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WILD BOAR FRUGIVORY IN THE ATLANTIC BASQUE COUNTRY

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ABSTRACT

After centuries of continuous deforestation and a noticeable loss of forest fauna, and since the early 19th Century, part of the Atlantic Basque Country has suffered an intensive plantation of haloctonous trees, such as Monte Rey pine *Pinus radiata* and eucaliptus *Eucaliptus globulus.* Today, forests represent more than half of the total area, even though broad-leaved forests represent less than 15%, (mainly beech *Fagus sylvatica,* oak *Quercus sp.,* and chestnut *Castanea sativa,* in decreasing order of importance). During the early 1960s, wild boar invaded the area from the neighbouring provinces and, today, occupies about 50% of the area. To determine what are the main food resources that permit wild boar to live in the area, we analyzed stomach contents obtained from hunting batues undertaken by local hunters during the hunting season (September to February). The wild boar has a frugivorous diet, mainly chestnuts. No relevant belowground parts of plants appeared in the stomachs we examined. Chestnut forests represent less than 3.6% of all of the forests in the area, and we conclude that the carrying capacity of the area for chestnut is low and will remain so. Forest plantations represent an important shelter area for the wild boar, but do not provide the appropriate food. Relict natural and semi-natural fragmented small forests and scattered oaks and chestnut trees maintain the wild boar populations. The conservation and increase in the amount of oak and chestnut forests and trees should permit an increase in the number of wild boars in the area.

Key words: chestnut, foods, fragmented forests, reforestation, wild boar.

INTRODUCTION

Recent expansions of wild boars *Sus scrofa* L.1758 throughout several countries have precipitated the recovery of the species in many areas were it was extinct for decades or centuries (Sáez Royuela and Tellería 1986). Today, wild boars live naturally or as an introduced species in a wide range of habitats, such as forests, high mountain environments, wetlands, agroecosystems (Genov 1987, Gerard et al. 1991, Durio et al. 1992), and the species is one of the most widespread mammals.

In the Atlantic Basque Country, Spain, wild boar became extinct in the 19th Century. Since the 1960s, the species has gradually re-colonized the country, moving from neighbouring areas to the west and south. Today (2002-03 hunting season), the wild boar is an important game species, and the annual bag in the provinces of Gipuzkoa and Bizkaia is about 800 animals.

One of the main reasons for the expansion of the wild boar is its ability to adapt to diverse food resources. At the same time, diet is an important issue in wild boar research, due partially to the facility of obtaining samples (mainly stomachs), and to the importance of knowing what are the natural resources used by the wild boar, a species that can cause significant damage to crops (Schley and Roper 2003) and root in sensitive environments (Howe and Bratton 1976).

In this paper, we examine the diet of wild boars living in the Atlantic Basque Country, which is a key factor in understanding the species' adaptation to a newly colonized habitat, and compare its trophic strategy to similar studies.

STUDY AREA

The study area includes the provinces of Gipuzkoa (1,972 km^2) and Bizkaia (2,203 km^2) in the Atlantic part of the Basque Country, Spain. In the region, the climate is Atlantic, with mild winters and an annual average precipitation of 1,200-2,400 mm. The provinces have a similar land use (Table 1). Forests represent slightly more than 50% of the total area, of which nearly two-thirds are planted haloctonous conifers (mainly Monte Rey pine *Pinus radiata*). Plantations of *Pinus nigra*, *Eucaliptus globulus, Larix sp*., and *Quercus rubra* are present. The original forests of oak *Quercus* sp., beech *Fagus sylvatica*, and chestnut *Castanea sativa* are represented by small, relict, fragmented forests (Table 2). Walnut trees are *Juglans regia* are scattered in forests and farmland. Oak, chestnut, and walnut produce hard mast in autumn. The relative abundance of tree species is presented in Table 3. Farms (mainly pastures) represent about 20% of the total area and are devoted to extensive sheep, cattle, and horse farming.

