat preference followed the procedures described by Neu et al. (1974) and Byers et al. (1984). That method combines a chi-square test - H_0 : Ui and Ai are equally distributed - with the Bonferroni confidence intervals on the observed use (Ui). The selectivity of each biotope (positive, neutral or negative) was determined by constructing confidence intervals for the proportion of use in each cover type (biotope) using the following formula:

$$pi - \frac{Z\alpha}{2k\sqrt{pi\,(1 - pi)/n}} < pi < pi + \frac{Z\alpha}{2k\sqrt{pi\,(1 - pi)/n}}$$

where *pi* is the proportion of locations in biotope *i*, $Z\alpha/2k$ is the upper standard normal variate corresponding to the probability tail of $\alpha/2k$, and k is the number of comparisons (or cover types examined).

Analysis of feeding activity

A transect of approximately 35 km, which covered about 1 km for each 100 ha, was travelled once a month in one year. An observer driving a vehicle at about 20 km/h surveyed the signs of feeding activity on either side of the transect line within sight range. Data treatment was the same as used for the tagged wild boars, except that *Ui* is the proportion of feeding signs detected on biotope *i*.

RESULTS

Radio-tracking

Two of seven captured wild boars were fitted with radio transmitters: (1) an adult female, leading a group that had as many as 16 individuals - 4 females and 12 piglets -, hereafter referred as F01; (2) a male about ten months old, at the time, presumably alone, hereafter referred as M01. The female was radio-tracked from April 1995 to April 1997 and the male was tracked from May to August 1996. F01 was radio located on 312 different days on its diurnal resting beds and tracked, once a month, from December 1995 to November 1996, during 12 periods of 24 h. M01 was radio-located on 42 days at its diurnal resting places and tracked, once a month from May to July, during three periods of 24 h.

F01's home range size exceeded 3,500 ha, while the home range size of M01 was about 750 ha.

The data for F01 were grouped into seasonal subsets, with eight surveying periods: spring 1995; summer 1995; autumn 1995; winter 1995/1996; spring 1996; summer 1996, autumn1996 and winter 1996/1997. According to Harris et al. (1990), M01 data was too limited to permit seasonal data subsets, so all of the radio-locations were pooled.

Pronounced seasonal changes in home range size were apparent based on diurnal radiolocations, also being clearly evident changes throughout the year in daily home range sizes, which correspond to nocturnal activity (Figure 1). In each season, the daily home range is an average area based on the three 24-h radio-tracking sessions conducted. With respect to seasonal home range size, the data shows a cyclic pattern of annual periodicity characterized by a strong peak in autumn and a minimum in spring. The smallest daily home ranges also occurred in spring, whereas \in suumer the home range is three times larger.

The seasonal change in habitat use by F01, either as diurnal refuge biotopes - day resting places - or as food biotope - data collected during night feeding activity -, is presented in Figures 2 and 3. The values of χ^2 in all seasons, both for diurnal use of refuge biotope and food biotope, allow us to reject the null hypothesis (d.f. = 9, P < 0.01). F01 clearly did not use the different cover types in the study area in proportion to their availability. Thus, we can conclude that this adult female showed cover "preferences". The comparison of expected versus observed use is presented in the Appendix.

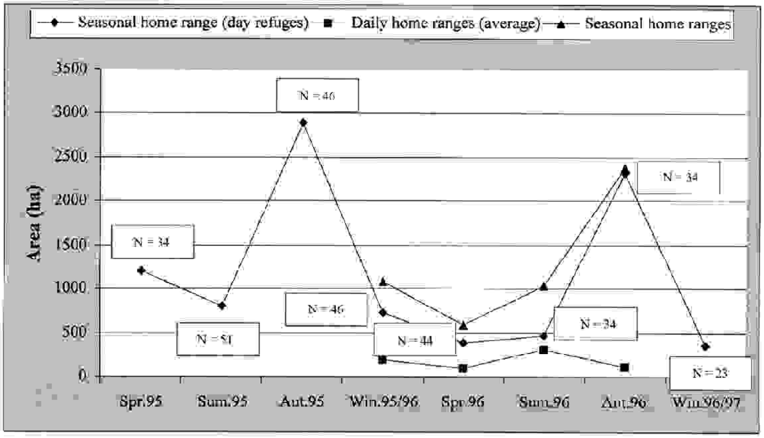

Figure 1. Seasonal home range (MCP) evolution considering day refuge locations (N is indicated on the graph for each season) and considering day and night locations all together in winter 95/96 (N = 85), in spring 96 (N =111), in summer (N = 111) and in autumn 96 (N = 75). An average of three daily home range considering night locations is presented for winter 95/96 (N = 39), spring 96 (N = 67), summer 96 (N = 77) and autumn 96 (N = 41).

