WILD BOAR DISTRIBUTION TRENDS IN THE LAST TWO CENTURIES: AN EXAMPLE IN NORTHERN SPAIN

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Abstract: An analysis of the Wild boar distribution in the province of Asturias has been monitored from 1800 to 1991. Considering periods of half a century our results reveal a minimum in Wild boar distribution occurring around the middle of the XIXth century and a strong increase in the second half of the XXth century. Several hypotheses have been advanced in order to explain this expansion, including an amelioration of winter temperatures, Wolf population reduction, human depopulation and ageing in rural areas. Comparing each of these data sets with the Wild boar distribution from 1850 until now the results show that only ageing of rural people has evidenced a good relation with the Wild boar expansion occured in these last decades. Obviously, ageing of human rural population led to the desertion of crops and field as well as to a decrease in stockbreeding practices. All this meant an instantaneous take over of shrublands and forests which have been used by wild boars as diurnal shelters.

Keywords: Wild boar, *Sus scrofa,* Suidae, Populations, Historical distribution, Environmental changes.

IBEX J.M.E. 3:137-140

1. Introduction

The spectacular expansion of the Wild boar during the last decades is a generalized fact in Europe (Sáez-Royuela & Tellería, 1986). Several hypotheses have been proposed in order to find the reasons which account for this process. These are based on several factors whose variation through time may have affected the population of wild boars, such as the milder winters (Sáez-Royuela & Tellería, *op. cit.*), the reduction of Wolf populations, the desertion of the countryside, the ageing of the rural population and other related activities, such as the decrease in the Goat population and in the wood collection activity. (Tellería & Sáez-Royuela, 1985).

The availability in Asturias of measurable information on the presence of wild boars and wolves (expressed in surface occupied by each species), thermometrical registers and estimations of human population by ages in the XIX and XX centuries, allow the validity of these hypotheses in that territory to be verified along a longer period of time than that studied in Spain by Tellería and Sáez-Royuela (*op. cit.*).

2. Study area

The Principado de Asturias spreads along a stretch of land of about 60 km of average width between the Cantabrian Mountain Range and the northern coast of Spain, with an extent of more than 10,500 km^2. Its relief and vertical zonation are very well defined, with altitudes between sea level and 2,648 m. Climatic conditions range from atlantic to mountain climats with average annual rainfall higher than 1,000 mm which duplicates in mountainous zones.

3. Material and methods

Historical information on the presence of wild boars and wolves has been obtained from a number of geographical dictionaries, specially those of Martinez Marina (1801-1802), Miñano (1825-1827), Madoz (1846-1850), González Aguirre (1897) and Sánchez Mazas (1956-1961) and recent information derives from a questionnaire carried out in 1991, by the Hunting and River Fishing Service of the Principado de Asturias.

The results have been studied considering five chronological periods of half a century, *i.e.* 1800, 1850, 1900, 1950 and the present one 1991. The territorial unit used has been the demarcation of the 78 asturian municipalities.

Faunistic information comes from the hunting species lists available in the geographical dictionaries for municipality, considering that a species is present when it is included in a list, absent when it is not included, and without information when there is not any list related

to the municipality or when the information is ambiguous. The study of the Wild boar presence variation was carried out considering only those municipalities with shared information (presence or absence) in the compared periods. Data on human population (density and percentage of inhabitants older than 60) only refer to rural municipalities (Criado & Pérez, 1975; Sadei, 1992). Climate data, such as the average minimum temperature in the coldest month, as a representation of winter temperatures, come from the climatological station of Oviedo, where there is a virtually continuous register since 1851 (Mateo, 1983).

4. Results

The Wild boar in Asturias has undergone reductions and expansions in its range in the last two centuries which may become evident considering the number of municipalities where its presence has been proved (Fig. 1) and it can be compared with other parameters equally variable during the same period (Tab. 1).

A statistically significant reduction of the range of the Wild boar between 1800 and 1850, when the smallest extent is reached, has been stated. In the 1850-1900-1950 periods its increase is not significant (Q of Chochram=3.700; p=0.1572; n=41), but since the middle of this century the Wild boar extends throughout the municipalities with a softer relief in the West center of the region along the montainous axes, and it reaches the East and West coasts. Nowadays it is absent, or scarce, in the central municipalities, which are flatter and more densely populated. The expansion is verified in the fact that an occupation of 63% of the land units around 1950, becomes 92% in 1991.

In Asturias, the Wild boar now is not an important prey for the Wolf, since it only appears in 6% of its scats (Braña *et al.*, 1982). Therefore, the present increase of the Wild boar does not correspond to a decrease in the number of wolves. The historical data corroborate this assumption, since they show a similar variation considering that the smallest number of wolves is in 1900 and there is also a later increase (Q=15.461; p=0.0004; n=53) which is smaller than that of the Wild boar in the second half of this century (Fig. 2).

The increase in winter temperatures doesn't either provide a sufficient explanation for the great increase of Wild boar in the last decades. Even though a positive and significant correlation through time is achieved (r=0.2871; p<0.005), indicating an increase of winter temperatures in more than one century, such increase is probably a slow and accumulated the long term effect. This is proved by the fact that dividing the thermometrical series in spans none of the slopes of temperature increments in each one differs significantly from zero ($b_{1851\text{-}1899}$=8.985, p=0.412; $b_{1900\text{-}1945}$=0.018, p=0.3; $b_{1946\text{-}1990}$=8.248, p=0.551). In addition, the comparison of the average temperature increase in winter between the first and second half of this century doesn't either show a significant increase (t=1.5716; p>0.1).

In rural municipalities, a reduction in the density of human population is confirmed, from 47.9 inhabitants/km^2 in 1950 to 37.2 inhabitants/km^2 in 1991. However, such variation is relatively small when compared with the ageing of rural population (the percentage of inhabitants older than 60 increase from 7.7 to 24.9).

5. Discussion

From the existing data in Asturias it is not possible to prove a significant relation of the milder winters, the lower rates of wolves, or the decrease in the density of human population in rural areas, with the recent expansion of the Wild boar. Nevertheless, the ageing of rural population shows a bigger increase which is parallel to that of the Wild boar. The ageing, caused by youth depopulation of the countryside, has caused the desertion of lands dedicated to production of grass using a traditional stockbreeding.

There is a parallel strong decrease in the Goat population, whose browsing feeding limited the expansion of the bush. The number of goats has decreased in Asturias from 102,313 in 1938 to 15,895 in 1964, with a slight increase in later years (Fernández Lamuño, 1986). Such decrease of goats was due to the reforestation policy which began in the fourties carrying out repressive measures against those livestock species which were harmful for the forest crops.

All these effects have increased the areas covered by bushes and woods, used by wild boars as diurnal shelters thus favouring their expansion, even in agricultural ecosystems which have been modified by mechanization (see Cargnelutti *et al.*, 1990).

While in the northern side of the Cantabrian Mountain Range the expansion developed from the mountain to the coast, in the southern side the contrary procedure took

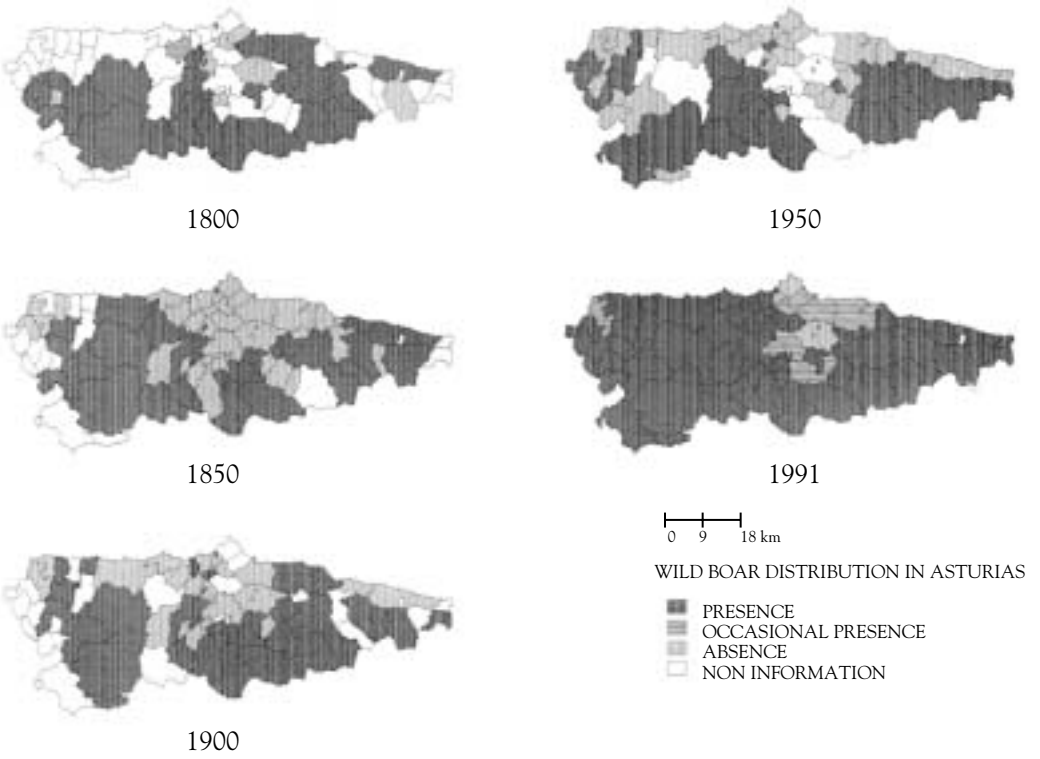

Figure 1. Asturian municipalities with a presence of wild boars between 1800 and 1991.

Tab. 1. Environmental variables susceptible to affect the Wild boar population in Asturias. Signification levels of the MacNemar correlated proportions test show the differences between frequencies of Wild boar presence at different periods.

Variables	1800	1850	1900	1950	1991
inhabitants/km^2	-	42.6	45.3	47.9	37.2
% inhabitants older than 60	-	4.0*	6.0*	7.7	24.9
average minimum temperature**	-	1.94	2.06	2.60	2.76
Signification level		0.007	0.092	0.179	0.000

*Estimated values; **average variable values of every 25 and 50 years

place. In the middle of the last century, wild boars were scarce in the Leonese mountainous areas and these were not widely occupied until a century later. Such recolonization is interpreted as an expansion to the least climatically suitable zones due to the human pressure in the lower cultivated lands (Sáenz de Buruaga, 1987).

An explanation to this inverse model of the territorial expansion of the Wild boar may be due to the topographical dissymmetry of both sides. Whereas in the northern one, with an average slope of 34%, deep valleys allow wild boars to experience great altitude variations with few movements, in the southern side this is not possible owing to its smaller slope (21%). Under such conditions, the answer of wild boars to adverse meteorological conditions is much more flexible in Asturias than in León.

6. Acknowledgements

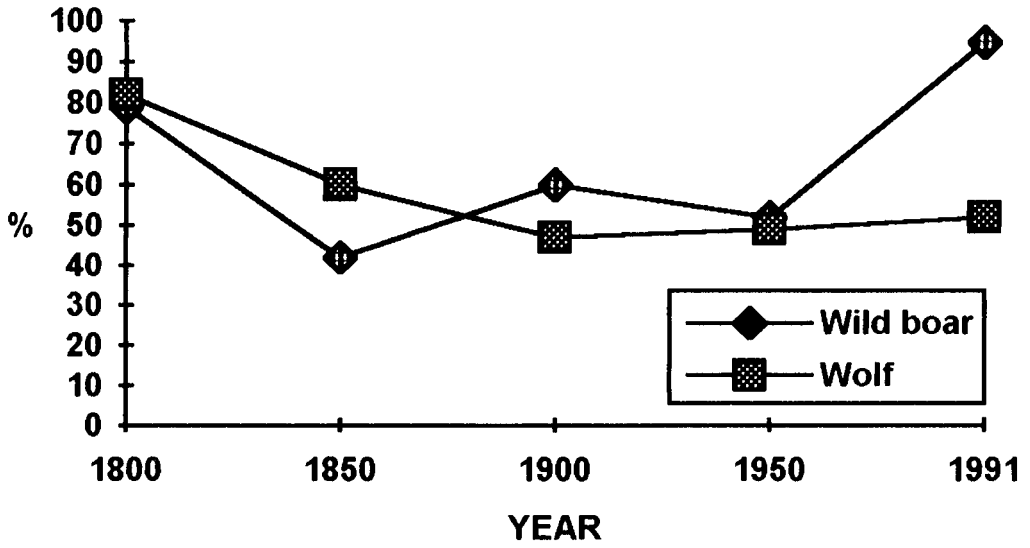

Figure 2. Variation of Wild boar and Wolf presence percentages in Asturian municipalities in the different time periods.

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DISTRIBUTION OF WILD BOAR (Sus scrofa) IN PIEDMONT AND AOSTA VALLEY (NW ITALY)

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Abstract: The authors analyse the distribution of Wild boar in Piedmont and Aosta Valley (NW Italy) on the basis of data collected from 1989 to 1993.

Keywords: Wild boar, *Sus scrofa,* Suidae, Distribution, Europe.

