Galemys, 16 (nº especial): 115-123, 2004
ISSN: 1137-8700

PRELIMINARY DATA ON THE DIET OF WILD BOAR LIVING IN A MEDITERRANEAN COASTAL WETLAND

JUAN HERRERO[1,2,5], SERGIO COUTO[2], CARME ROSELL[3,4] AND PILAR ARIAS[5]

1. Department of Ecology. University of Alcala. E-28871 Alcalá de Henares. (egasl@arrakis.es)
2. Pirenean Institute for Ecology. P.O.Box 64. E-22700 Jaca. (sergiocouto@yahoo.es)
3. Minuartia, Estudis Ambientals. P/Doménech, 3 1. E-08471 Sant Celoni. (crosell@minuartia.com)
4. Department of Animal Biology. University of Barcelona. E-08028 Barcelona
5. Ega, Wildlife Consultants. Sierra de Vicort 31, 1ºA. E-50003 Zaragoza. (fonta@mixmail.com)

ABSTRACT

In the last two decades, a wild boar population became established in the Natural Park of Aïguamolls de l'Empordà, a coastal wetland of the West Mediterranean (Catalonia, Spain). As part of a monitoring program in this area, the stomach contents of 38 animals were analysed to determine the diet of the species, to determine its degree of dependence on surrounding agricultural areas, and to identify the possible consumption of endangered species, such as some ground-nesting birds. The results suggest the wild boar population in the area had a diverse diet, in which the main food items were plants (92% of total volume) and, particularly (66%), the aboveground parts. Agricultural resources represented 49% and underground non-agricultural resources were 26%. Animal matter represented only 8% of total volume, but it appeared in more than 80% of the stomachs examined. In our sample, most were birds (4.9% by volume, > 30% by frequency) and American crab *Procambarus clarkii*, an introduced haloctonous species (1% by volume, 35% by frequency). Seasonal variation in the diet was reflected in shifts between aboveground (mainly agricultural) and belowground parts of plants, and the latter represents the wild boar diet in periods of food scarcity. In the study area, between July and October, wild boars depend heavily on agricultural compounds growing near the coastal wetland. The wild boar appears to have a potentially important impact on both plant and animal wetland communities.

Key words*:* Catalonia, coastal wetland, foods, impact, *Sus scrofa.*

INTRODUCTION

The expansion of wild boar *Sus scrofa* L.1758 populations throughout Europe in recent decades (Sáez-Royuela and Tellería 1986) has allowed the species to occupy very diverse ecosystems, from high mountain environments to agroecosystems (Gerard et al. 1991, Durio et al. 1995). Wild boar can occupy coastal wetlands, which is one of the most endangered habitats in the Mediterranean region; typically, they are relict, small, and isolated areas where the risk of local extinctions is high. Today, in many areas, only small patches exist and are surrounded by urbanized, agricultural or industrial environments. To preserve some of the coastal wetland habitat, Natural

Protected Areas have been designated with the aim of preventing the degradation and assuring the survival, biodiversity, and ecological function of this habitat.

In recent decades, the foods of wild boar have been studied extensively. The species' diet is based predominantly on plants and, to a much lesser extent, animals (see Schley and Roper 2003 for a recent review for Western Europe). Although some studies were carried out in Doñana National Park (Venero Gonzáles 1984, Garzón et al. 1984) and the Camargue (Dardaillon 1984), the diet of wild boar living in wetlands has not been a relevant issue in applied research, despite of the potential importance of the species as a predator of endangered or sensitive species, such as ground-nesting birds, amphibians, and reptiles.

The aim of this paper is to describe the foods of wild boar living in a coastal wetland in the western Mediterranean (Catalonia, Spain) and its seasonality, and to determine the impact the species is having on the affected ecosystems.

STUDY AREA

The study site is located in the Aïguamolls de l'Empordà Natural Park, a coastal Mediterranean marshland with an area of 4,824 ha. The area is part of the Natura 2000 network and is a UN Ramsar Site. The area is divided into two polygons caused by extended urbanisation (see Figure 1) and surrounded by a densely populated tourist area, the Gulf of Roses. The area is located between two rivers, the Fluvià and the Muga, and it includes three Integral Reserves. The two largest reserves, where the study was focused, are 321 and 523 ha in size.