The human population of the area is about 1,900,000, which represents a density of 455 km^{-2}. The deep transformations of the landscape since the beginning of the 20th Century are due to land abandonment and the human population is strongly concentrated in large urbanized areas, which has led to the recovery of natural and semi-natural forests and forest plantations. Wild boars have naturally re-colonized both of the provinces, and no supplementary feeding of wild boars occurs.

TABLE 1
Land use in Gipuzkoa and Bizkaia provinces, Spain.
Source: Departamento de Agricultura, Gobierno Vasco.

	Gipuzkoa		Bizkaia		TOTAL	
Land use	Ha	%	Ha	%	Ha	%
Farms	47,059	23.9	43,378	19.7	90,437	21.7
Shrubs	7,208	3.6	17,088	7.8	24,296	5.8
Unproductive	9,635	4.9	17,285	7.8	26,920	6.4
Multiple uses	14,524	7.4	20,224	9.2	34,748	8.3
Forest areas	118,837	60.2	122,411	55.5	241,248	57.8
TOTAL	197,262	100	220,386	100	417,649	100

TABLE 2
Main forest types in Gipuzkoa and Bizkaia, Spain.
Source: Departamento de Agricultura, Gobierno Vasco.

	Gipuzkoa		Bizkaia		TOTAL	
Forest types	Ha	%	Ha	%	Ha	%
Conifer plantations	83,986	70.7	94,018	76.8	178,004	73.7
***Quercus robur* forests**	2,549	2.1	4,377	3.6	6,926	2.9
***Quercus ilex* forests**	1,691	1.4	5,595	4.6	7,286	3.0
***Quercus rubra* plantations**	1,058	0.9	319	0.3	1,377	0.6
***Castanea sativa* forests**	400	0.3	87	0.1	487	0.2
***Fagus sylvatica* forests**	16,699	14.1	3,077	2.5	19,776	8.2
Mixed Atlantic forest	9,950	8.4	5,690	4.6	15,640	6.5
Other forests and plantations	2,504	2.1	9,248	7.5	11,752	4.9
TOTAL	118,837	100	122,411	100	241,248	100

MATERIALS AND METHODS

Wild boars were collected during hunting seasons between September and February in 1989-90 in Gipuzkoa and 1990-91 in Bizkaia. Wild boar stomachs were stored in 5% formalin. Stomach volume was measured to a precision of 10 ml. To remove gastric juices (Abáigar 1993) and unidentifiable particles (Wood and Roark 1980), stomach contents were washed with water on a 1.0-mm mesh. After stomach contents were dried, a 250-ml sample was taken for complete identification. The

sample was washed on four consecutive sieves of decreasing mesh size (8.0, 4.0, 2.0, and 1.0 mm). In that way, the items within the four subsamples are of similar size are much easier to identify.

TABLA 3
Main tree stocks based on Normalized diameter (> 75 mm) in the study area in Guipuzkoa and Bizkaia, Spain. Source: Departamento de Agricultura, Gobierno Vasco.

	Gipuzkoa	**Bizkaia**	**TOTAL**
Main tree stocks (D75 mm)	%	%	%
Conifers (planted)	57.7	78.4	67.8
Quercus robur	6.3	3.6	5.0
Quercus ilex	2.5	3.2	2.8
Quercus rubra (planted)	1.1	-	0.6
Castanea sativa	5.9	1.3	3.6
Fagus sylvatica	10.7	1.8	6.3
Other *Quercus*	0.5	1.0	0.8
Others	15.3	10.7	13.1
TOTAL	100	100	100

Vegetable items were normally identified *de visu* after the creation of a reference collection, or using plant identification keys, such as in the case of *Graminae* (García Suárez et al. 1993). Specifically, acorns from different *Quercus* species were differentiated by the aspect of the tegument that covers the seed. Animal matter was identified *de visu* or using keys, as in the case of mammal hair (Faliú et al. 1979).