The female exhibited consistant strong positive selectivity for Trees & Shrubs as the diurnal refuge biotope (Figure 2, Appendix). In spring and summer, Bank Streams were also frequently used for diurnal resting places. Trees and Cereals were positively selected as diurnal refuge biotopes in winter and spring, or at least used relative to their availability.

Concerning food biotopes selectivity stands out the neutrality showed by F01 during winter for Trees & Shrubs, for Trees & Pasture, and for Trees & Cereal (Figure 3, Appendix). The two last cover types were still used by F01in spring in proportion to their availability, season in which this adult female positively selected Bank Streams. In summer, F01 made use of a broader set of food resources, such as Trees & Pasture, Trees & Cereal, Irrigated Fields, Bank Streams, and Not Cultivated. During autumn, the female wild boar kept diversified nourishment, adding Olive to the cover types used in summer, except for Trees & Cereal.

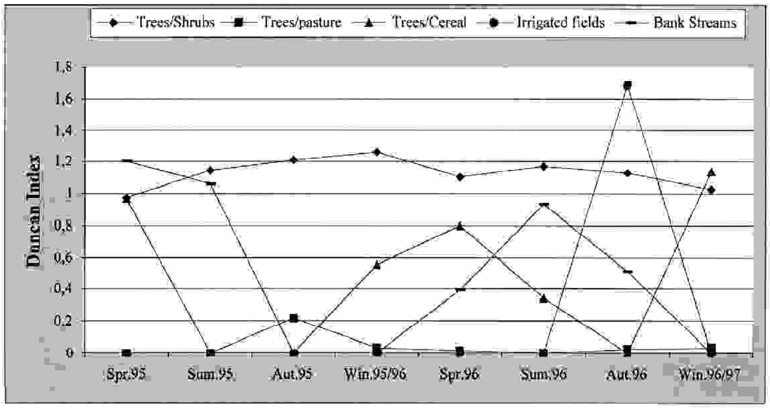

Figure 2. Selectivity showed by F01 for the different cover types as diurnal refuge biotopes in spring 95 (N = 34), in summer 95 (N = 51), in autumn 95 (N = 46), in winter 95/96 (N = 46), in spring 96 (N = 44), in summer 96 (N = 34), in autumn 96 (N = 34) and in winter 96 (N = 23).

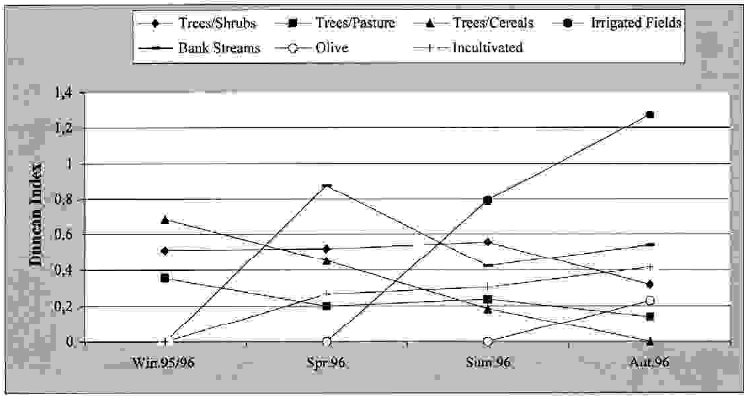

Figure 3. Selectivity showed by F01 for the different cover types as food biotopes (night feeding activity), in winter 95/96 (N = 39), in spring 96 (N = 67), in summer 96 (N = 77) and in autumn 96 (N = 41).

Also M01, did not use the different cover types according to their availability, either as diurnal refuge biotopes or food biotopes (d.f. = 4, $P < 0.01$); the seasonal selectivity exhibited by the male is presented in Tables 1 and 2.

During the study period, in spring and summer, M01 strongly selected Trees & Shrubs for diurnal resting beds, while Trees & Cereal was used for the same purpose in proportion to its availability. Other cover types were not used as diurnal refuge biotopes. Like F01, M01 also appeared to have a rather diversified nocturnal habitat use and selection in summer (Table 2). However, this young male showed a positive selectivity for cereals fields that were not under tree cover.

TABLE 1
M01 selectivity in spring and summer for the different cover types as diurnal refuge biotopes, comparing the expected use (*Ai)* with the confidence intervals for the observed use (*Ui)* (α = 0.05).