IBEX J.M.E. 3: 141-144

1. Introduction

Wild boar disappeared from North-West Italy at the beginning of the 19th century (De Beaux & Festa, 1927). After about a century the species reappeared in Piedmont owing to migration of individuals from France (De Beaux & Festa, *op. cit.*); afterwards artificial restocking contributed to its re-colonization of Piedmont and Aosta Valley.
Data concerning the distribution of Wild boar in the area during the past have been reported by Ghigi (1950), VV.AA. (1981) and Pavan & Mazzoldi (1983) (Fig. 1).
The aim of this study was to verify the present distribution of the species in Piedmont and Aosta Valley, according to new data collected from 1989 to 1993 for the Italian Mammal Atlas Project (Prigioni *et al.*, 1991).

2. Study area

Study area (Fig. 2) consists of Piedmont and Aosta Valley regional territories, for a total of about 2.87 millions ha. It can be divided into four main geographical parts: Alps (areas with alpine peaks above 1,500 m u.s.l.), Pre-Alps (areas skirting the alpine foothills with peaks

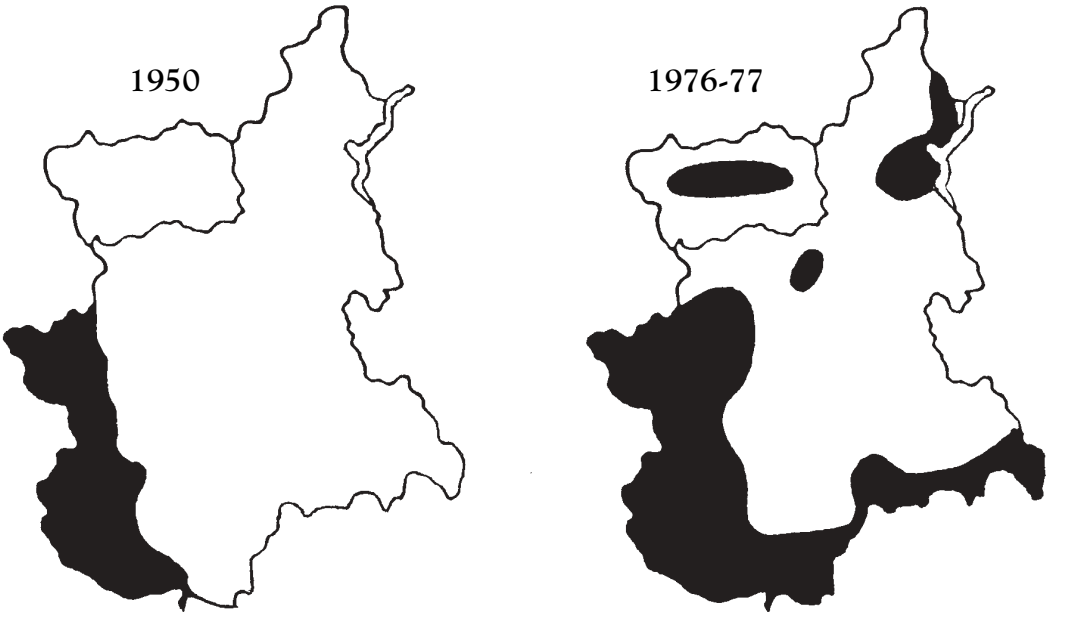

Figure 1 - Wild boar distribution in 1950 (Ghigi, 1950) and in 1976-77 (VV. AA., 1981; Paran & Mazzoldi, 1983)

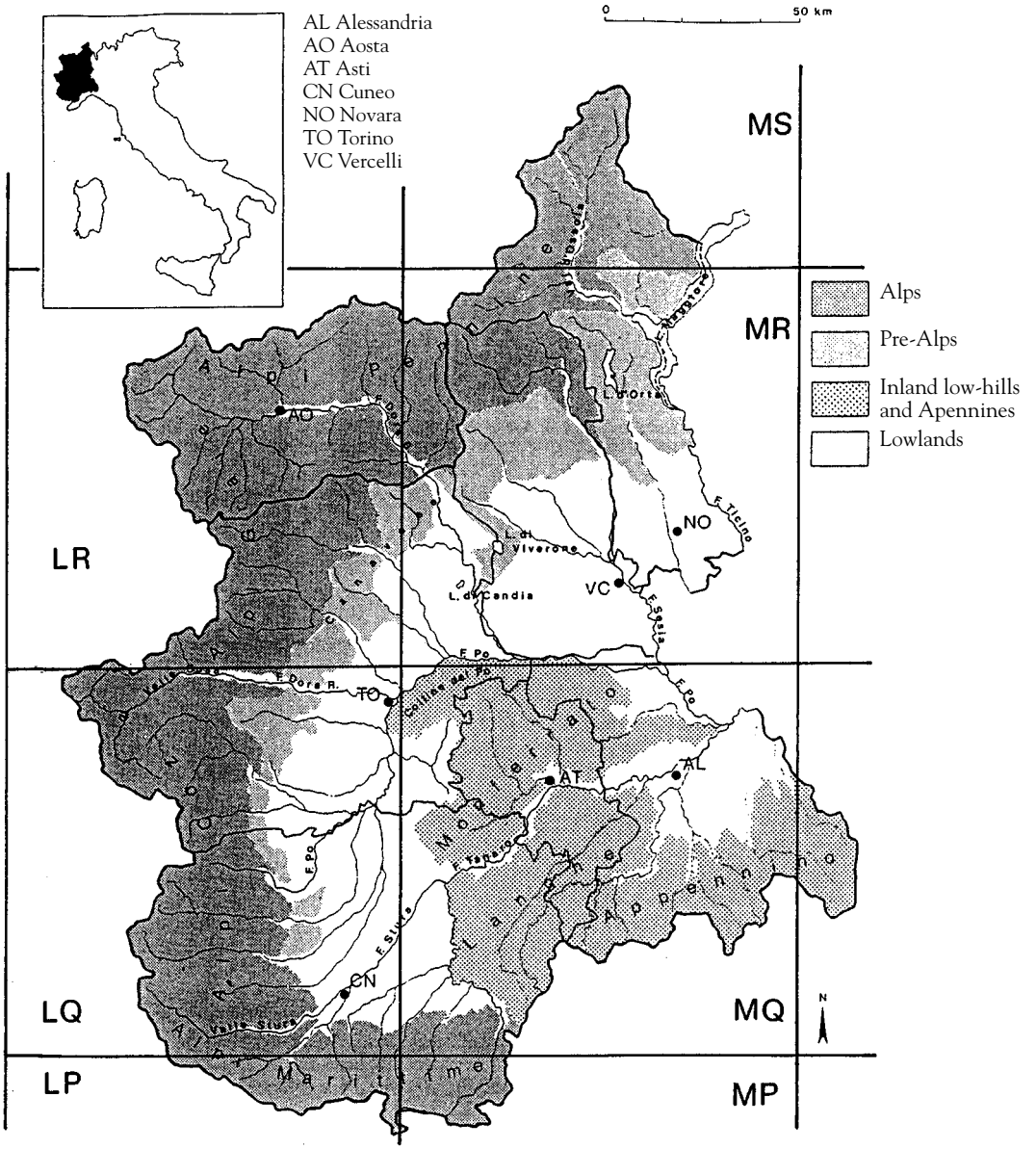

Figure 2 - Study area. Physical map of the two regions and main touns (from Mingozzi et al., 1988, modified). Squares identification according to UTM 100 km grid.

not higher than 1,500 m u.s.l.), Inland low-hills and Apennines (Po Hills and Monferrato, Langhe and Apennines uplands) and Lowlands (lowland areas and wide alpine valley floors of altitude not over 600 m u.s.l.). 35.47% of the area is occupied by forests, 44.08% by fields and grazing lands (ISTAT, 1993).

3. Material and methods

2402 records of Wild boar presence have been collected, arising from:
- hunting (70.2%);
- sightings (8.2%);
- signs of presence, crop damages (20.1%);
- road casualties (1.5%).

Distribution of Wild boar in the study area has been mapped using 10 km squares of the UTM grid (Universal Transverse Mercator projection). Recorders (people and organizations) who have contributed records are listed in appendix.

4. Results

Wild boar was recorded on 214 of the 346 grid squares of the study area (Fig. 3). The maximum altitude record has been collected at 2,600 m u.s.l. (P.ta Lunella, Usseglio, Viù Valley, Turin), the minimum at 102 m u.s.l. (Loc. Fabbriche, Solero, Alessandria).

The sharing of records according to the four main geographical parts of the study area does not significantly differ from their availability (χ^2 = 1.120, d.f. = 3, p >0.5; Fig. 4), confirming the ecological adaptability of the species.

In comparison with the distribution registered in 1976-77 (VV.AA., *op. cit.*; Pavan & Mazzoldi, *op. cit.*) Wild boar has widely extended its range.

At present, Piedmont and Aosta Valley appear entirely re-colonized by the species, with the exception of the alpine area of the province of Novara.

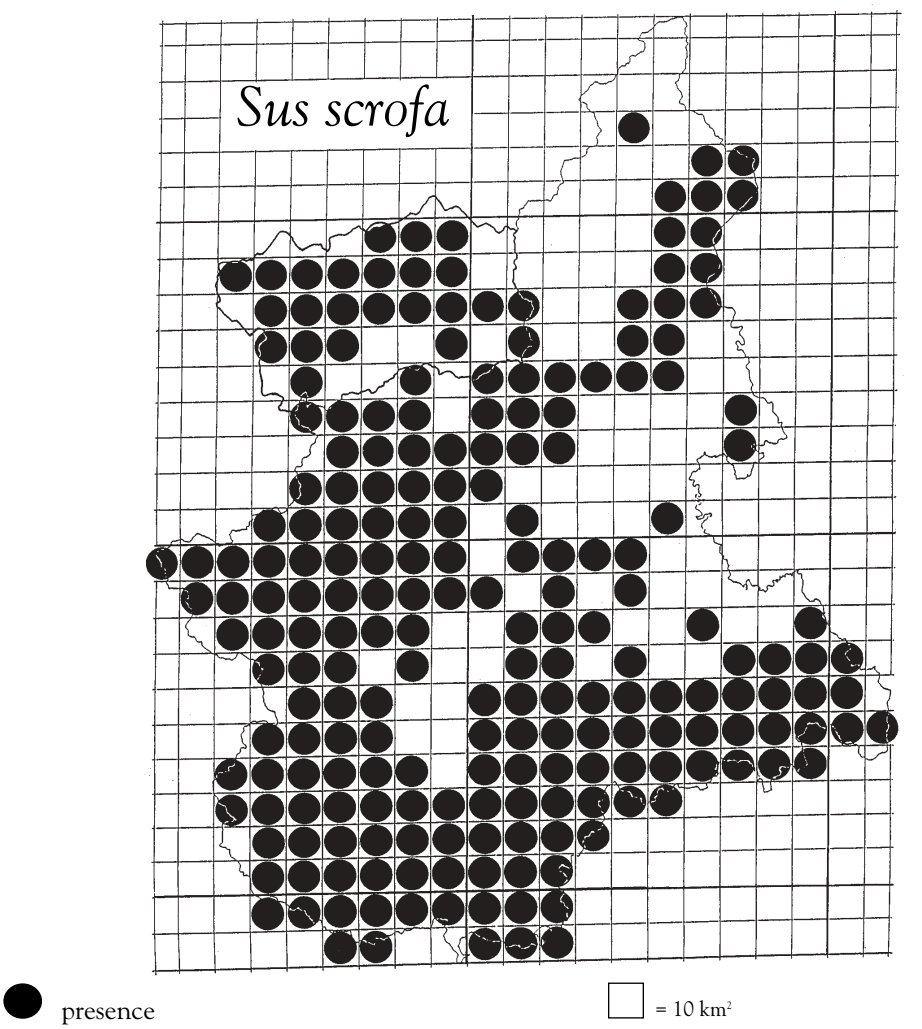

Figure 3 - Wild boar coverage map on the basis of data collected from 1989 to 1993

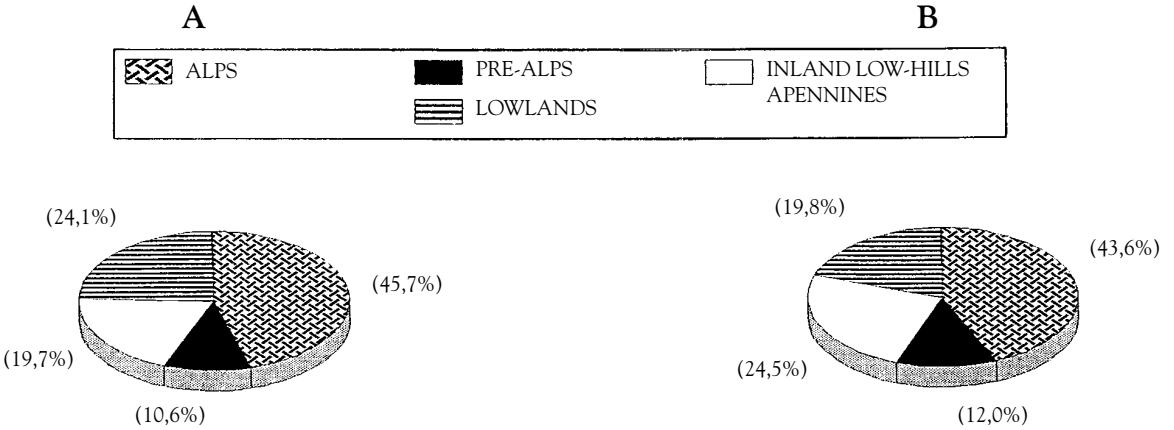

Figure 4 - UTM grid squares availability (percent of the total surface) in relation to the geographical features of the study area (A) and their use by Wild boar (B)

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Appendix

Recorders:

Foresters of Alessandria, Alessandria Provincial Government, Asti Provincial Government, Cuneo Provincial Government, Novara Provincial Government, Torino Provincial Government, Vercelli Provincial Government, Baratti N., Bassano B., Bertolino S., Blondin M., Boano G., Canepari M., Cout G., Debernardi P., Durio P., Janavel R., Gallo Orsi U., Gennaro A., Grosso M., Macchi E., Mangini V., Orellier P., Laghi di Avigliana Natural Park, Orsiera-Rocciavré Natural Park, Val Troncea Natural Park, Gran Paradiso National Park, Patriarca E., Perrone A., Aosta Valley Autonomous Region, Reteuna D., Rizzotto M., Rosselli D., Sabidussi R., Silvano F., Spanò S., Tabladini S., Trogolo A.