The volumes of the different food items from each stomach were calculated using a graduated test tube that had a precision of 0.1 ml. The total volume of each food item found in all of the stomachs was divided by the total volume to calculate percentage volume. The volumes of items smaller than 0.1 ml were considered as trace amounts. The frequency of occurrence of each of the food items was calculated by dividing the number of stomachs that contained a given item by the total number of stomachs examined.

The variation in diet between was determined by comparing the average annual volume of the main food items using a U of Mann-Whitney non-parametric test because the data were non-normal distributed.

RESULTS

We collected 43 stomachs from 24 males, 16 females, and 3 individuals of unknown sex, with body weights between 20 and 102 kg. Specimens were collected from September to January (2 in September, 12 in October, 22 in November, 12 in December, and 2 in January; 21 in Bizkaia and 22 in Gipuzkoa). No stomachs were empty. The main food items in stomachs (hard mast, leaves and stems, animal matter, invertebrates, vertebrates) did not differ significantly (U of Mann-Whitney test, $p>0.05$ in all cases) between provinces so the data from the two provinces were pooled for analysis (Table 4).

TABLE 4

Percentage by volume and frequency of occurrence of food items identified in stomachs of wild boars from Gipuzkoa and Bizkaia collected in autumn and winter (N=43, 1989-90 and 1990-91 hunting seasons, respectively).

Food	Volume (%), N=41	Frequency (%), N=43
Plant material	**94.1**	**100.0**
Leaves and stems	1.5	53.5
Gramineae	0.4	44.2
Pine needles	0.1	13.9
Fruits	89.1	97.7
Hard mast	87.1	95.3
Quercus ilex	3.5	9.3
Quercus robur	21.7	53.5
Quercus rubra	7.3	18.6
Castanea sativa	53.0	67.4
Fagus sylvatica	1.7	2.3
Juglans regia	0.0	2.3
Soft mast	0.3	11.6
Crataegus monogina	0.1	2.3
Prunus sp.	0.03	4.6
Arbutus unedo	0.02	4.6
Undetermined berries	0.1	2.3
Other fruits	0.02	7.0
Other vegetal parts	0.1	41.9
Animal matter	**5.9**	**90.7**
Invertebrates	1.8	67.4
Earthworms	0.04	18.6
Snails	0.4	11.6
Insects	0.1	51.2
Vertebrates	3.2	41.9
Mammals	2.7	18.7
Birds	-	9.4
Reptiles	0.2	2.3
Amphibians *S. salamandra*	0.04	7.0

Stomach contents were predominantly plant material, which was present in all of the stomachs. Animal matter was scarce, but occurred frequently. The diet is based largely on fruit, mostly hard mast, particularly chestnuts and acorns of a few species of *Quercus*. Beechnuts were not common. Soft mast was not relevant in terms of volume or frequency in the stomachs examined.

Among the animal matter, vertebrates were the main items, which appeared in almost half of the stomachs. All of the invertebrates and vertebrates in the diet were in small volume. By frequency of occurrence, earthworms, snails, insects, and mammals had the higher values. *Salamandra salmandra* appeared in three of the stomachs we examined.

DISCUSSION

The diet of the wild boar has been widely studied in autochthonous and introduced populations in different temperate forest areas of the world (Matshcke 1964, Briedermann 1976, Wood and Roark 1980, Howe et al. 1981, Singer and Ackerman 1981, Scott and Pelton 1975, Leránoz 1983, Abáigar 1993, Groot-Bruinderink et al. 1994, Valet et al. 1994, Durio et al. 1995, Sáenz de Buruaga 1995, Massei et al. 1996, Baubet et al. 1997, Schely and Roper 2003). The results from our study area are similar to the general pattern for the species in these habitats during autumn and winter: the diet is heavily based on high energy fruits, such as chestnuts, acorns, and beechnuts. In Mediterranean habitats, another relevant food is olives *Olea europea* (Massei et al. 1996).