Spring/Summer 1996 (N = 42)			
Cover type	*Ai*	Confidence intervals Ui	Selectivity
Trees & Shrubs	0.1025	0.8604 - 1	Positive
Trees & Pasture	0.5753	0.0000 - 0.0000	Negative
Trees & Cereals	0.1058	0.0000 - 0.1396	Neutral
Cereals	0.0155	0.0000 - 0.0000	Negative
Not cultivated	0.2009	0.0000 - 0.0000	Negative

TABLE 2
M01 selectivity in spring and summer for the different cover types as food biotopes, comparing the expected use (*Ai)* with the confidence intervals for the observed use (*Ui)* (α = 0.05).

Spring/Summer 1996 (N = 69)			
Cover type	Ai	Confidence intervals Ui	Selectivity
Trees & Shrubs	0.1025	0.1129- 0.4089	Positive
Trees & Pasture	0.5753	0.3387 - 0.6758	Neutral
Trees & Cereals	0.1058	0.0000 - 0.2032	Neutral
Cereals	0.0155	0.0169 - 0.2440	Positive
Not cultivated	0.2009	0.0000 - 0.0000	Negative

Feeding activity

The survey routes were travelled once a month from September 1998 to October 1999. About 400 km were travelled during this period and about 40 h were spent looking for signs of feeding activity.

The seasonal variation in selectivity for the different cover types as food biotopes, is presented in Figure 4. In the Appendix the expected use is compared to the confidence intervals for the observed use. Except for autumn, the population did not use the different cover types in proportion to their availability (d.f. = 9, $P < 0.01$).

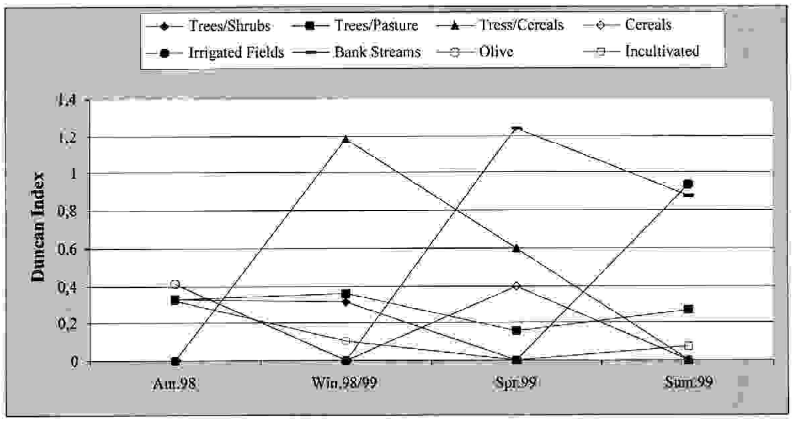

Figure 4. Population selectivity for the different cover types as food biotopes in autumn 98 (N = 105), in winter 98/99 (N = 42), in spring 99 (N = 33) and in summer 99 (N = 36).

There was strong positive selectivity for Trees & Cereal in winter, for Bank Streams in spring, and Bank Streams and Irrigated Fields in summer. Olive and Not Cultivated areas were used only in autumn, and Cereals were only used in spring. Trees & Shrubs was used in autumn and in winter, and Trees & Pasture in all seasons, except spring.

The neutrality showed by the population for Cereals as a food biotope in spring, contrasts with the F01 negative selectivity or with the M01 positive selectivity for this cover type during the season.

DISCUSSION

Radio-tracking

The overall home ranges of the radio-tagged animals are within the range of reported values for the species, considering the period of study and the ecological context (Janeau and Spitz 1984, Maillard and Fournier 1994).

The constant positive selectivity for Trees & Shrubs by both F01 and M01 as diurnal refuge biotope shows clearly the importance of this cover type to the individuals in the population. Those results are in agreement with the conclusions of some other studies and support the hypothesis that the selection of diurnal refuge biotopes is narrower in environments where selected cover types are abundant and distributed in large patches (Cargnelutti et al. 1995). According to the same authors, in areas where selected cover types are scarce, wild boars tend to show a broader selection and use all cover types safe enough not be avoided.

On the other hand, strong seasonal changes in the Duncan index are apparent for Trees & Cereals and Bank Streams (Figure 2). The use of Trees & Cereals as diurnal refuge cover happens only when the cultivated plants reach at least 0.5 m tall, which can occur in late winter, spring, and early summer. The location of day resting beds in riparian zones in spring and summer might be interpreted as a behavioural response to rather high ambient temperatures, as previously reported for feral pigs by Baber and Cobletz (1986). The day resting beds on Irrigated Fields in the autumn of 1996 might be explained by the unusual delay in the harvest of corn in that year; in fact, F01 stood in cornfields during several periods of 24 hours, using this cover both as diurnal resting places and for nocturnal feeding activities.