THE WILD BOAR (Sus scrofa) IN THE GRAN PARADISO NATIONAL PARK (ITALY): PRESENCE AND DISTRIBUTION

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Keywords: Wild boar, *Sus scrofa,* Suidae, Distribution, Europe.

IBEX J.M.E. 3:145-146

The distribution of Wild boar in the Gran Paradiso National Park (Western italian Alps), between 1987 and 1993 is presented (Fig. 1). Prior to this period indications regarding the presence of this ungulate, never recorded before in this area in historical times, were the exception and confined to limited low-level areas on the Piedmont side of the Park (Soana valley).

From 1987 onwards direct and indirect reports of the presence of this animal have become increasingly numerous and more and more within the Park itself. The valleys which have the greatest populations of this ungulate are those on the Piedmont side of the Park (Orco and Soana valleys) which are doubtless more suitable to Wild boar from the point of view of physiognomy and vegetation.

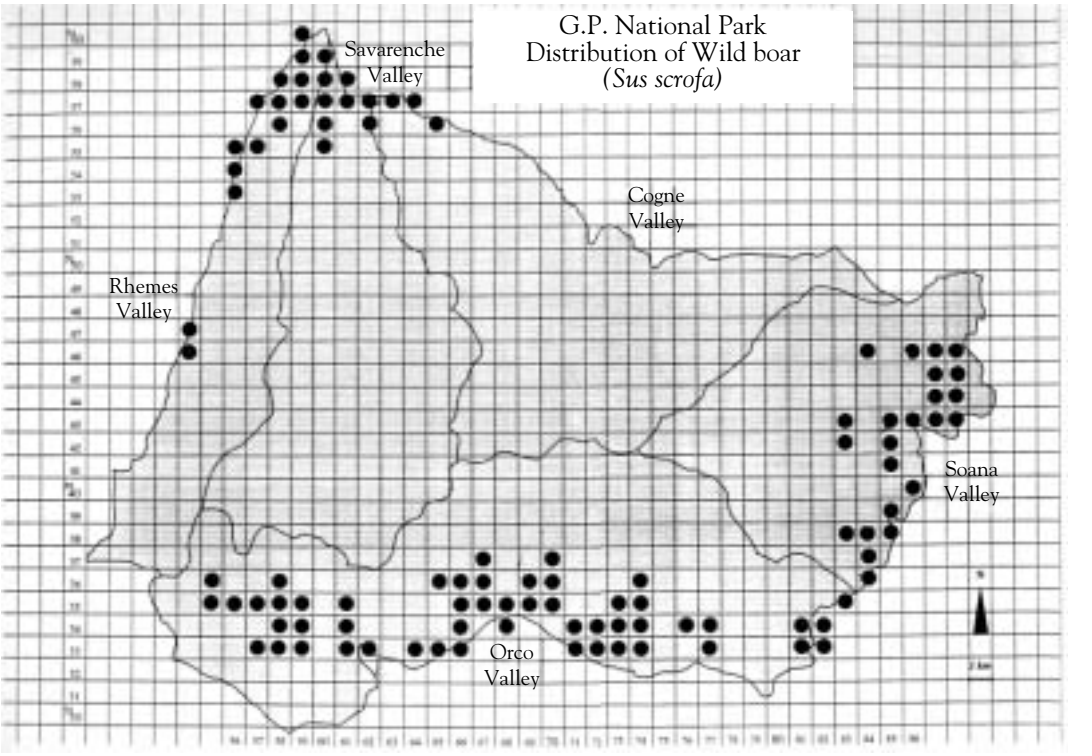

Figure 1 - Gran Paradiso National Park: distribution of Wild boar. ☐ = 1 km² ● = Presence of Wild boar

The year in which the initial first-hand reports were given and the highest altitudes at which traces of their presence were found, both directly or indirectly, are given for each valley, together with the sightings of sows with newborn or striped young.

Soana valley:
First direct sightings in the spring of 1987; highest altitude at which sighted: 2,150 m - Alpe Giuoco; highest altitude sighting of female(s) with striped litter: 1,350 m, at the end of September (2 females with 2 litter of 5).

Orco valley:
First direct sightings: 1987; highest altitude: 2,600 m - Gran Piano, trace of presence on alpine pasture; highest altitude sighting of female(s) with litter: 1,800 m - Gran Prà, at the end of June (1 female with litter of 4).

Rhemes valley:
First traces: 1988; highest level: 2,000 m on north-western slopes of Mont Blanc; highest altitude sighting of female(s) with young: 1,750 m - Mt. Puppet (1 female with suckling litter of 4).

The Cogne and Valsavarenche valley today still note only marginal reports of the presence of Wild boar. The reports in the Cogne valley are limited to the areas at the valley bottom at the edge of the Park, while some reports testify its presence at the head of the Valsavarenche valley on the orographic left, up to a height of 1,800 m and in the valley bottom (Fenille - 1,300 m).
In some lower areas of deciduous woodland in the Soana valley, a gradual modification of the areas occupied by Chamois (*Rupicapra rupicapra rupicapra*) has been noted probably following the arrival and establishment of the Wild boar.

THE EXPANSE OF THE WILD BOAR HABITAT IN SLOVENIA

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Keywords: Wild boar, *Sus scrofa,* Suidae, Ecological project.

IBEX J.M.E. 3:147

Since 1978 and 1982 respectively, in two hunting-grounds measuring approximately 4,000 hectares each a field study of the expanse of the Wild boar habitat was carried out. The entire project which has not been concluded yet, is carried out in an area, where Red and Roe deer are the most important game species, and where the environment is still in a pretty good shape, though the first consequences of the man's activities already begin to show themselves. The main objective of our research was to establish the expanse, and the characteristics of Wild boar habitats, as well as ecological and ethological properties of this game species.

For this purpose wild boars were trapped in special catching sets, marked with ear-tags, and released immediately. Animals were caught by skilled personnel, using only mechanical catching devices so that there were practically no losses. With regard to the feeding conditions wild boars were caught mainly in autumn, and partly in spring. It is also possible to do this in summer, of course, but we made the same experience as it is mentioned in the literature, namely that sows bite of tags from the ears of their piglets during social care. Generally we used plastic tags, and marking tongs "Dalton".

Till the end of October 1993, about 160 animals, mainly piglets, have been caught. For more than a half of them we collected feedback information (the place where they have been taken, the weight of the animal, its social rank, etc.).

The first research area lies approximately 70 km south-east of Ljubljana at 300-350 m u.s.l. in a typical karst landscape with predominately leafy woods with rich undergrowth. Though there is a lot of food throughout the year, wild boars are fed in order to prevent game damage.

The second area lies approximately 25 km west of Ljubljana (south of the Ljubljana-Postojna highway) at approximately 700 m u.s.l.. The fir and the beech are the predominant tree species here. The natural food for the wild boars is rather scarce. Here, too, wild boars are fed throughout the year. In both areas the bear and the linx are sedentary game; the wolf appears rarely.

The data we collected mainly confirm that some animals, first of all adult males, have big areales, while others, mainly sows, are quite happy with smaller ones.

FERAL PIG ECOLOGY IN CAPE TRIBULATION NATIONAL PARK, NORTH QUEENSLAND, AUSTRALIA

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Abstract: Results of an initial feral pig trapping and sampling program in the Cape Tribulation National Park and results from a survey of pig activity are presented. Pigs from the central and northern areas of the Park have a different origin from feral pigs from other regions of Australia. This is based on coat colour, the presence of a Melanesian tick, and a stomach nematode not previously recorded in Australia. Feral pigs pose a risk to human health. From this sample of 61 pigs, 11 different serovars of Leptospirosis were isolated. 66% of the sample was positive for Meliodosis, while Brucellosis occurred in 1% of the sample. The pig helminths Stomach Worm, Lungworm and Kidney Worm were found at high infection rates. A peculiarity of the area was the close association of human habitation with feral pigs around subdivisions adjacent to the Park. Pigs from these areas were on average 2x heavier, weight for age, than their purely forest dwelling associates. Pig activity in the central and southern areas of the Park was recorded as an adjunct to a survey of cassowaries in the area. With data on elevation and habitat, it was possible to investigate the association of pig activity with these variables in selected catchments over the 7 months of the survey. Information presented includes: measured impacts on the environment, management implications of these initial research data and guidelines for future work on trapping, investigation of seasonal habitat usage and applied ecology of feral pigs in the Wet Tropics World Heritage Area of North Queensland.

Keywords: Feral pig, *Sus scrofa,* Suidae, Diseases, Parasites, Health, Pathology.

IBEX J.M.E. 3:148-151

1. Introduction

The origin of pigs in North Queensland is uncertain. They may have been traded with Timor, New Guinea and/or Melanesia before the arrival of Europeans.

There has been limited feral pig research in North Queensland. This includes a 4 year ecology study in the tropical savannah environment (Pavlov, 1991) and the examination of a sample of 6 animals from the Tully area (Pavlov & Graham, 1985). The pig situation prior to January 1992 was presented in Pavlov, Crome and Moore (1992). A small project on the ecology and control of pigs on the tropical coastal lowlands (Pavlov, 1992; Pavlov & Edwards, 1992) was carried out between April and July 1992. A cassowary survey, which included pig activity observations, by Crome and Moore was undertaken between September 1992 and April 1993.

Pigs are distributed throughout the area and they are perceived as having an adverse but as yet unquantified impact on many aspects of the environment. There is a heightened public awareness that feral pigs are a negative feature of rainforests of the wet tropics. Results of community consultation during 1992 (community attitude survey, public introductory questions, a workshop summary and public submission summary) demonstrated to the Wet Tropics Management Agency, that control of feral animals and weeds were the highest priority issues in the public's mind (W.T.M.A., 1992).

Feral pigs cause further problems as reservoirs for diseases and parasites that can infect humans and/or domestic livestock (Pavlov, 1987; Pavlov, 1988) and are a potential physical threat to visitors of forested areas.

2. Methods

Ecological information was obtained from trapped and field shot animals. After basic morphometrics were recorded and the pig aged according to Matschke (1967), each animal was autopsied and parasite infections determined, pathology samples collected and reproductive information recorded from the females. Blood samples were left to clot at ambient temperature for 12 hours. Sera were sent to the Department of Primary Industries, Oonoonba Research Laboratory, for Leptospirosis, Brucellosis and Meliodosis screening, and also to the Department of Health, Brisbane, for detailed Leptospirosis screening. Stomach contents were weighed at the time of dissection and stored frozen for later particle and nutritio-

nal analysis. Contents were sorted by hand and the relative components weighed. Nutritional analysis of pig stomach contents was carried out by the Department of Primary Industries, Animal Research Institute, Yerongpilly, Qld.
Control: Weldmesh traps of panel, circular and box design were used. The panel and the circular traps incorporated a one-way swinging gate at the entrance, while the box trap used a drop door at the entrance. A range of food sources for the traps was trialled subjectively. The most suitable, as judged by cost, availability, safety for non-target species and effectiveness, was found to be cracked corn (soaked in water overnight).
Because of the short duration of the study, it was not possible to assess the long-term response of the pig population to the continuous presence of traps baited with particular foods, or the seasonal acceptability of the most suitable bait used during the trial period.
Transects: Activity transects were defined by flagging a one kilometer line from sea level directly west, with a marker (plastic flagging tape) every l0 metres. Pig activity was recorded each week, in a strip 5 metres wide, either side of this line. The two sites recorded for the duration of the project were in an area of high visitor use (including the Oliver Creek Marrdja Boardwalk) and an area partially developed which passed an open rubbish dump and then continued through rainforest (Myall valley). With regular monitoring, it was possible to define pig activity in three categories: fresh (< 24 hours old), recent (< one week old), and old (> than 1 week old).