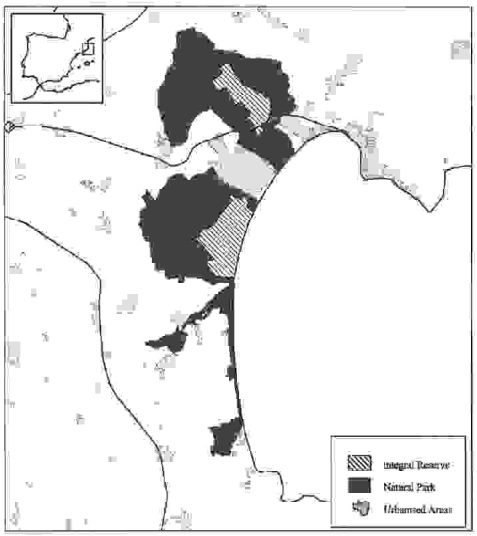

Figure 1. Location of the study area in the Mediterranean coastal area of the Gulf of Roses (Girona, Northeastern Iberian Peninsula).

The area of the park is only slightly elevated above sea level, and the plain is formed by Quaternary sediments that are the result of the interaction of the sediments brought by the two rivers and the dynamics of the sea. The development of this deltaic system is responsible for the marsh's existence. The area has a typically Mediterranean climate, with an average annual precipitation of 600 mm, and a mean annual

temperature of 15 ºC. The area experiences periods of strong winds from the north, which occasionally exceed 100 km/h.

The coastal wetland ecosystem contains a wide diversity of habitats including beaches with sand dunes, salt marshes, brackish and salt water coastal lagoons, with vegetation composed of glasswort *Arcthocnemum fruticosum*, broom *Spartina versicolor* and rush *Juncus maritimus*; meadows delimited by tree lines of tamarisk *Tamarix gallica* and *T. Africana*, permanent and temporal rivers and streams, temporal freshwater lagoons, salt and brackish marshes with permanent and seasonal water, and flooded meadows. The area has small ditches where reed *Phragmites australis* and lesser bulrush *Typha angustifolia* grow. The majority of these habitats are within the Integral Reserves, although flooded meadows are also found elsewhere in the park.

The Natural Park is surrounded by irrigated agricultural land, which mainly consists of sunflower *Helianthus annuus*, corn *Zea mays*, barley *Hordeum vulgare* and, to a lesser extent, fruit trees, such as apple *Malus sp*., and rice fields *Oryza sativa*. Rice fields are an important habitat for waterfowl.

The area has a high diversity of vertebrates, especially of endangered birds, including bittern *Botaurus stellaris*, little bittern *Ixobrychus minutus*, night heron *Nycticorax nycticorax*, a reintroduced species, purple gallinule *Porphyrio porphyrio*, as well as several species of ducks and geese. The most important amphibians and reptiles are palmate newt *Triturus helveticus*, Western spade-foot *Pelobates cultripes*, common toad *Bufo bufo*, stripeless tree-frog *Hyla meridionalis*, large psammodromus *Psammodromus algirus*, three-toed skink *Chalcides striatus*, ladder snake *Elaphe scalaris*, and viperine snake *Natrix maura*. The most important mammals are polecat *Mustela putorius* and otter *Lutra lutra*. A population of fallow deer *Dama dama* was introduced in 1991 and now is estimated to have 140 individuals. Other introduced species are American crab *Procambarus clarkii* and carp *Cyprinus carpio*.

Wild boars are not artificially fed in the area and have spread into the Natural Park naturally. Before 1990, it was an occasional visitor to the area and, in recent years, it has become a resident species.