The size and shape of the seasonal home ranges seems to depend on food abundance, availability, and distribution. The sharp decrease from autumn home range to winter home range (Figure 1) might be related to the reduction in acorns, given that no other relevant food is available during this period. In winter, F01 tended to restrict her movements to relatively small areas that had not been grazed, and where acorns were still fairly abundant. That explains why Trees & Cereals, a cover type where sheep are not allowed, is used so much as a food biotope in this season. The concentration of food resources in spring and summer in riparian zones and agricultural fields might also be related to the small home ranges of F01 in these seasons (Figure 1). Daily home ranges in spring are smaller than in summer because the main cover types used in the spring, Trees & Cereals and Bank Streams are simultaneously diurnal refuge and food biotopes. Otherwise, the main food biotopes in summer, namely Irrigated Fields, are relatively far away from the major refuge biotope Trees & Shrubs. This is reflected by the seasonal differences in daily movement patterns showed by F01. According to the daily movement patterns proposed by Spitz and Janeau (1990, 1995), in spring, the *stay* and the *stay and rest nearby* were the prevailing patterns, while in summer the *loop* and the *ranging widely* were the most frequently used. In autumn, the large number of food resources found scattered and in abundance agrees with the small size of some daily home ranges and the large seasonal home range showed by F01. She exhibited at that time either the *stay* or the *ranging* daily movement patterns, the former was used when using Irrigated Fields and the latter when grazing in Trees & Pasture.

The food dispersion in autumn might permit greater mobility of the species at that time; however, the large distances travelled by some adult individuals in this season might be directly related to hunting. Maillard and Fournier (1994) and Brandt et al. (1998) have reported how chasing wild boars with dog teams can make them leave the shooting area and enlarge their home ranges considerably. We tracked F01 during two hunts with dog teams chasing the wild boars to waiting guns. In both cases, she was resting in a bed nearby the shooting area, about 700 m away. Although the shoots and the barking dogs clearly disturb the animal (several times she stood up), she did not leave the area, either during the hunts or in the days that followed. It seems that if the dogs do not directly chase the wild boars, they remain in the area.

Thrush *Turdus spp.* hunting might be more disturbing to wild boars, although with no dogs or beaters; in fact, on the day after a thrush shoot in which more than a thousand shots were fired at about 600 m from F01’s resting bed that day, she left the area. She moved about 10 km southwest, apparently following the main river and showing an orographic anisotropism (Dardaillon and Beugnon 1987, Gerard et al. 1992). Her return to the area occurred about two months later, still in winter. The route taken back clearly followed the main river. In agreement with Maillard & Fournier (1994) findings, by the beginning of spring this female was back into her former spring home range.

M01’s home range was restricted to a few hundred ha, distributed mostly in Tree & Shrubs and agricultural land, similarly to F01’s home range in the same seasons (spring and summer). However some differences in habitat use between these two radio-tracked wild boars were evident.

The habitat use of M01 shows that this young male selected agricultural fields mainly as food biotopes. The scarcity of large trees in Trees & Cereals on the quarter frequented by this wild boar, and the shortage of adequate cover for diurnal resting places in its area, might explain why this wild boar used less Trees & Cereals as a diurnal resting biotope than did than F01. Another remarkable difference between the two radio-tracked individuals concerns Cereals selectivity. F01 did not use this cover type at all, while M01 showed a clear, strong positive selectivity for Cereals as a food biotope. These divergent spatial ecologies seem to reflect the differences in the behaviours of individuals of different sex and age. As previously reported by Spitz and Janeau (1995), the subadult males, as a tactic to maximize energy intake, might select biotopes “first for their food potential” while the adult females raising young are evidently more cautious, and seem to select biotopes primarily “for maximization of immediate security of offspring.”

Feeding activity

The analysis of feeding activity, namely rooting and signs of either natural or agricultural plants utilization, shows an annual pattern of space use in which the spatial ecology of the two radio-tracked wild boars match perfectly. In autumn, signs of feeding activity were seen mostly in Trees & Pasture and Olive, which agrees with previous studies in the area on wild boar diet in autumn (Santos, 1994). The population neutrality for Tree & Pasture, even thought this was by far the most used cover type, might be explained by the fact that this biotope covers more than 50% of the study area. By the end of autumn, wild boar tended to concentrate feeding activities in the less grazed zones, where mast could still be found in abundance.

In late winter, all zones, except Tree & Cereal, had been grazed and that seems to explain why this cover type was the most used as a food biotope at that time. Signs of feeding activity were concentrated at that time in hilly zones dominated by cork-oak trees. That kind of land provided safety and abundant food at the same time.

After the hunt with chasing dogs that took place in late February, signs of activity were greatly reduced. However, in the next March, the feeding signs were as abundant as before, which agrees with the behaviour of wild boars directly chased by dog teams (Maillard and Fournier 1994).