3. Results

3.1. Ecology

Pigs in the rainforest of Cape Tribulation National Park are mostly agouti patterned adults. The range of species of rainforest fruits eaten by pigs is potentially great, but awaits detailed analysis over all seasons at representative sites. Earthworms were present in most of the stomachs, reaching 20.4% of the contents in one instance. The percentage reduction of worms due to pig predation varied from 62% to 93%. Unidentified fibrous plant material was the most common item in forest-dwelling pigs. Of interest was the occurrence of garbage in one animal (No. 51). The stomach contents of a further three pigs from the vicinity of the rubbish dump consisted almost entirely of garbage, indicating their role as scavengers around human habitation.

3.2. Parasites and diseases

Parasites and diseases (the latter recorded by positive antibody titres) found in feral pigs are listed in table 1. They include the pathogens that cause disease in humans (Brucellosis, Leptospirosis and Meliodosis). Ross River Virus and Murray Valley Encephalitis Virus have been isolated from feral pigs on Cape York Peninsular (Pavlov, 1988), but have not been surveyed for in the Wet Tropics Management Area to date.
Of note is the high external parasite load. Ticks averaged 1.6 per animal and the groin was the preferred site of attachment. There was a high incidence of Kidney Worm and Red Stomach Worm. These helminths have a direct infective larval stage so that an intermediate host is not required for the successful completion of the life cycle. Lungworm was also common, and with earthworms as the intermediate host, the importance of this dietary item to feral pigs is further supported.

Table 2 illustrates the development of parasite infection in young pigs. By 6 months of age, Kidney Worm has infected 75% of the sample, and Stomach Worm and Lungworm have infected approximately 50% of the sample. Because Kidney Worm and Lungworm are capable of direct infection, the penning of pigs of this age would ensure an escalation of helminth infection. By 12 months of age, infection rates have reached adult levels.

Table 3 illustrates the sex of trapped pigs, showing a 2:1 ratio of females to males trapped in this trial.

4. Discussion

The presence of a high proportion of agouti patterned adults, body stripes on many of the pigs under 6 months of age, a high incidence of Melanesian ticks and confirmation of the identity of the Stomach Nodule Worm (a new parasite record for Australia) all support the contention that pigs from this area do not have a common origin with the European domestic pig.
There is no documentation of pig introduction to this area, so the origin of these animals remains unknown.
Particle analysis of stomach contents from Cape Tribulation indicated that pigs were a regular predator of earthworms. Because the protein content of worms (58-71% on a dry weight basis) is high in essential amino acids

Table 1: Parasites and diseases found in feral pigs from Cape Tribulation National Park (number in sample = 52)

Parasite/Disease	% infected
External Parasites	
Ornate Tick *Ambylomma cyprium cyprium*	40
Pig Louse *Haematopinus suis*	91
Internal Parasites	
Red stomach Worm *Hyostrongylus rubidus*	75
Stomach Worm *Physocephalus sexalatus*[1]	1
Stomach Nodule Worm *Simmondsia paradoxa*	8
Thorny-headed Worm *Macracanthorhynchus hirudinaceus*	6
Lungworm *Metastrongylus* spp.	79
Plerocercoids of *Spirometra erinacei* [1]	1
Cysts of Bladder Worm *Taenia hydatigena*	1
Kidney Worm *Stephanurus dentatus*	90
Diseases	
Brucellosis *Brucella suis* [1]	2
Meliodosis *Pseudomonas pseudomallei* [1]	66
Leptospirosis *Leptospira interrogans* serovar *australis* [1]	2
" " " *bulgarica*[1]	6
" " " *celledoni* [1]	4
" " " *gippotyphosa* [1]	2
" " " *hardjo* [1]	2
" " " *kremastos* [1]	2
" " " *pomona*[1]	6
" " " *robinsoni* [1]	4
" " " *swajizak* [1]	2
" " " *tarrasovi* [1]	4
" " " *zanoni* [1]	2

[1] = Human pathogen

Table 2: Percentage infection rate of Cape Tribulation pigs < 12 months old (N = 34).

Age Class (months)	Percentage Infection Rate				
	Stomach Worm	Kidney Worm	Lung Worm	Thorny-headed Worm	Stomach Nodule Worm
< 6	52.6	75	43.8	0	0
7-12	83	100	88.9	5.6	11.1

Table 3: Sex of trapped pigs

Age (months)	Males	Females
60	0	1
43-48	0	1
31-36	0	1
25-30	0	3
18-24	1	0
6-12	6	10
0-6	5	9
Total	12	25

(Sabine, 1983), and the overall protein content of the pig diet is low, it indicates that pigs will choose high protein sources when available. Earthworm predation by feral pigs should be further examined, since the finding that they can remove up to 93% of the worms from a feeding site.

With a worm population density of up to 188 per m^2, and the finding of 263 earthworms in one pig stomach, it is estimated that pigs can dig up significant areas (1.4 m^2 to 150 m^2) during one period of feeding activity. The introduced earthworm *Pontoscolex corethrurus* and the native earthworm *Diporochaeta nashi* were identified as the species present in the pig stomachs and feeding areas sampled. Further sampling would elaborate on the range of species involved. Dr. G. Dyne (pers. comm.) suggested that the transport of egg capsules of introduced earthworms on the hair or feet of feral pigs could assist in their distribution into the rainforest. Seasonal dietary sampling would determine impacts on other species of earthworms and soil-dwelling fauna, *i.e.* land snails, insects and their larvae. With the lack of information about pigs in tropical rainforest the following needs to be addressed: (a) determine the distribution and abundance of feral pigs, based on indirect assessment; (b) estimate the seasonal ecological impact of pigs on rainforest environments, particularly in relation to the long-term processes of forest dynamics; (c) estimate basic population parameters of pigs in those target areas in order to assess the likely efficacy of control methods.

5. Acknowledgements

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ECOLOGICAL COMPARISON OF TWO WILD PIG POPULATIONS IN SEMI-ARID AND SUB-ALPINE AUSTRALIA

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Abstract: The ecology of two distinct feral pig populations in south-eastern Australia were compared. Study sites consisted of: 1. a sub-alpine region with open grassy plains and heavily timbered mountains; 2. permanent marshes surrounded by perennial grasslands of the semi-arid western plains. Parameters examined included reproductive data, age structures, mortality rates, food availability, population density, health and age-specific morphometrics. The sub-alpine population appeared to be relatively stable and had a marked seasonality of breeding with a general period of anoestrus through autumn and early winter. This was attributed to a decreasing availability of high protein food during these seasons. Population density was then much lower as that of marsh population which had a relatively constant rate of conceptions throughout the year and potential rates of explosive increase dependant on food availability. Age-specific body weight and body length were greater in the sub-alpine population. Similarly, overall health was much better with no evidence of the heavy parasitic burdens which were found in the semi-arid population.

Keywords: Feral pig, *Sus scrofa,* Suidae, Reproduction, Density, Health, Environment, Food availability.

IBEX J.M.E. 3:152-155

1. Introduction

The feral pig *(Sus scrofa)* is the only member of the family Suidae to be found wild in Australia and is also the most common and widespread feral domestic mammal (Wilson *et al.*, 1992). Pullar (1953) concluded that Australian feral pigs originated from escaped domestic stock and that there was no evidence of their existence prior to European settlement. Similarly there was no evidence to suggest the deliberate release of the true Eurasian Wild boar. Pigs are considered a major pest of agriculture and the environment, and at the same time have positive resource values for recreational hunting and export of game meat (O'Brien & Meek, 1992). The information presented in this paper resulted from two separate field studies of feral pigs reported by Giles (1980) and Saunders (1988). Because the studies were conducted at different times using various sampling strategies, statistical significance has not been ascribed to the comparisons which are presented.

2. Methods

2.1. Study sites

1. Sub-alpine: The Long Plain/Yarrangobilly Caves are situated in Kosciusko National Park (36°43'S,148°32'E), south-eastern New South Wales. The park is mostly wilderness and topography varies from large areas of open grassy plains at altitudes of 1,100 m to heavily timbered mountains, the highest at 1,620 m. The climate is cool, moist temperate, with no month frost free. Snow cover is not often continuous, but occasionally heavy snowfalls may lie on the ground for a number of weeks. Average yearly rainfall is approximately 1,500 mm, with high reliability. Temperatures range from average maximums of 21.2°C in January to 4.0°C in July.

2. Semi-arid: 'Oxley' station, primarily a cattle grazing property, is situated at the southern edge of the Macquarie Marshes in the western plains of N.S.W. (30°15'S, 149°29'E). The site is dominated by shallow marsh with the remainder, open woodland and perennial grassland. The climate is hot and semi-arid with temperatures ranging from average maximums of 34.6°C in January to 16.8°C in July. Rainfall in the area can vary greatly from year to year with an average of approximately 440 mm.

2.2. Population structure, reproduction and mortality

Capture-recapture programmes were conducted at both sites. Animals required for post-mortem were either shot, trapped or captured by dogs. Age of captured animals was determined by

tooth eruption and molar wear (Matschke, 1967). All adult sows were examined for signs of pregnancy or lactation. Crown-rump measurements were used to estimate foetal age (Henry, 1968). A gestation period of 114 days (Day, 1962) was used to calculate birth dates. Life tables for both populations were constructed using methods described by Caughley (1977). Age classes were delineated so that there was no overlap between breeding seasons.

2.3. Variations in age specific body measurements

The relationship of mean age with body weight and head/body length was used to examine comparative growth rates and body condition at the two sites. These were assumed to vary according to food supply and energy requirements.

2.4. Food habits, diseases and parasites

Post-mortem examinations, for evidence of pathogenic or parasitic infection, were made of animals destroyed during the course of the studies. Stomach contents for adult pigs were examined macroscopically with the relative volumes of major food items estimated visually.

2.5. Population estimates

Total population estimates were derived at both study sites. At Kosciusko the method of estimating population size involved the laying of bait stations every 1 km along fire trails, each of which was checked daily over 33 days of a trapping evaluation. By fitting a model to the percentage of bait trails removed by pigs against the cumulative number of pigs destroyed it was possible to estimate the total kill required to reduce the percentage bait take to zero, presumably equivalent to a pig population of zero. At Oxley, estimates were obtained from aerial survey using the index-removal method (Caughley, *op. cit.*). Aerial surveys of feral pig abundance using helicopters were conducted immediately before and after an extensive control program during which a known number of individuals were removed from the population.

3. Results

3.1. Population structures, reproduction and mortality

The distribution of conceptions at Oxley was relatively constant throughout the year indicating no seasonal trend in reproduction. Distribution of births (N=536) was less predictable although this tendency reflected variation among seasons in juvenile survival rather than variation in births. This, however, was in marked contrast to Kosciusko where there was a strong tendency for births to occur in summer and early autumn (N=177). Of a sample of 155 adult sows shot throughout the year, no pregnancies were recorded from March through to the end of July (N=89). These observations are also reflected in the estimated annual frequency of births (1.93 at Oxley compared to 0.84 at Kosciusko).

Comparative life tables for the sub-alpine and semi-arid populations are presented in table 1. All other comparative population parameters are presented in table 2.

3.2. Variations in age specific body measurements

Morphometric measurements were collected from 182 pigs at Kosciusko and 242 at Oxley. For any given age, males and females at Kosciusko were markedly larger, particularly in body weight, than their Oxley counterparts.

3.3. Food habits, diseases and parasites

Specific details of food habits are provided in Giles (*op. cit.*). Examination of the stomach

Table 1: Comparative life tables for sub-alpine and semi-arid wild pig populations.

Age Class	Sub-alpine			Semi-arid		
x	lx	dx	qx	lx	dx	qx
0	1.00	0.85	0.85	1.00	0.89	0.89
1	0.15	0.06	0.40	0.11	0.03	0.27
2	0.09	0.02	0.22	0.08	0.02	0.28
3	0.07	0.02	0.29	0.06	0.03	0.45
>4	0.05	0.02	1.00	0.03	0.03	1.00

Table 2: Comparative population parameters for sub-alpine and semi-arid wild pig populations.

Population Parameters	Sub-alpine (Kosciusko)	Semi-arid (Oxley)
Mean Litter Size	6.58	6.36-7.39
Sex Ratio (M:F)	1:1 (106:106)	1.2:1 (898:755)
Yearly Frequency of Births	0.84	1.93
Population Density (/ km^2)	1.6	10

contents of a small number of pigs from Kosciusko revealed the stems and roots of Poaceae to be the most common food item. The only other common plant item was *Medicago* sp. At both sites, green herbaceous material and roots, fruit and seed made up the bulk of the stomach contents. Animal material, mostly carrion from cattle, was commonly found at Oxley but not Kosciusko, reflecting the difference in enterprises at the two sites. Frogs were the next most common animal item followed by beetles, earthworms and insect larvae. Most pigs examined post-mortem at Kosciusko were in extremely good condition with a low incidence of disease and parasites. The most common parasites were those found in the gut (*Ascarops strongylina*, *Hyostrongylus rubidus* and *Physocephalus sexalatus*), although none of these were found at high levels of infestation. Infection with gut parasites in the Oxley population was much more severe, particularly for *Macracanthorhyncus hirudenaceus* and *P. sexalatus*. The extent to which these infections reduced fitness and survival of pigs at Oxley could not be determined. However, post-mortem observations such as thickening of the intestinal wall and partial occlusions of the lumen, particularly in juvenile pigs, suggest that body condition at least would have suffered.