The salient difference between the results of our study and the general diet pattern of the species is the absence of belowground parts of plants. In our study area, wild boars eat subterranean animals, but they so not appear to need roots or bulbs, at least based on the samples we examined. A possible reason for that result is related to the importance of chestnuts as a food resource. Even if chestnut is scarce and scattered, it is the main food of the species in the area. For that reason, relict, small, forest fragments play a key role in the maintenance of this species, and because the abundant conifers only provide shelter, but not relevant food items, the carrying capacity for wild boars in the area is strongly dependent on the production of chestnut hard mast. Chestnuts have been favoured by man for many centuries, planting and extending their natural range and now support the recovery of a wild ungulate who's expansion strongly depends on the mechanization of agriculture, rural abandonment, and forest availability. The irregular production of *Quercus* and beech, and the regular production of chestnuts is probably the reason why chestnuts are the main food of wild boars in the region. It might explain the

absence of rooting and agricultural damage, given that that the lack of beechnuts and acorns of *Quercus* can lead to an increase in agricultural damage by wild boars (Leránoz 1983).

The recovery of the wild boar population is in the initial stage, so an increase in density is possible in future years, which should be followed by an increase in agricultural damage, which is almost absent today.

Earthworms are probably a more important part of wild boar's diet than is suggested by the volume in stomach contents because earthworms easily digested (Baubet et al. 1997), and they appear in about 25% of the stomachs examined. Together with mammals, earthworms represent the main animal food by frequency. The only endangered species that appeared in the wild boar's diet, *S. salamandra,* is considered "Vulnerable" in Spain and has experienced a significant reduction in recent years (Alcobendas and Buckley 2002). It is a common species in the study area and is considered "Not endangered" at a regional level (Fernández de Mendiola 1998). We suspect that wild boars are preying on those salamanders, as they do in other populations (Scott and Pelton 1975, Howe et al. 1981, Garzón et al. 1983).

Forest plantations have increased the amount of shelter available to wild boars in the area, but they do not produce food attractive to wild boars. The role of food resource is played by small, relict, fragmented, small forests that produce hard mast in autumn. As shelter areas are much larger than these autochthonous patches, the latter probably are a key factor influencing the carrying capacity of the study area for wild boars.

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References

Abáigar, T. (1993). Régimen alimentario del jabalí (*Sus scrofa* L., 1758) en el sureste ibérico. *Doñana, Acta Vertebrata,* 20 (1): 35-48.

Alcobendas, M. and D. Buckley (2002). *Salamandra salamandra*. Pp. 55-57. In: Pleguezuelos, J.M., R. Márquez and M. Lizana (eds.). *Atlas y Libro Rojo de los Anfibios y Reptiles de España.* Dirección General de Conservación de la Naturaleza, Madrid.

Baubet, E., C. Touzeau and S. Brandt (1997). Les lombriciens dans le régime alimentaire du sanglier (*Sus scrofa* L.) en montagne. *Mammalia,* 61 (3): 371-383.

BRIEDERMANN, L. (1976). Ergebnisse einer inhaltsanalyse von 665 wildscweinmayer. *Zool. Garten*, 46: 157-185.

DEPARTAMENTO DE AGRICULTURA, GOBIERNO VASCO (1988). *Inventario forestal 1986*. C.A.P.V, Vitoria-Gasteiz: Servicio Central de Publicaciones del Gobierno Vasco.

DURIO, P., U. GALLO-ORSI, E. MACCHI AND A. PERRONE (1992). Monthly birth distribution and structure of an Alpine population of Wild Boar (*Sus scrofa*) in North-West Italy. Pp. 395-397. In: F. Spitz, G. Janeau, G. Gonzalez and S. Aulagnier (eds.). *Oungulés/ Ungulates*. SFEPM-IRGM, Tolosa, France.

DURIO, P., D. FOGLIATO, A. PERRONE AND N. TESSARIN (1995). The autumn diet of the Wild boar (*Sus scrofa*) in an alpine valley. Preliminary results. Ibex. *Journal of Mountain Ecology*, 3: 180-183.

FALIÚ, L., Y. LIGNEREUX, J. BARRAT, J. RECH AND J. Y. SAUTET (1979). Etude en microscopie optique des poils (Pili) de la faune pyrénéene sauvage en vue de leur détermination. *Zbl. Vet. Med. C. Anat. Hidtol. Embryol*., 8: 307-317.