In spring, signs of feeding activity progressively decreased in proportion to the decrease in available mast and to the increase in soil dryness. In late spring, feeding signs were seen only in riverbeds and nearby riparian zones. Those cover types became almost the only food biotopes. Thought during spring cereals turn very appetizing, particularly at the maturation stage, just a few signs of wild boar feeding on cereals were seen. Wild boar fed on cereals only in small zones of hilly grounds almost covered with trees. It was wild boar's tracks in cereals that made Cereals a cover type used according to its availability, but no signs of feeding on cereals were found. By the end of spring, the first agricultural damages became evident; a significant number of sunflower plants were broken down in a manner typical of wild boar.

In early summer, wild boar continued to feed in riverbeds and riparian environments. The prolonged dry weather seemed to cause it to move into irrigated fields, namely sunflower, and so, in the middle of the season, this cover type became the main food biotope. In late summer, irrigated corn was strongly selected by wild boar, both as a food and as diurnal refuge biotope. In summer, the association of food, water and shelter in irrigated fields make these environments very much used by wild boar.

In the study area, it is obvious that there is a phenological pattern of space use, in which food distribution plays an important role. That was reported for other feral hog and wild boar populations inhabiting very diverse environments, such as wetlands (Kurz and Marchington 1972, Dardaillon 1984), Mediterranean plains and foothills with several different cover types, such as irrigated pastures, oak savannah and oak woodland (Singer et al. 1981), agricultural land interspersed with small woods (Cargnelutti et al. 1990), Mediterranean forest interspersed with agricultural fields (Boitani et al. 1994), temperate deciduous forest (Mauget 1980), mountain forest with height rainfall and low temperatures (Barret 1982), altitude forests (Baubet 1998). However, in our study area, the different biotopes were not used throughout the year according to their availability, while in other Portuguese wild boar populations there tends to be some selection neutrality in all seasons (Castro 1995). In this Mediterranean forest area, when acorns are not available and food becomes scarce, wild boars seem to reduce their feeding movements. It appears to us that the risk and energy involved in travelling a long distance to reach agricultural fields are not compensated by the higher quality of food provided by crops. Apparently, wild boars maximize their ecological efficiencies by shortening their home ranges while increasing the time they spend feeding. That type of behaviour and the energy efficiency advantage provided by such a strategy was reported for a captivewild boar population inhabiting a Mediterranean area dominated by *maquis* and pinewood (Massei et al. 1997).

On the other hand, in the farm and forest mixed lands we have studied, wild boar seem to behave according to the *food exploitation hypothesis*: a clear opposite relationship between food abundance and the size of the home ranges was noticed.

The comparison of our results with those obtained in other environmental conditions confirms the low habitat specificity of the wild boar, as well as its known behavioural plasticity.

REFERENCES

BABER, D. W. AND B. E. COBLENTZ (1986). Density, home range, habitat use, and reproduction in feral pigs on Santa Catalina Island. *Journal of Mammalogy*, 67 (3): 512-525.

BARRETT, R. H. (1982). Habitat preferences of feral hogs, deer, and cattle on a sierra foothill range. *Journal of Wildlife Management*, 35 (3): 342-346.

BAUBET, E. (1998). *Biologie du sanglier en montagne: biodémographie, occupation de l´espace et régime alimentaire*. Doctorat Thesis, Université Claude Bernard-Lyon. 281 pp.

BOITANI, L., L. MATTEI, D. NONIS, AND F. CORSI (1994). Spatial and activity patterns of wild boars in Tuscany, Italy. *Journal of Mammalogy*, 75 (3): 600-612.

BRANDT, S., J. VASSANT AND J. M. JULLIEN (1998). Domaine vital diurne des sangliers en forêt de Châteauvillain - Arc-en-Barrois. *Bulletin Mensuel de l'Office National de la Chasse*, 234: 4-11.

BYERS, C. R., R. K. STEINHORST AND P. R. KRANSMAN (1984). Clarification of a technique for analysis of utilization-availability data. *Journal of Wildlife Management*, 48: 1050-1053.

CARGNELUTTI, B., J. F GÉRARD, F. SPITZ, G. VALET AND T. SARDIN (1990). Occupation par le sanglier (*Sus scrofa*) des habitats d'un agro-écosystème modifié lors de la mécanisation de l´agriculture. *Gibier Faune Sauvage*, 7: 53-66.

CARGNELUTTI, B., G. JANEAU, F. SPITZ AND S. COUSSE (1995). GIS as a means to identify the environmental conditions of wild boar diurnal resting places. *IBEX Journal of Mountain Ecology*, 3: 156-159.