3.4. Population estimates

At Kosciusko a number of models were fitted by regression to the percentage of bait stations removed by pigs against the cumulative number of pigs destroyed during the trapping evaluation. The most appropriate model was that which assumed the cumulative rate of kill approximated a quadratic curve. This model was used to estimate the cumulative kill required to reduce the percentage bait take per day to zero. The predicted kill and hence population size was 229 pigs using the following model:

$$y = 228.9 - 484\,x + 301\,x^2 \qquad (R^2 = .792)$$

A population of 229 is equivalent to a density of approximately 1.6 animals per km^2 over the entire study site. At Oxley, the population indices calculated from the helicopter surveys were 432 before reduction and 87 immediately after. A total of 989 pigs were removed during the control exercise giving an initial estimated population of 1238 pigs which was equivalent to 10/km^2. Crude estimates derived previously during capture/recapture programmes indicated that in favourable conditions pig populations on Oxley could peak as high as 50/km^2.

4. Discussion

The most notable difference between the two populations was the marked seasonality in reproductive activity found at Kosciusko compared to continuous breeding at Oxley. The available evidence suggests that a regular seasonal decline in food supply at Kosciusko was the initiate of anoestrus. A high-protein food available in the spring increased body condition and initiated breeding while a decreasing availability of high-protein food in the autumn and winter months caused reduced rates of conception. In an environment such as Kosciusko where winter growth of these plants would be retarded by frost and snow, a flush of growth, and hence increased protein and energy levels, would be expected in the spring. For example, the seasonal accumulation of total dry matter (kg / ha) for *Poa* grass increases by 530% from minimum yearly production in winter to a maximum in spring (Robinson & Archer, 1988). At Oxley, pig populations fluctuated markedly in response to seasonal conditions, and were limited by the availability of dietary protein. This was obtained mostly through ingestion of fresh green legumes, grasses and forbs. Animal matter (mostly as carrion) was a valuable supplement when available. Fresh green vegetation was available only after heavy rain. When it was short in supply, pigs obtained most of their food from roots and other starch rich plant organs, which are relatively rich in digestible carbohydrate, but contain lit-

tle protein. When little green pasture was available, survival of young piglets was very low, mostly due to a lack of dietary protein for suckling sows, but most adult sows continued to breed. Despite the seasonal variation in reproduction at Kosciusko, there was no evidence to suggest that longer-term population trends were other than stable. This apparent stability is probably related to the relative consistency in climate for the area. Variation in climate is greater in semi-arid regions where pig populations have the potential to double as a result of favourable rainfall and temperature.

A population density of 1.6 pigs/km^2 at Kosciusko was markedly less than the peak estimates of 50/km^2 suggested at Oxley. These probably reflect the productivity of the respective environments. Age-specific body weight and body length at Kosciusko were greater than those found at Oxley (Saunders, 1993). Age-specific weight and length measurements declined markedly at Oxley when competition for available food was particularly high. Large body size can confer advantages consistent with the effect of a harsh environment. These include: reduction in relative heat loss; the ability to move longer distances in search of food; and the ability to survive on qualitatively inferior food (Clutton-Brock & Harvey, 1983).

In conclusion, the differences between the Kosciusko and Oxley populations are substantial. The sub-alpine habitat was obviously marginal for feral pigs as evidenced by environmental productivity, population density and seasonality of breeding. In seeming contradiction was the relative good health and body size of Kosciusko's pigs. This was attributable to low densities, the lack of competition for resources and biological advantages associated with large body size. In contrast to the stability of the sub-alpine population, the semi-arid study revealed potential rates of increase to be explosive dependant on prevailing seasonal conditions.

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GIS AS A MEANS TO IDENTIFY THE ENVIRONMENTAL CONDITIONS OF WILD BOAR DIURNAL RESTING PLACES

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Abstract: A sample of 1529 resting places of Wild boar, recorded in four areas in southern France, was analysed as regards habitat selection. Two areas were heavily forested and showed a medium or high density of Wild boar. The landscape in the two other areas was composed of cultivated fields with small scattered woods. Each resting place, located by radio-tracking, was assigned a one-hectare cell. A Geographic Information System was set up to include descriptive information on each cell in the study areas (5,000 to 19,000 hectares each). Selection of habitat by resting wild boars was analysed by comparing the frequency of selected habitats with their frequency in the corresponding study area. There is an overall preference for the most secure habitat class (wood with dense low stratum). Results also show that the selection is broader in the open landscape than in the forested landscape. In the open landscape the preference is extended to "incomplete" mixtures of the two strata.

Keywords: Wild boar, *Sus scrofa,* Suidae, Artiodactyla, GIS, habitat, landscape, resting place.

IBEX J.M.E. 3:156-159

1. Introduction

Geographic Information Systems (GIS) are particular databases where information is stored by reference to geographic objects defined in a rectangular coordinate system. Geographic objects may be assemblages of vectors like points, lines, or polygons (giving a vector GIS) or assemblages of square cells (giving a raster GIS). Geographic Information Systems are very useful to deal with ecological data collected in natural conditions.

Wild boar spend half of their daily time-budget at a resting place (Mauget, 1980; Cousse & Janeau, 1992). This site is of particular importance for them and we expect that the habitat used for resting places will be carefully selected. Security, quietness and comfort are important (Dardaillon, 1986). Despite the fact that the study of resting places is relatively easy, few publications deal with this subject (Janeau & Spitz, 1984; Cousse *et.al.,* in press).

To study the selection of habitats by wild boars for their resting places, we used radio-tracking locations obtained in 4 study areas in the south of France.

2. Study areas

Two of the study areas were predominantly forested: Caroux (19,000 hectares) and Cabardes (13,000 hectares) located at about 43° 20' N and 2° 00' E are mountainous areas (elevation 200 m to 1,200 m) extending from mediterranean to deciduous forest climate, more than 50% composed of broad-leaf forest, conifer plantation and shrubland, the remaining part including areas of pasture, clearing and cultivated valleys.

The two other sites were predominantly open environments: Camargue (9,000 hectares, 43° 30' N and 4° 30' E) and Lauragais (5,000 hectares, 43° 30' N and 1° 20' E) are low elevation, open landscape areas. Camargue is a low-lying area along the Mediterranean sea, covered in approximately equal proportions of agricultural land and marshes with a few small scattered woods and shrubland. Lauragais is an extensive hilly agricultural region with very small areas of woodland or copse.

3. Material and methods

In each study area, resting places of several radio-collared individuals were located daily, as far as possible at different times of the year. Locations were assigned to 100 m x 100 m cells (one hectare). It means that the study did not account for the proximate environment of the resting place but only the general environment within a cell.

The GIS was built from classified SPOT images (Joachim *et al.,* 1992). To fit with the Wild boar data (one-hectare cells), original 20 x 20 m pixels from SPOT were aggregated into 100 x 100 m squares. The habitat type within each square was defined by a hierarchical selection

system (see below) using ERDAS software. Original image pixels were classified according to the vegetation cover, considering its consequences for security and quietness. Two simple parameters were considered: does the original pixel contain trees? Does the pixel contain dense woody plant cover between 0 and 2 m above ground? Then we considered three aggregation processes giving three differing classifications of the one-hectare cells:

- Classification 1 is made according to the vegetation type covering the largest relative area (*i.e.* the relative majority in number of pixels among 25 in the cell). This provides 4 majority types: (*i*) not wooded without predominant dense vegetation; (*ii*) not wooded with predominant dense vegetation; (*iii*) wooded without predominant dense vegetation; (*iv*) wooded with predominant dense vegetation.
- Classification 2 is made with respect to the simple presence of tree cover in non-wooded cells. The presence of at least one pixel containing trees classifies the cell as "with tree". Otherwise, the hectare is classified as "no tree at all".
- Classification 3 is made with respect to the simple presence of dense vegetation. It was applied to cells without predominant dense vegetation. As for classification 2, cells with at least one pixel with dense vegetation were classified as "with some dense vegetation". Otherwise they were classified as "no dense vegetation at all"

When combining the 3 classifications, each one-hectare cell falls into one of 9 classes (Fig. 1).

The observed distribution of resting places among the habitat classes was compared with the expected distribution, *i.e.* the frequencies of habitats in the study area, using a Kolmogorov-Smirnov's test. For each study area, each class (or group of classes, see hereafter) of habitat was identified as avoided, neutral or selected.

4. Results

The upper part of table 1 shows the observed and expected distribution for each class; the list of classes is arranged by rank of density of cover. In all samples the distributions in the "study site" and the "resting places" samples are significantly different (Tab. 1, bottom part). Table 2 gives the classification of habitats in the three categories "avoided", "neutral" or "selected". For each study site, two or several successive classes were cumulated when they showed similar differences between observed and expected frequencies (intercalated classes with insignificant number of observations were associated in the sequences). In all samples, class 9 (majority of wood with dense vegetation) was selected but in Lauragais the selected habitat was the sequence 5-7-9. In open landscapes (Camargue, Lauragais) class 4 (completely open) was avoided and the intermediate classes were neutral. In Caroux, the sequence of classes 8-6-5-7 (moderately dense) was avoided, whereas predominantly open classes (4-2-3-1) were neutral. In Cabardès, the only neutral class was class 1, whereas 4-2-3 and 8-6-5-7 were avoided.

Table 1: Comparison of expected and observed distributions of habitat classes (classes are arranged by rank of density of cover).

Class number	Lauragais		Camargue		Caroux		Cabardes 90		Cabardes 91	
	expect.	obs.	expect.	obs.	expect.	obs.	expect.	obs.	expect.	obs.
4	48	5	132	16	9	9	15	2	12	10
2	2	2	16	22	4	12	8	0	7	3
3	32	7	—	—	1	1	5	0	5	8
1	36	52	59	59	13	14	35	36	30	47
8	<1	0	—	—	15	2	3	0	3	0
6	<1	0	—	—	5	1	9	0	7	0
5	2	14	34	38	7	4	64	5	55	5
7	<1	1	31	32	18	1	17	7	15	11
9	11	51	16	121	27	55	212	317	183	232
D max	0.5152		0.4028		0.2828		0.2877		0.1569	
Critical value 1%	0.2068		0.1400		0.2388		0.1239		0.1335	

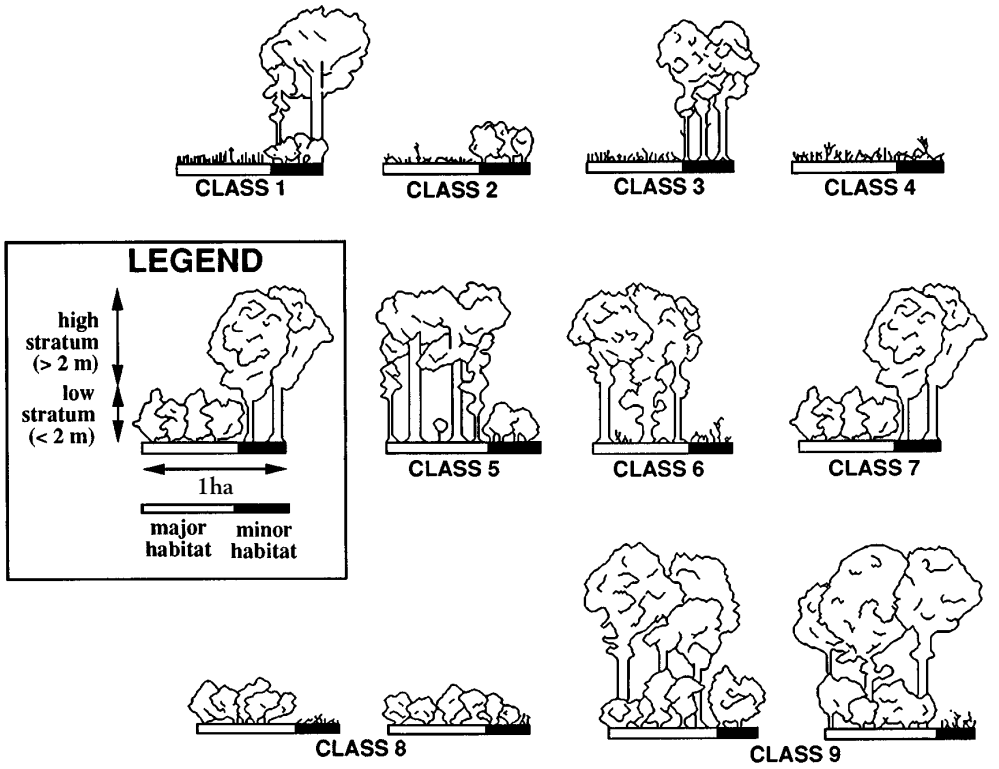

Figure 1 - Schematic description of the nine classes of habitat.

Table 2: Selection of habitat classes by resting wild boars. For explanation of the cumulation of classes, see text.