MATERIAL AND METHODS

In 2001, wild boars were collected during 2001 from a culling program undertaken in the Natural Park to prevent population growth and to reduce the concentration of wild boar in the Integral Reserves and their surroundings, where the species causes crop damage (Rosell et al. 2004). Thirty-eight stomachs were gathered and stored in 5% formalin. Stomach volume was measured to a precision of 10 ml. To eliminate

gastric juices (Abáigar 1990) and unidentifiable particles (Wood and Roark 1980), stomach contents were washed with water on a 1.0-mm mesh. A 250-ml fraction was used for complete identification. The sample was washed in four consecutive sieves of decreasing mesh size (8.0, 4.0, 2.0, and 1.0 mm). In that way, the items of the four sub-samples (>8, 8-4, 4-2, 2-1 mm) were much easier to identify. Plant and animal items were identified *de visu*.

The volume of each of the different food items taken from each stomach was calculated using a graduated test tube having 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 traces. The frequency of occurrence of all food items was calculated by dividing the number of stomachs with a given item by the total number of stomachs examined.

Seasonal variation in diet was analysed by comparing the average annual proportion of each item and a Kruskal-Wallis non-parametric test.

RESULTS

The items found in the stomachs of wild boar are presented in Table 1. Calculations were based 37 stomach contents because one stomach was virtually empty (<2 ml). Overall, the diet was predominantly plants (92% of total volume). Aboveground parts of plants were predominant over belowground parts. Approximately half of the total volume was agricultural matter. Corn (25% by volume) and sunflower seeds (10% by volume) were the major agricultural products in stomachs. Plant matter of non-agricultural origin (typically, leaves and twigs) was frequent, but overall represented 17% by volume. Belowground parts are relevant (26% of total volume), especially pignut *Conopodium* sp.

Animal matter had a low total volume and a high frequency in the diet. Vertebrates and invertebrates had a similar importance, both in terms of volume and frequency. Birds were an important component by volume and, in decreasing order of importance, snails, insects, and crustaceans were important by frequency. Birds were present in 21.6% of the stomachs. The main crustacean in the diet, American crab *Procambarus clarkii*, was found in 35% of the stomachs. Birds in the diet included a common moorhen *Gallinula chloropus* and its nest. Among insects, caterpillars were the main prey consumed by wild boar. The legs and beak of a purple gallinule, three chicks, and the egg, and an unidentified *Anas sp*. were also found.

TABLE 1
Foods of wild boar living in the Aïguamolls de l'Empordà Natural Park. Average volume and frequency were determined using stomach content analysis (2001, N=37).

Foods	**Volume (%)**	**Frequency(%) N=37**
Plant matter	91.9	100.0
Aerial parts	65.8	91.9
Agricultural elements	48.6	70.3
Corn *Zea mays*	25.4	37.8
Apples *Malus* sp.	1.5	10.8
Sunflower seeds *Helianthus annuus*	10.1	24.3
Oat *Avena sativa*	5.6	16.2
Barley Hordeum vulgare	5.9	18.9
Non agricultural elements	17.2	67.6
Leaves and twigs	13.9	62.2
Fruits	3.3	10.8
Berries	0.3	2.7
Hard mast *Quercus* sp.	2.8	5.4
Undetermined black fruit	0.3	2.7
Underground	26.0	54.1
Pignut *Conopodium* sp.	17.4	29.7
Undetermined plant matter	0.1	5.4
Animal matter	8.1	83.8
Invertebrates	3.2	28.0
Crabs	1.1	35.1
Earthworms	0.1	13.5
Insects	0.9	37.8
Snails	1.0	51.4
Vertebrates	4.9	32.4
Fish	+	2.7
Birds	4.9	21.6
Mammals	+	5.4
Garbage	+	8.1

A clear seasonal pattern in the diet was evident (Figure 2 and Table 2). Aboveground components of plants (agricultural and non-agricultural) were gradually replaced by belowground parts of plants between summer and winter; then, aboveground components increased gradually. The consumption of below ground plant components was lowest in summer and highest in early winter, with more than 50% of total volume. Even if there was no statistically significant seasonal shift, non-agricultural products varied between 1% (January-February) to 24% (July-August) of total volume. Finally, two stomachs contained garbage.