CASTRO, L. R. (1995). *Alguns aspectos da ecologia espacial e gestão do javali (*Sus scrofa*) na Reserva Natural da Serra da Malcata*. Unpublished Report (R.N.P.S.M./ S.N.P.R.C.N.). Lisboa. 21 pp. (In Portuguese).

DARDAILLON, M. (1984). *Le sanglier et le milieu camargais: dynamique coadaptative*. Thèse du Doutorat de 3éme Cycle, Univiversité Paul Sabatier.

DARDAILLON, M. AND G. BEUGNON (1987). The influence of some environmental characteristics on the movements of wild boar, *Sus scrofa*. *Biology of Behaviour*, 12: 87-92.

DUNCAN, P. (1983). Determinants of the use of habitats by horses in a Mediterranean wetland. *Journal of Animal Ecology*, 52: 93-109.

FERNÁNDEZ-LLARIO, P., P. MATEOS-QUESADA, A. SILVERIO AND P. SANTOS (2003). Habitat effects and shooting techniques on two wild boar populations (*Sus scrofa*) in Spain and Portugal. *Zeitschrift für Jagdwissenschaft*, 49: 120-129.

FOURNIER, P., C. FOURNIER-CHAMBRILLON AND F. KLEIN (1995). Anésthésie du sanglier par le zoletil ND. *Bulletin Mensuel de l'Office National de la Chasse*, 196: 18-21.

GERARD, J. F., B. CARGNELUTTI AND F. SPITZ (1992). Relation entre anisotropie de l´occupation de l´espace et dispersion: un exemple chez le sanglier du sud-ouest de la France. *Mammalia*, 56 (2): 177-187.

HARRIS, S., W. J CRESSWELL., P. J FORDE., W. J TREWHELLA., T. WOOLARD AND S. WRAY (1990). Home-range analysis using radio-tracking data - a review of problems and techniques particularly as applied to the study of mammals. *Mammal Review*, 20: 97-123.

JANEAU, G. AND F. SPITZ (1984). L'espace chez le sanglier (*Sus scrofa scrofa* L.) occupation et mode d' utilization. *Gibier Faune Sauvage*, 1: 73-89.

JULLIEN, J. M., J. VASSANT, S. DELORME AND S. BRANDT (1987). Une Technique de capture de groupes de sangliers particulièrement efficace: le fillet tombant. *Gibier Faune Sauvage*, 4: 203-208.

JULLIEN, J. M., S. BRANDT, J. VASSANT AND S. CHANTECAILLE (1991). Des sangliers chassés en battue en forêt domainale de Châteauvillain/Arc-en-Barrois: leurs «estratégies» poue échapper aux chasseurs et aux chiens. *Bulletin Mensuel de l'Office National de la Chasse*, 162: 29-36.

KURZ, J. C. AND R. L. MARCHINGTON (1972). Radiotelemetry studies of feral hogs in South Carolina. *Journal of Wildlife Management*, 36 (4), 1240-1248.

MAILLARD, D. AND P. FOURNIER (1994). Le sanglier en milieu méditerranéen, occupation de l'espace, unité de gestion. *Bulletin Mensuel de l'Office National de la Chasse (n. e.)*, 191: 26-35.

MASSEI, G., P. V. GENOV, B. W. STAINES AND M. L. GORMAN (1997). Factors influencing home range and activity of wild boar (*Sus scrofa*) in a Mediterranean coastal area. *Journal of Zoology*, 242: 411-423.

MAUGET, R. (1980). Régulations écologiques, comportamentales et physiologiques (fonction de reproduction) de l´adaptation du sanglier *Sus scrofa* L. au milieu. Thèse de Docteur d´Etat ès Sciences, Université François-Rabelais de Tours. 333 pp.

MERIGGI, A. AND O. SACCHI (2001). Habitat requirements of wild boars in the northern Apennines (N Italy): a multi-level approach. *Italian Journal of Zoology*, 68 (1): 47-55.

NEU, C. W., C. R. BYERS AND J. M. PECK (1974). A technique for analysis of utilization-availability data. *Journal of Wildlife Management*, 38: 541-545.

RIVAS-MARTÍNEZ, S. AND J. LOIDI (1999). Biogeography of the Iberian Peninsula. *Itinera Geobotanica*, 13: 49-67.

SANTOS, P. (1994). *Interacção entre o javali,* Sus scrofa *L. 1758, e a perdiz-vermelha,* Alectoris rufa *(L.) 1758: dinâmica interespecífica e ordenamento cinegético.* Provas de Aptidão Pedagógica e Capacidade Científica. Universidade de Évora. 233 pp.