Study areas	Avoided	Neutral	Selected
Lauragais	(2+3+4)	(1+6+8)	(5+7+9)
Camargue	4	(1+2+5+7)	9
Caroux	(5+6+7+8)	(1+2+3+4)	9
Cabardes 90	(2+3+4),(5+6+7+8)	1	9
Cabardes 91	(5+6+7+8)	(1+2+3+4)	9

5. Discussion and conclusion

In all landscapes, Wild boar resting places were preferentially located in environments with a majority of woods with dense vegetation. In Lauragais, *i.e.* the most open and agricultural landscape, Wild boar also selected a mixture of woods without dense vegetation and tree-less bush patches. In open landscapes, avoidance is restricted to predominantly open cells, except when a minority of wood with dense vegetation is present. In forested landscapes, it is remarkable that a part of the predominantly open classes are neutral. These results are in agreement with the hypothesis that selection is broader in areas where the selected habitats are scarce, and narrower in areas where the selected habitats are predominant and distributed in very large patches. Neutrality of some the predominantly open habitats in the forested landscapes is puzzling. An explanation would be that in these areas large patches of natural low vegetation (heathland or similar) are secure enough to not be avoided by resting wild boars. Selection rules established can be extrapoled to larger areas, and using the GIS vegetation maps issued from it, zones potentially favoured by wild boars for their resting places can be identified.

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WHERE AND WHEN: THE ECOLOGICAL PARAMETERS AFFECTING WILD BOARS CHOICE WHILE ROOTING IN GRASSLANDS IN AN ALPINE VALLEY

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Abstract: Rooting is the most obvious sign of presence of the species in a given area and it has been used to study habitat and space use. The study was carried out in Susa Valley at altitude from 700 to 1,410 m u.s.l. 58 plots of grassland or pastureland have been studied by visiting them every fortnight looking for rooting. Each plot was characterized by measuring some physical parameters and on each visit the soil hardness, vegetation or snow height, sign of deer use, human activity and amount of rooting were recorded. Climatic condition in the period before each visit was measured by two meteorological stations.

Keywords: Wild boar, *Sus scrofa,* Suidae, Plot, Rooting, Feeding, Italy, Europe.

IBEX J.M.E. 3:160-164

1. Introduction

Rooting is the most obvious sign of Wild boar presence in a given area and it has been used to evaluate the space and habitat use of the species (Dardaillon, 1985; Lescourret & Génard, 1985; Coblentz & Baber, 1987; Abaigar, 1992) or to try to estimate Wild boar (or feral hog) density (Mackin, 1970; Hone, 1988). Extensive rooting can modify the chemistry of the soil mixing the 0, A and B horizons, it accelerates decomposition, it causes loss of nutrients in the forest floor (Singer *et al.*, 1984), it modifies the local flora (Bratton, 1974; Welander, this volume), it affects beech sprouting (Lacki & Lancia, 1986), it changes small mammals distribution (Singer *et al.*, *op. cit.*) and possibly it causes soil erosion (Bratton, 1975).

Rooting has a seasonal pattern possibly related to food availability and geophytes distribution (Falinsky, 1986).

On the other hand it is commonly known that wild boars often perform rooting activity many times in the same place in the course of the year or year after year *i.e.* they seem to prefer some restricted areas in apparently uniform habitat.

The aim of this study was to examine the seasonal pattern of rooting on grassland in an Alpine valley and to identify the environmental parameters that may justify the choice of some field. We have focused on grasslands that are rooted throughout the year even if a seasonal pattern may be present (Macchi *et al.*, 1992).

2. Study area

The upper Susa Valley (Piedmont, NW Italy) is a typical piedmontese alpine valley running SW-NE. The climate might be considered as continental with low rainfall (1,000 mm annual) and strong temperature changes from winter to summer. At the bottom (700 m u.s.l.) the broadleaves are widespread and are replaced at higher altitudes by Larch (*Larix decidua*), *Picea abies, Abies alba* and *Pinus cembra* on the north-facing slope, and by *Pinus sylvatica* on the warmer, south-facing slope. Timberline is at ca. 2,400 m u.s.l..

Cereals and grapes on less steep and warmer slopes were cultivated until some thirty years ago, now most of these areas are only mowed or abandoned. Shrubs are invading many fields and woods are enlarging their surfaces.

3. Methods

Open areas are mainly represented by grasslands, pasture lands and meadows. 58 plots were chosen on both slopes of the valley in order to represent a range of elevation, aspect, management (mowed or abandoned), etc., irrespectively to previous rooting activity. Altitude ranges from 700 to 1,450 m u.s.l..

For each plot 20 characteristics were recorded and those were defined as "geographical" parameters. They were: Altitude, Side of the valley (left or right hydrographic), Aspect, Slope, Area, Perimeter, Management (mowed or abandoned), Visibility index (average distance from the centre of the field to the next sight obstacle in accord to the direction of the four

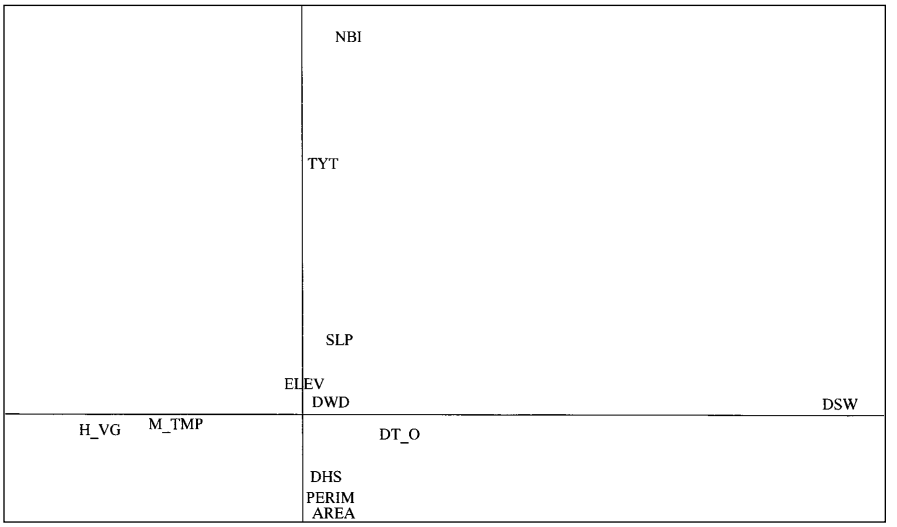

Figure 1a - Variables distribution - Never or once visited fields.

List of the "geographic" parameters measured on each plot. For the analysis all data were transformed in classes.
NBI = Number of bushes in the plot - TYT = Typology of the trees on the edge (single, row, group) - SLP = Slope - ELEV = Elevation - DWD = Distance from wood borduary - DHS = Distance from human settlements - PERIM = Perimeter - AREA = Area
List of the "ecological" parameters recorder in each time a plot was visited. All were transformed in classes.
H_VG = Grass height
List of "climatic" parameters recorded in each visit. All values were transformed in classes.
M_TMP = Mean temperature - DT_0 = Number of days with mean temperature below 0° C - DSW = Number of days with snow cover

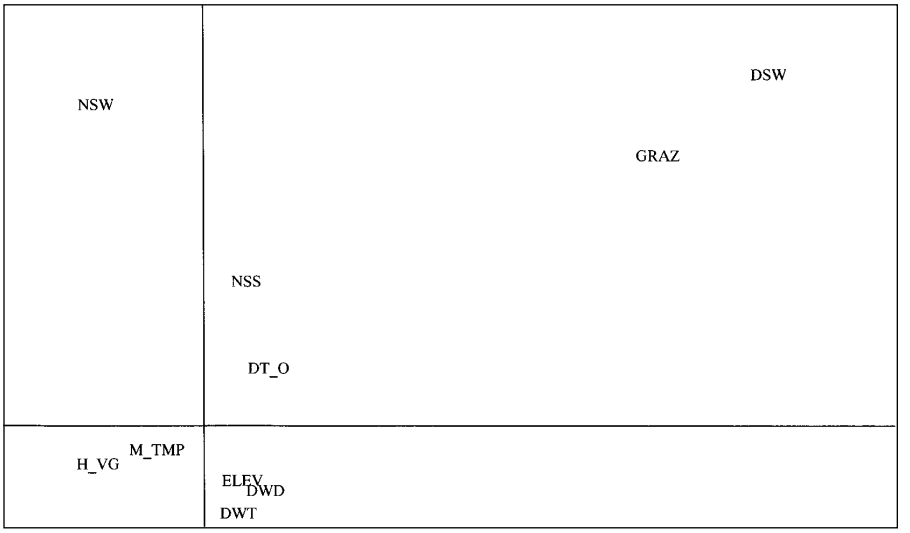

Figure 1b - Variables distribution - Often visited fields.

List of the "geographic" parameters measured on each plot. For the analysis all data were transformed in classes.
NSW = Number of sides in contact with wood - NSS = Number of sides in contact with shrubs - ELEV = Elevation - DWT = Distance from water bodies - DWD = Distance from wood borduary
List of the "ecological" parameters recorder in each time a plot was visited. All were transformed in classes.
GRAZ = Sign of grazing by Domestic/Wild/None - H_VG = Grass height
List of "climatic" parameters recorded in each visit. All values were transformed in classes.
DSW = Number of days with snow cover - DT_0 = Number of days with mean temperature below 0° C - M_TMP = Mean temperature

cardinal points), Presence of small mammals, Distance from human settlements, Distance from roads, Distance from water bodies, Distance from wood borduary, Number of sides in contact with woods, Number of sides with shrubs, Percentage of the perimeter in contact with woods, Percentage of the perimeter with shrubs, Typology of trees in the edge (single, in a row, in group), Number of trees in the field and Number of bushes in the field.
Each plot was visited two times per month from the second half of December 1992 to the end of October 1993 resulting a total of 18 visits and 935 visit charts. On each visit 7 "ecological" parameters were recorded: Soil condition (dry, wet, frozen, etc.), Snow height, Grass height, Sign of cattle or wild Ungulates presence, Sign of human activities, (mowing and hay collection, disturbance) and Wild boar rooting signs.
In order to estimate the amount of rooting and express it in percentage, a 10-metres wide line transect was performed.
Besides, data collected by two meteorological stations allowed us to include 5 "climatic" parameters: Mean temperature, Total rainfall, Number of rainy days, Number of days with mean temperature below zero degrees and Number of days with snow cover. All these data referred to the period between two consecutive visits.
In order to point out which parameter(s) influenced the extent of rooting and to create a predictive model a Stepwise Multiple Regression Analysis was performed with all parameters having set as dependent variable the amount of rooting (SAS/STAT, 1988).
Since some plots were rooted several times during the study period (up to 8 times), we tried to understand which parameter(s) could affect the Wild boar choice.
Thus a Correspondence Analysis was done both on fields that suffered no rooting or that were rooted only once and on fields that were rooted two or more times (Snedecor & Cochran, 1982).
It was not possible to use the Regression Analysis since the dependent variable should have been a continuous number and not a count as in this case.
In the Correspondence Analysis only the variable that showed higher squared cosin values (>0.45) were plotted.
This allowed to show which were the parameters that better represent the fields of each group.

4. Results

On the whole study period 33 (57%) of the plots were never rooted, 15% were rooted only once and two plots were rooted 7 and 8 times respectively. This may indicate that some plots were preferred to others and some were avoided.
The sequence of rooting shows that in most occasions after Wild boar has rooted on a plot this resulted not rooted in the following visit. Very rarely the plots were recorded as rooted more than two following visits.

The Correspondence Analysis was used to see which were the parameters that better represent the two plot types (Not Rooted and Often Rooted). The analysis of the parameters representing the plots that were rooted only once or never (Fig. 1a) shows a clear difference between "geographic" and "ecological" parameters. All "geographic" parameters lay on the second axis while "ecological" ones are found on the first axis. The first axis represents the weather conditions (Number of days with snow cover, Number of days with average temperature below zero degrees, Average temperature) and the second the plots' characteristics (Number of bushes, Typology of the trees on the edge of the plot, Slope, Elevation, etc.). In Fig. 1b (often visited plots) a strong difference between "geographic" and "ecological" parameters still exists, but the climatic parameters are moved toward the second axis. Thus in this case the two axis do not represent so well the two groups of parameters.
In both the analyses the parameters that better indicate the Wild boar choice are the same: Number of day with snow cover, Number of days with temperatures below zero degrees, Presence of shrubs, Altitude and Distance from woods.

The number of rooted plots varied throughout the study period. Highest percentages were recorded in December, late September, January and February; no rooting was found in March and mid April but the zero score was reported between two high scores. From June to early September the average percentage is below 10% (Fig. 2): the extent of rooting shows a different pattern: high in April and May, moderate in winter and summer, low in autumn.