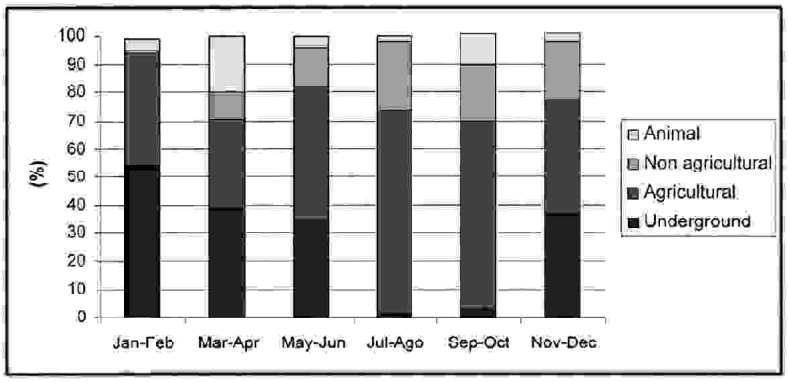

Figure 2. Bimonthly diet of wild boar in the Aïguamolls de l'Empordà Natural Park determined from stomach content analysis (2001, N =35).

TABLE 2
Percentage volumes of bimonthly diets of wild boar living in the Aïguamolls de l'Empordà Natural Park determined using stomach content analysis (2001, N =35). Kruskall-Wallis Test: ns, non significative; *, significative, p≤ 0.05.

Food	January-February (N =5)	March-April (N = 5)	May-June (N = 8)	July-August (N = 5)	September-October (N = 7)	November-Dicember (N = 5)	Weighed average (N = 35)	*P K-W*
Agricultural	40	32	47	73	67	40	49.8	ns
Non agricultural	1	9	14	24	20	21	14.8	ns
Underground	54	39	35	1	3	37	28.2	*
Animal matter	4	20	4	2	11	3	7.3	ns
TOTAL	100	100	100	100	100	100	100	

DISCUSSION

The diet of the wild boar in the Natural Park is similar to the general pattern described for other localities (Henry and Conley 1972, Briedermann 1976, Baettig 1980, Genov 1981, Scott and Pelton 1981, Leránoz 1983, Sjarmidi et al. 1992,

Abáigar 1993, etc.). In general, the diet is quite diverse, based on the four major food categories found in the species' diet (Schley and Roper 2003): mast, roots, green plant matter, and agricultural crops. Those four elements are not always present in all of the local diets.

In comparison with the diets in other populations occupying wetlands in the Mediterranean region, some important similarities and differences are apparent. As in the Aïguamolls de l'Empordà Natural Park**,** in Doñana National Park (Venero Gonzáles 1984, Garzón et al. 1984) and the Camargue (Dardaillon 1984) there are important agricultural resources nearby (Doñana) or inside the area (Camargue).

In the Aiguamolls, wild boar prefer aboveground plant resources (agricultural and non-agricultural) to belowground parts. Agricultural fruit are consumed year-round, but especially in summer, when fruit have their highest nutritional value. The belowground diet is relevant throughout much of the year, except from July to October, when the agricultural diet is more important. The alternative food to agricultural and other above-ground resources are the belowground parts of plants, as occurs in the Camargue and Doñana NP. Pignut is of particular importance in the Aiguamolls. In Doñana and the Camargue wild boars consume *Scirpus maritimus* bulbs (the main food in Doñana), *Phragmites communis* shoots, *Sonchus maritimus* roots, *Crepis bulbosa* bulbs, and *Cynodon dactylon* bulbs. Agricultural products are important only in the Camargue and the Aiguamolls and, consequently, appear in the wild boar diets. Those seasonal resources provide wild boars with high-energy products, such as corn over a long portion of the year, and probably prevent more extensive rooting in the wetlands. In Doñana NP, wild boars consume mushrooms in winter, and a some amount of bracken *Pteridium aquilinum* in autumn and winter. Acorns and pine seeds *Pinus pinea* also present, but are not relevant to the diet. In the three areas, the consumption of vertebrate animals is of some importance and the diet is diverse compared to other local diets, which is probably due to the high diversity of these habitats, e.g., In Doñana NP, amphibians, reptiles, carp, large mammal carrion, and birds); in Aiguamolls, birds and American crab); in the Camargue, carp. Clearly, local wild boar diets mainly depend on which foods are available in each area.