SINGER, F. J., D. K. OTTO, A. R. TIPTON AND C. P. HABLE (1981). Home ranges, movements, and habitat use of European wild boar in Tennessee. *Journal of Wildlife Management*, 45 (2): 343-353.

SPITZ, F. AND G. JANEAU (1990). Spatial strategies: an attempt to classify daily movements of wild boar. *Acta Theriologica*, 35: 129-149.

SPITZ, F. AND G. JANEAU (1995). Daily selection of habitat in wild boar, *Sus scrofa* (L.). *Journal of Zoology*, 237: 423-434.

VASSANT, J. AND S. BRANDT (1995). Adaptation du piégeage par enclos-piège de type corral pour la capture de compagnies de sangliers. *Gibier Faune Sauvage*, 12: 51-61.

Appendix

F01 seasonal selectivity for the different cover types as diurnal refuge biotopes - comparison of the expected use (*Ai*) with the confidence intervals for the observed use (*Ui*) (α = 0.05).

Spring 1995 (N = 34)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.1323 - 0.6300	Positive
Trees &Pasture	0.5490	0.0000 - 0.0000	Negative
Trees &Cereal	0.0034	0.0000 - 0.1200	Neutral
Cereal	0.0554	0.0000 - 0.0000	Negative
Irrigated Fields	0.0202	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.3350 - 0.8414	Positive
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2546	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Summer 1995 (N = 51)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.3922 - 0.7802	Positive
Trees &Pasture	0.5490	0.0000 - 0.0000	Negative
Trees &Cereal	0.0034	0.0000 - 0.0000	Negative
Cereal	0.0554	0.0000 - 0.0000	Negative
Irrigated Fields	0.0202	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.2198 - 0.6078	Positive
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2546	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Autumn 1995 (N = 46)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.4914 - 0.8812	Positive
Trees &Pasture	0.4821	0.1188 - 0.5086	Neutral
Trees &Cereal	0.0698	0.0000 - 0.0000	Negative
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0065	0.0000 - 0.0000	Negative
Bank Streams	0.0376	0.0000 - 0.0000	Negative
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2878	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Winter 1995/1996 (N = 46)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.6011 - 0.9460	Positive
Trees &Pasture	0.4821	0.0000 - 0.1163	Negative
Trees &Cereal	0.0698	0.0275 - 0.3499	Neutral
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0065	0.0000 - 0.0000	Negative
Bank Streams	0.0376	0.0000 - 0.0000	Negative
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2878	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative

Spring 1996 (N = 44)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.3197 - 0.7391	Positive
Trees &Pasture	0.4820	0.0000 - 0.0779	Negative
Trees &Cereal	0.0698	0.1871 - 0.5973	Positive
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0324	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.0000 - 0.1577	Neutral
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2620	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Summer 1996 (N = 34)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.3676 - 0.8677	Positive
Trees &Pasture	0.4820	0.0000 - 0.0000	Negative
Trees &Cereal	0.0698	0.0000 - 0.2342	Neutral
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0324	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.0597 - 0.5285	Positive
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2620	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Autumn 1996 (N= 34)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.3034 - 0.8143	Positive
Trees &Pasture	0.5128	0.0000 - 0.1163	Negative
Trees &Cereal	0.0392	0.0000 - 0.0000	Negative
Cereal	0.0003	0.0000 - 0.0000	Negative
Irrigated Fields	0.0101	0.0828 - 0.5642	Positive
Bank Streams	0.0375	0.0000 - 0.2342	Neutral
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.3202	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Winter 1996/1997 (N= 23)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.1247 - 0.7449	Positive
Trees &Pasture	0.5128	0.0000 - 0.1710	Negative
Trees &Cereal	0.0392	0.2093 - 0.8342	Positive
Cereal	0.0003	0.0000 - 0.0000	Negative
Irrigated Fields	0.0065	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.0000 - 0.0000	Negative
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.3228	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative

F01 seasonal selectivity for the different cover types as food biotopes - comparison of the expected use (*Ai*) with the confidence intervals for the observed use (*Ui*) (α = 0.05).