As a first step a Multiple Regression Analysis was performed with all data for the whole study period. This analysis created a model statisti-

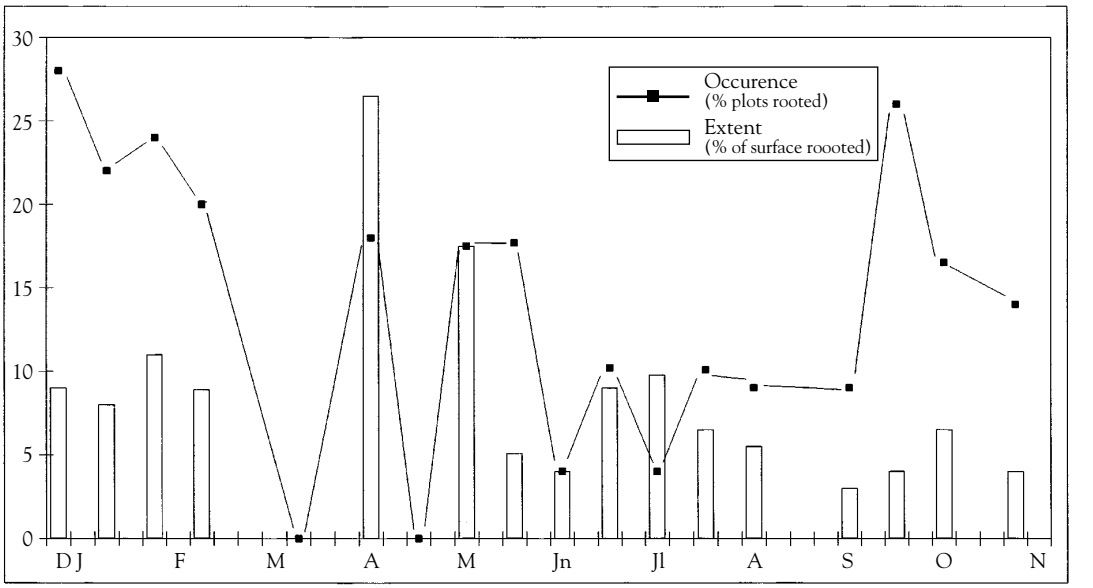

Figure 2 - Variations in occurence and extent of fields rooting during the study.

cally highly significant, thus the measured parameters described well the phenomenon. The obtained equation includes both "geographical" and "ecological" parameters: the amount of rooting increases with the Visibility Index and with the presence of groups of trees at the edge of the plot, and decreases when other wild Ungulates use the plot and when the temperature is high; it also increases with the number of days with snow cover.
It can be said that Wild boar seeks for food on larger areas (extensive rooting) in those fields that allow to detect any approaching predator (high Visibility Index) and that give the opportunity to gain cover quickly (presence of a group of trees or of a wood nearby).
In plots used by other Ungulates (Red Deer, *Cervus elaphus*, and Roe Deer, *Capreolus capreolus*) rooting intensity is low, but from the results of the Correspondence Analysis, they seem to be rooted more often.

Three different periods were identified: winter (late September - February) when many fields are rooted but not on large surfaces; spring (March - May) when rooting is not performed continuously, but rarely and on large areas; summer (late May-August) when rooting is less performed both in terms of number of plots and extension.
Therefore Multiple Regression Analysis was done on these three periods. All the analyses were statistically highly significant for all three identified periods.
During the winter period rooting increases with the number of days with average temperature below 0°C and is more common in the less cold south-facing slopes and in plots closer to woods. The only parameter included in the general model as in the winter one is the distance from wood borduary.
In Spring, the same difference between the two sides of the valley was enlighted. The rooting is moreover more intense in plots located at lower altitudes, with less shrubs, with a low Visibility Index and abandoned. Rooting is less performed during rainy periods.
Although the model resulting from the analysis carried on the summer period is statistically highly significant, it may be considered as a descriptive model rather than predictive: during this period the rooting is performed rarely and the temperatures are high.

5. Discussion and conclusion

Both in spring and winter the more rooted side of the valley is the south-facing one. Since the damage caused by the species has been found not to be related to the number of animals the reason for this should be searched in the fact that this was the side that was more intensively cultivated until few decades ago and the bushes and cover is more available if compared to the north-facing side covered mostly by coniferous woods.

Radio-tracking data collected nearby also indicate that Wild boar tend to move to lower altitudes during spring and summer probably looking for fresh and cover since most females give birth in this period.

The comparison between the outcomes from the Correspondence Analysis for Often-Rooted and Not-Rooted plots indicate that Wild boar uses more frequently the fields whose characteristics change more along the year.

Analyzing the extent of rooting and how it changes along the year it may be concluded that its has been possible to depict a general model to predict when and where the rooting happens.

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WELANDER J., this volume - Are wild boars a future threat to the Swedish flora?

ARE WILD BOARS A FUTURE THREAT TO THE SWEDISH FLORA?

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Abstract: The degradation of natural communities as a result of pig rooting, trampling and damage to different agricultural crops has been noted in numerous publications, but there is seldom mention of the animals' positive effect on flora and fauna. Exceptions are mainly collected from silviculture, where wild boars effectively locate areas with large numbers of pest species for consumption and with increased growth of different tree species, presumably caused by enhanced nutrient mobilization as a result of the animals rooting activity. The purpose of this study was to document the rooting effect of Wild boar and compare the vascular flora of different rooted and undisturbed vegetational types in the part of Sweden with the densest population of wild boars. The result was an increase in species number in all six vegetational types studied. The average number of total species found in rooted areas was 61.6 ± 36.5, to be compared with 39.2 ± 25.8 species (n for rooted sites is 288, n for control sites is 232). The largest difference was found in alder marshes with a total of 115 species to be compared with 66. Species found in rooted areas were not always found in control areas but species found in control areas were most often found in the rooted areas. Species found in rooted sites and not otherwise were mainly species with low competition ability and field weeds.

Keywords: Wild boar, *Sus scrofa*, Suidae, Rooting, Species diversity, Plant diversity, Sweden, Europe.

IBEX J.M.E. 3:165-167

1. Introduction

The degradation of natural communities and damage to agricultural crops as a result of pig rooting has been documented in numerous publications (Mackin, 1970; Vassant *et al.*, 1992; Vtorov, 1993 etc.). Reports on the positive effect of the animal on flora and fauna are more seldom found. Exceptions are mainly concerned with silviculture where wild boars effectively locate areas with large numbers of insects for consumption or increased forest growth induced by a higher rate of mineralization after the earth has been rooted.
The rooting behaviour of Wild boar creates patches of bare soil which are subsequently colonized by plants. While rooting they also consume plant parts like bulbs, rhizomes etc. The question of interest is whether the creation of patches by wild boars has any effect on plant species diversity.

From a theoretical point of view it is expected that the highest species diversity is maintained at an intermediate level of disturbance (Connell, 1978). This is because of the fact that if disturbances are too infrequent, local competition will proceed to equilibrium and fugitive species will be eliminated. If disturbance is too frequent, it will eliminate fugitive and equilibrium species alike. At intermediate frequencies, the combination of fugitive species and equilibrium species produces a maximum diversity of species (Caswell & Cohen, 1991).
In this communication I have restricted the question to the following problem. Since rooting is a disturbance to an existing plant community, my question is: do patches rooted by Wild boar show any changes in plant species richness as compared with untouched ground? For this purpose three wet plant communities and three dry plant communities were used.

2. Study area and methods

The study area was Tullgarn nature reserve area situated approximately 70 kilometres south of Stockholm along the Swedish east coast. The landscape is a mixture of fields, pastures, exposed bedrock and forests. Wild boars first reached during the end of the 1970s the area which is now considered to harbour the densest population in Sweden. Local sportsmen estimate the population to be between 5-10 animals/100 ha.
During June and July 1993 a number of different vegetational types were randomly surveyed for rooted sites. Rooted as well as unrooted patches were censused for vascular plants. An undisturbed reference site was chosen as near as possible. The distance between the rooted and unrooted sites was usually only a couple of meters apart for all vegetational types except alder marshes, alder shores and reeds "without wild boars". Alder marshes and alder shores were so heavily used by the wild boars that no

ground in the vicinity could be considered undisturbed. For alder marshes and alder shores, reference sites were therefore located approximately between 20 to 30 kilometres further to the south. Reeds "without wild boars" are, however, from the area with wild boars but in the vicinity of buildings and landing-stages which apparently keep wild boars at a distance.

The size of the censused patch was 1 m^2, with the exception of alder marshes, alder shores and reeds. For alder marshes and alder shores, 100 m^2 were used because of the heavy utilization by wild boars. In the reeds, the whole disturbed patch was inventoried with a reference patch of equal size surrounding the disturbed patch. The reason for this was the high heterogeneity of both the size and plant composition of the disturbed patch.

Since there was no way of determining the age of the rooted patches, no consideration was taken to this factor except for the fact that there was at least some vegetation to be censused. In practise, this means that in open areas the disturbed patches could be less than a year old while in areas with a closed canopy they were most certainly more than one year old.

3. Results

All vegetational types showed an increased number of species on disturbed ground in comparison with undisturbed. The most striking difference was found in reeds and alder marshes. Of the six different vegetational types, four showed significant differences in the mean number of species (Tab. 1). Exceptions were alder shores and young, recently thinned pine forests already being disturbed by man. The amount of species in common as well as species unique to disturbed or reference patches varies considerably (Tab. 1). The difference in species composition is significant for all vegetational types except for the recently thinned pine forest. It is of great interest that species unique to reference areas are all considered as common species. A few species unique to disturbed patches are classified as uncommon.

4. Discussion

During ecological time, species diversity is likely to be maximized when the disturbance pattern resembles historical characteristics of the community. However, locally or during a short period of time, disturbance may reduce single-species dominance and free resources to be divided among other species. During longer periods of time, disturbance is an important selective factor affecting the evolution of species (Denslow, 1985). In a situation where disturbance regimes are only slightly different from the historical one, the consequence for community composition may only be a shift in the relative abundance rather than a loss of species (Denslow, *op.cit.*).

My results that rooted patches enhance plant species diversity are in agreement with several other studies. Jonsson and Esseen (1990) found the number of bryophyte species as well as their diversity to increase in places where the soil had been disturbed by uprooting in comparison with the surrounding undisturbed forest floor in a boreal spruce forest. They found the number of species to be 112 as compared with 56 on disturbed and undisturbed ground, respectively; 67 species appeared exclusively in disturbed patches and only 11 on undisturbed ground.

Danell (1977) found an increase in diversity with muskrats as a disturbance factor. Hobbs *et al.* (1988) and Tilman (1983) showed that plant diversity has a clear tendency to increase with the activities of pocket gophers.

The historical background in Sweden shows that wild boars disappeared during the 17th century. However, the disturbance regime was not lost because of farmers letting domestic pigs forage freely in the forests. On the contrary, the disturbance was probably increased by the large numbers of pigs. From historical notes and old maps of forests in the southern part of Sweden, we can roughly estimate pig density around 1650 to be at least four domestic pigs per hectare (Andersson, 1991). High densities of pigs were most certainly not only located in the southern parts of Sweden but were a rather common phenomenon. Species sensitive to foraging behaviour of domestic pigs or wild boars should, therefore, already have been lost historically while species still existing should be tolerant. The result indicates that the effects of wild boars lead to changes in species composition as well as in frequency.

Since no consideration has been taken to the age of the disturbed patches, the mean number of species (as shown in table 1) from the different vegetational types is based on a mixture of very new (species-poor) and older (species-rich) patches. Because of the increased difficulty to distinguish between rooted patches and the surroundings with increasing age, probably only a few very old patches were included in the data set.

Table 1. Ratios (disturbed/reference) between disturbed and reference patches in different vegetational types.
Reeds 1 shows the difference between patches in reeds with wild boars; **Reeds 2** shows the difference between patches in reeds with or without wild boars; **Alder shores**, **Alder marshes**, **Older pine forest**, **Young pine forest** and **Calcareous bedrock** shows the difference between patches in alder shores, alder marshes, older pine forest, recently thinned young pine forest and calcareous bedrock respectively. **Species No**. gives the total number of species found in all patches of a certain vegetational type. **Mean** gives the average number of species per patch among the inventoried patches in a certain vegetational type. **Min**. gives the minimum number of species found in a single patch. **Max**. gives the maximum of species found in a single patch.

	Reeds 1	Reeds 2	Alder shores	Alder marshes	Older pine forest	Young pine forest	Calcareous bedrock
No. of patches	44/44	44/13	21/8	49/36	53/53	22/22	45/46
Species No.	69/21	69/15	90/63	115/66	40/29	21/18	98/80
Mean	8.1/3.9	8.1/2.5	19.0/21.1	19.4/10.4	5.9/4.5	5.8/6.6	19.0/10.8
Min.	1/1	1/1	10/15	2/2	1/1	3/2	9/7
Max.	29/11	29/8	28/30	35/20	15/12	8/9	30/19
Std	7.28/2.28	7.28/1.98	4.77/5.26	6.40/4.60	3.22/2.14	1.62/1.65	4.55/2.63
Mann-Whitney test	***	***	n.s.	***	*	n.s.	***
Species in common	20	13	41	59	27	16	74
Unique species	49/1	56/2	49/22	56/7	13/2	5/2	24/6
McNemar's test	***	***	***	***	***	n.s.	***

5. Conclusion

The reintroduction of wild boars in Sweden has merely recreated a formerly common disturbance regime that most certainly has been an important aspect to which many plant species have become adapted. This and other natural disturbance regimes play an important role on a landscape level which must be considered when, for instance, creating nature reserves as well as conservation plans for both plant communities and individual plant species depending on disturbances of the soil. To conclude, there is no doubt about the effects of wild boars disturbance to the flora; plant species richness is enhanced.