Wild boar might have some impact on the Aïguamolls, partly because of the relatively high frequency of birds in the diet, and the possible influence on vegetation dynamics when searching for food below ground. For instance, the purple gallinule, an endangered bird, was recently successfully reintroduced to Aïguamolls de l'Empordà Natural Park and has become part of the wild boar's diet. Wild boars are known to feed on the eggs and young of ground-nesting birds (Matshcke 1964, Henry and Conley 1972, Venero Gonzáles 1984), which are relatively easy to catch, but the impact of wild boar on bird populations is unknown. On the other hand, rooting for

pignuts might advantageous for this bulb, creating through this perturbation, new opportunities for its growth.

To better understand the impact of wild boar on the fauna and flora of the Aïguamolls de l'Empordà Natural Park, particularly on ground-nesting birds and bulbs, the ongoing wild boar culling programme and stomach content analysis should continue.

Acknowledgments

This communication is part of the results of a survey on wild boar biology in the Natural Park of Aïguamolls de l'Empordà, who financed the research. We especially acknowledge the support of Josep Espigolé and Sergi Romero, from the staff of the Natural Park. We are also grateful to the rangers of the Cos d'Agents Rurals for their help with the field work, and to the ornithologist Jordi Martí, who helped us in the identification of bird parts. Finally, we would like to thank Javier Aguirre, Daniel Gómez, Federico Fillat, and Pedro Monserrat from the Pyrenean Institute for Ecology for the determination of plant parts.

References

Abáigar, T. (1990). *Características biológicas y ecológicas de una población de jabalíes (*Sus scrofa *L., 1758) en el SE Ibérico.* PhD Thesis. Universidad de Navarra. Pamplona, España.

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

Baettig, M. (1980). *Contribution á la biologie et écologie du sanglier (*Sus scrofa*) dans le Canton de Vaud.* PhD Thesis. Universidad de Bale.

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

Dardaillon, M. (1984). Utilization des ressources trophiques par le sanglier (*Sus scrofa*) en Camargue. Pp. 419-426. In: A. Haro and X. Espadaler (eds.). *Processus d'acquisition précoce*. Barcelona University and Societé Française pour l'etude du comportament animal. Barcelona, Spain.

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.

Garzón, P., F. Palacios and C. Ibáñez (1984). 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. (1981). Die Verbreitung des Schwarzwildes (*Sus scrofa* L.) in Eurasien und seine Anpassung an die Nahrungsverhältnisse. *Zeitschrifte für Jagdwissenschaft*, 27: 221-231.

Gerard, J. F., P. Teillaud, F. Spitz and R. Campan (1991). Le sanglier. *Rev. Ecol. (Terre Vie)*, Suppl., 6: 11-66

HENRY, V. G. AND R. H. CONLEY (1972). Fall foods of european wild hogs in the southern Appalachians. *Journal of Wildlife Management*, 36 (3): 854-860.

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:* 639-645. Trujillo (Cáceres), España.

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.

ROSELL, C., F. NAVAS, S. ROMERO AND I. DE DALMASES (2004). Activity patterns and social organization of wild boar (*Sus scrofa* L.) in a wetland environment. Preliminary data on the effects of shooting individuals. *Galemys*, 16 (n.e.): 157-166.

SÁEZ-ROYUELA, C. AND J. L. TELLERÍA (1986). The increased population of the wild boar (*Sus 5scrofa*) 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 (1981). Seasonal food habits of the European wild hog in the Great Smokey Mountains Park. *Proceedings of the Annual Conference of the South East Association of Fish & Game Wildlife Agencies*, 29: 585-593.

SJARMIDI, A., F. SPITZ AND G. VALET (1992). Food resource used by Wild Boar in Southern France. Pp. 171-173. In: F. Spitz, G. Janeau, G. González and S. Aulaguier (eds.). *Proceedings of the International Symposium Ongules/Ungulates 91*. Tolosa, France.

VENERO-GONZÁLES, J. L. (1984). Dieta de los grandes fitófagos silvestres del Parque Nacional de Doñana. *Doñana, Acta Vertebrata*, 2 (3): 19-130.

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.