FERNÁNDEZ DE MENDIOLA, J. A. (1998). *Vertebrados continentales: situación actual en la Comunidad Autónoma del País Vasco*. Vitoria-Gasteiz : Servicio Central de Publicaciones del Gobierno Vasco.

GARCÍA-SUAREZ, R., J. A. FERNÁNDEZ AND M. J. FERNÁNDEZ-CARVAJAL (1993). Clave para la identificación de gramíneas pratenses de Asturias. *Lagascalia*, 17 (1): 37-57.

GARZÓN, P., F. PALACIOS AND C. IBÁÑEZ (1983). Primeros datos sobre la alimentación del jabalí (*Sus scrofa baeticus* Thomas, 1912) en el Parque Nacional de Doñana. *II Reunión Iberoamericana Cons. Zool. Vert.*: 466-474.

GENOV, P. (1987). Food composition of the wild boar (*Sus scrofa attila* Thos) in the Danubian plain. *Ecology*, 20: 47-57.

GERARD, J. F., P. TEILLAUD, F. SPITZ AND R. CAMPAN (1991). Le sanglier. *Rev. Ecol. (Terre Vie), Suppl.,* 6: 11-66.

GROOT-BRUINDERINK, G. W. T. A., E. HAZEBROEK AND H. V. D. VOET (1994). Diet and condition of wild boar, *Sus scrofa scrofa*, without supplementary feeding. *Journal of Zoology, London*, 233: 631-648.

HOWE, T. D. AND S. P. BRATTON (1976). Winter Rooting Activity of The European Wild Boar in the Great Smoky Mountains National Park. *Castanea*, 41: 256-264.

HOWE, T. D., F. J SINGER AND B. ACKERMAN (1981). Forage relationships of European wild boar invading northern hardwood forest. *Journal of Wildlife Management,* 45 (3): 748-754.

LERÁNOZ, I. (1983). Sobre la relación del jabalí (*Sus scrofa* L.) con la agricultura, en Navarra septentrional. *XV Congreso Internacional de Fauna Cinegética y Silvestre, Trujillo, España*: 639-645.

MASSEI, G., P. V. GENOV AND B. W. STAINES (1996). Diet, food availability and reproduction of wild boar in a Mediterranean coastal area. *Acta Theriologica*, 41: 307-320.

MATSCHKE, G. H. (1964). The influence of oak mast on European wild hog reproduction. *Proceedings of the Annual Conference of the South Game and Fish Commission,* 18: 35-39.

SÁENZ DE BURUAGA, M. (1995). Alimentación del jabalí (*Sus scrofa castilianus*) en el norte de España. *Ecología*, 9: 367-386

SÁEZ-ROYUELA, C. AND J. L. TELLERÍA (1986). The increased population of the Wild Boar (*Sus scrofa*) in Europe. *Mammal Review*, 16 (2): 97-101.

SCHELY, L. AND T. J. ROPER (2003). Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. *Mammal Review*, 33: 43-56.

SCOTT, C. D. AND M. PELTON (1975). Seasonal food habits of the European wild hog in the Great Smokey Mountains Park. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners,* 29: 585-593.

SINGER, F. J. AND B. B. ACKERMAN (1981). *Food availability, reproduction, and condition of European wild boar in Great Smoky Mountains National Park.* U.S. Department of the Interior, National Park Service Southeast Region.

VALET, G., C. ROSELL, L. CHAYRON, P. FOSTY AND F. SPITZ (1994). Regime alimentaire automnal du sanglier (*Sus scrofa*) en Ariege, France, et en Catalogne, Espagne. *Gibier Faune Sauvage, Game & Wildlife*, 11: 313 - 326.

WOOD, G. W. AND D. N. ROARK (1980). Food habits of feral hogs in Coastal South Carolina. *Journal of Wildlife Management,* 44 (2): 506-511.