Winter 1995/1996 (N = 39)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.0000 - 0.2483	Neutral
Trees &Pasture	0.4821	0.3817 - 0.8491	Neutral
Trees &Cereal	0.0698	0.0659 - 0.4982	Neutral
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0065	0.0000 - 0.0000	Negative
Bank Streams	0.0376	0.0000 - 0.0000	Negative
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2879	0.0000 - 0.0000	Negative
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.00006	0.0000 - 0.0000	Negative
Spring 1996 (N= 67)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.0000 - 0.2166	Neutral
Trees &Pasture	0.4820	0.1184 - 0.4488	Negative
Trees &Cereal	0.0698	0.0093 - 0.2593	Neutral
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0324	0.0000 - 0.0000	Negative
Bank Streams	0.0375	0.0942 - 0.4132	Positive
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2620	0.0000 - 0.3767	Neutral
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Summer 1996 (N = 77)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.0070 - 0.2267	Neutral
Trees &Pasture	0.4820	0.1875 - 0.5138	Neutral
Trees &Cereal	0.0698	0.0000 - 0.1051	Neutral
Cereal	0.0363	0.0000 - 0.0000	Negative
Irrigated Fields	0.0324	0.0318 - 0.2798	Neutral
Bank Streams	0.0375	0.0000 - 0.1492	Neutral
Olive	0.0233	0.0000 - 0.0000	Negative
Not cultivated	0.2620	0.1205 - 0.4250	Neutral
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative
Autumn 1996 (N = 41)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0435	0.0000 - 0.15497	Neutral
Trees &Pasture	0.5128	0.0094 - 0.3808	Negative
Trees &Cereal	0.0392	0.0000 - 0.0000	Negative
Cereal	0.0003	0.0000 - 0.0000	Negative
Irrigated Fields	0.0101	0.0000 - 0.2753	Neutral
Bank Streams	0.0375	0.0000 - 0.2366	Neutral
Olive	0.0233	0.0000 - 0.0967	Neutral
Not cultivated	0.3202	0.2780 - 0.7464	Neutral
Vine	0.0125	0.0000 - 0.0000	Negative
Urban Area	0.0006	0.0000 - 0.0000	Negative

Population seasonal selectivity for the different cover types as food biotopes - comparison of the expected use (*Ai*) with the confidence intervals for the observed use (*Ui*) (α = 0.05).

Autumn 1998 (N = 105)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0450	0.0000 - 0.1246	Neutral
Trees &Pasture	0.5407	0.4564 - 0.7841	Neutral
Trees &Cereal	0.0134	0.0000 - 0.0000	Negative
Cereal	0.0536	0.0000 - 0.0000	Negative
Irrigated Fields	0.0069	0.0000 - 0.0000	Negative
Bank Streams	0.0391	0.0000 - 0.0000	Negative
Olive	0.0242	0.0000 - 0.1025	Neutral
Not cultivated	0.2632	0.1378 - 0.4445	Neutral
Vine	0.0131	0.0000 - 0.0000	Negative
Urban Area	0.0007	0.0000 - 0.0000	Negative
Winter 1998/1999 (N = 42)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0450	0.0000 - 0.1195	Neutral
Trees &Pasture	0.5407	0.5344 - 0.8465	Neutral
Trees &Cereal	0.0134	0.0579 - 0.3230	Positive
Cereal	0.0536	0.0000 - 0.0000	Negative
Irrigated Fields	0.0069	0.0000 - 0.0000	Negative
Bank Streams	0.0391	0.0000 - 0.0000	Negative
Olive	0.0242	0.0000 - 0.0000	Negative
Not cultivated	0.2632	0.0000 - 0.1584	Negative
Vine	0.0131	0.0000 - 0.0000	Negative
Urban Area	0.0007	0.0000 - 0.0000	Negative
Spring 1999 (N = 33)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0450	0.0000 - 0.0000	Negative
Trees &Pasture	0.5407	0.0958 - 0.3842	Negative
Trees &Cereal	0.0134	0.0000 - 0.1061	Neutral
Cereal	0.0536	0.0000 - 0.1716	Neutral
Irrigated Fields	0.0302	0.0000 - 0.0000	Negative
Bank Streams	0.0391	0.4780 - 0.8020	Positive
Olive	0.0242	0.0000 - 0.0000	Negative
Not cultivated	0.2399	0.0000 - 0.0000	Negative
Vine	0.0131	0.0000 - 0.0000	Negative
Urban Area	0.0007	0.0000 - 0.0000	Negative
Summer 1999 (N = 36)			
Cover	***Ai***	**Confidence intervals *Ui***	**Selectivity**
Trees & Shrubs	0.0450	0.0000 - 0.0000	Negative
Trees &Pasture	0.5407	0.3029 - 0.6399	Neutral
Trees &Cereal	0.0134	0.0000 - 0.0000	Negative
Cereal	0.0536	0.0000 - 0.0000	Negative
Irrigated Fields	0.0302	0.0868 - 0.3703	Positive
Bank Streams	0.0391	0.1096 - 0.4047	Positive
Olive	0.0242	0.0000 - 0.0000	Negative
Not cultivated	0.2399	0.0000 - 0.1112	Negative
Vine	0.0131	0.0000 - 0.0000	Negative
Urban Area	0.0007	0.0000 - 0.0000	Negative