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PRELIMINARY ANALYSIS OF FOOD AVAILABILITY AND HABITAT USE BY THE WILD BOAR IN A MEDITERRANEAN AREA

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Abstract: Twenty adult wild boars were radiotracked for one year to determine habitat use in relation to food seasonal availability. Results showed that wild boars used more intensively the pinewood and the meadows, whilst maquis was used less than it would be according to its availability. Cluster analysis showed that the Wild boar's habitat use, measured by the number of active fixes, was correlated with the seasonal abundance of the main food resources.

Keywords: Wild boar, *Sus scrofa,* Suidae, Habitat selection, Food availability, Italy, Europe.

IBEX J.M.E. 3:168-170

1. Introduction

Several authors have emphasised the importance of different foods availability in determining the habitat use by the Wild boar (e.g. Aumaitre *et al.*, 1982; Mauget *et al.*, 1984), but a quantitative estimate of the main food items as well as their correlation with habitat selection has never been attempted. The aims of the present study were: 1) to assess seasonal variation in habitat selection by adult wild boars living in a Mediterranean coastal area; 2) to relate seasonal habitat use to food availability.

2. Methods

The study was carried out in the Maremma Natural Park, Central Italy (42° 39' N, 11° 05' E). The study area covers about 2,700 ha and is characterized by the following kinds of habitat: maquis, pinewood, olive-grove, meadows and dunes. Hunting within the study area is not allowed. Habitat use was studied by radiotracking in order to determine habitat selection by individuals. Twenty adult wild boars (> 4 years old) were equipped with transmitters and radiotracked from September 1992 to August 1993. A minimum of 20 fixes/animal month were taken. Habitat availability was determined by vegetation maps (scale 1:5,000). To test the hypothesis that wild boars use the different habitats according to their availability, chi-square test was adopted. When significant values for chi-square ($P<0.05$) were found, the hypothesis was rejected and Bonferroni Confidence Intervals for the observed percent of use were calculated (Randall Byers *et al.*, 1984). A one-year pilot study allowed us to determine the main food items used by the wild boars in our study area. The availability of these items (acorns, olives, grasses and cicadas) was estimated. The relative abundance of fruits was assessed by counting their number in cone-shaped collectors suspended under the trees each fortnight. The availability of cicada larvae *(Cicada orni)* was estimated by counting their numbers each fortnight in random plots 50 x 50 cm, 40 cm deep and by counting the number of exuviae along the trunk of pine trees. Both leaves and roots of grasses such as *Cynodon dactylon* and *Dactylis* sp. were eaten throughout the year in all habitats. These grasses are perennial and their relative abundance may be considered as a constant within each habitat and estimated only once in order to rank the different habitat types. This was done by randomly selecting 100 plots (20 x 20 cm) in each habitat. Cluster analysis was applied to Spearman Rank Correlation Coefficients (Zar, 1984) to test correlations among different factors influencing habitat use.

3. Results

Significant differences ($P< 0.01$) resulted in the use of the different habitat types in the four seasons. Results from chi-square and Bonferroni Confidence Intervals, based on active fixes only, showed that wild boars preferred the pinewood and the meadows during the whole year, while the maquis that covers about 50% of the study area, was used less than

expected according to its availability (Tab.1). The olive-grove was avoided in spring and summer but was used according to its availability in autumn and winter; the dune was always used less than its availability except in autumn. The pattern of monthly habitat use derived by the number of active fixes is shown in figure 1. Acorns and olives were available from October 1992 to January 1993; cicada larvae were available from the end of April to the end of July and pine-seeds were available in summer. Grasses were more abundant in the meadows and absent in the dune. Cluster analysis (Fig. 2) showed that the Wild boar's habitat use measured by the number of active fixes, was correlated with the seasonal abundance of the main food resources.

Table 1: Percent availability (P exp.) and use (P obs.) of different habitats by individual radio-marked wild boars in 1992-1993. P< 0.01. Results from the Bonferroni Confidence Intervals are shown as follows: – = excluded; + = preferred; n.s.= used in proportion to availability.

HABITAT		AUTUMN		WINTER		SPRING		SUMMER	
	P exp.	P obs.		P obs.		P obs		P obs	
MAQUIS	0.58	0.25	–	0.30	–	0.15	–	0.12	–
PINEWOOD	0.24	0.44	+	0.38	+	0.54	+	0.54	+
OLIVE-GROVE	0.11	0.09	n.s.	0.09	n.s.	0.05	–	0.03	–
MEADOWS	0.05	0.21	+	0.22	+	0.26	+	0.31	+
DUNE	0.02	0.01	n.s	0.005	–	0.001	–	0	–

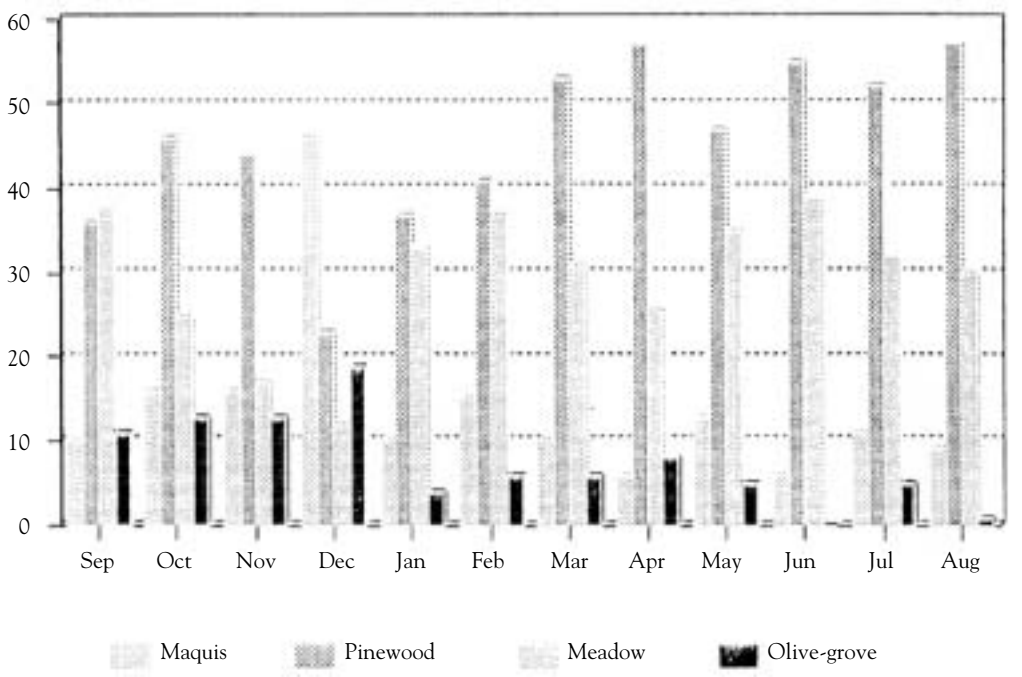

Figure 1 - Habitat use by the Wild boar as determined by the number of active fixes in different habitat types.

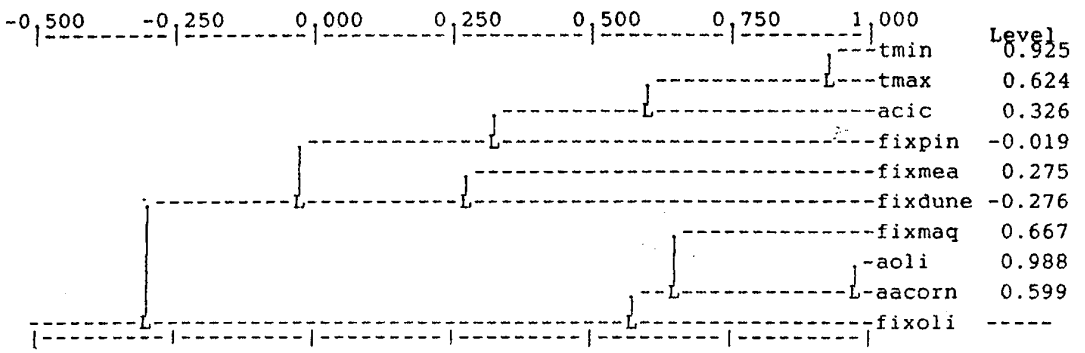

Figure 2 - Dendrogram resulting from the cluster analysis of the following variables: mean temperatures (tmin and tmax); number of active fixes (fix) recorded in each habitat; availability (a) of acorns (acorn), cicada larvae (cic), olives (oli). Clustering by minimum distance method.

4. Discussion and conclusion

A number of authors have assumed or suggested that habitat use by the Wild boar is correlated with food availability and that the searching for highly energetic food such as acorns may cause local migrations (e.g. Bromlej, 1964; Durov, 1987). During our study the general patterns of habitat use by the Wild boar showed little seasonal variation and a constant preference for the pinewood and the meadows. The Wild boar spends much of its active time feeding (Mauget, 1978), so that the number and proportion of active fixes in different habitats can be related with food availability. The relative abundance of olives and acorns which were concentrated over three to four months can explain the use of the olive grove in autumn-winter and the increased use of the maquis in the same period. The winter 1992-1993 acorn availability was very low in comparison to other years and the wild boars fed mostly on grasses (unpubl. data) during that time. That is why the preference for meadows justified the great number of active fixes recorded in this habitat. A close relationship was also found between the cicada larvae abundance and the pinewood use. In Maremma Natural Park, meadows and pinewood are in close association and this explains the constant preference by wild boars for both. We conclude that any study on habitat use should also take into account the availability of the main food resources for the species under study.

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WILD BOARS (Sus scrofa scrofa L.*) AROUND CHERNOBYL, UKRAINE. SEASONAL FEED CHOICE IN AN ENVIRONMENT UNDER TRANSITION - A BASELINE STUDY.*

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Abstract: After the accident at the atomic powerplant in April 1986, the 30 km zone around underwent a drastic change. The inhabitants were transfered and agricultural lands were abandoned and left to develop in any direction. This study, dealing with the transfer of radionuclides from food to wild animals' (e.g. Wild boar) tissues, began in June 1992. As preliminary result, a full one year cycle of boar's forage choice is presented here.

Keywords: Wild boar, *Sus scrofa,* Suidae, Food selection, Stomach contents, Radionuclides.

IBEX J.M.E. 3: 171-173

1. Introduction

After the accident in the nuclear powerplant of Chernobyl on April 26, 1986, the wildlife habitats in the area, roughly 30 km in radius have changed drastically. The inhabitants (ca. 90,000) and their livestock were immediately evacuated. The local drainage system was not maintained, and arable land, 50% of the zone, was abandoned and is expected to return to forest typical of the region. Neither crops nor game have been legally harvested since the accident. The overall goal of the project is to study the transfer of radionuclides from feed to tissues of Wild boar and Roe deer (*Capreolus capreolus* L.). The limited goal of this paper is to report on the seasonal diet of wild boars within the abandoned 30 km zone around the powerplant.

2. Material and methods

The research area is situated in the Polesie region. It is characterized by a mainly low and flat relief (110-145 m u.s.l.) with river floodplains, terraces, end-moraine ridges, moraine fluvioglacial and limnoglacial plains. Rather infertile sandy soils dominate the upper levels, where fallow arable land occupies the major part. Grassland with *Elytrigia repens* (L.) Nevski, *Festuca ovina* L., *Festuca rubra* L., and *Oenothera biennis* L. is dominant.
Planted forests with Scots pine (*Pinus sylvestris* L.) of various ages, sometimes occasionally with oak (*Quercus robur* L.) in the understory occur in the upland sandy areas. *Alnus glutinosa* (L.) Baertn dominates low-lying swamp forest. The lower level of the zone is occupied by the flood plains of the River Pripyat and its tributaries are covered by *Salix acutifolia* Wells, xerophytic shrubs, forbs and graminids.
Stomach contents from groups of about six boars, were and will be sampled annually during 1992-1995 in February, May, August and October.
Quantitative botanical analyses of stomach contents (cf. Scotter, 1967; Eriksson, 1981) are conducted. Sampling is carried out in early mornings, evenings as well as late nights. Efforts are made to obtain specimens that are unruffled. From a radioecological and ethical point of vue weaned and non-lactating specimens are preferred. The mineral content of stomach ingesta is determined after freeze drying and ashing in a muffle furnace.

3. Results and discussion

It must be emphasized that results shown are based only on specimens obtained during about the first year of sampling. Regarding age, live weight and sampling period see table 1.
Figure 1 shows that the summer diet (samples of June 1992 and August 1993 combined) consists of herbs, dominated by leaves of *Oenothera biennis* L., *Elytrigia repens* L. as well as wheat and rye and small animals. At the end of the season, fruit from abandoned orchards is eaten in large quantity. The grain portion is obtained from a deserted barn with some of the 1985 crop still remaining. Potato tubers were probably grown by resettlers on the southern rim of the zone.

Table 1: Sampling period, estimated age and live weight of Chernobyl boars (n = 37).

Age group (years)	June 1992	October 1992+1993	February 1993	March 1993	May 1993	August 1993	Live weight range (kg ± 0.5)
Juveniles (<1)	-	1	2	1	2	-	21.5-50
Yearlings (1-2)	-	-	3	1	1	2	42.5-74
Adults (>2)	5	6	3	1	5	4	66.5-230

Free access to orchards is especially important during the autumn when apples and also pears and plums constitute nearly half of the feed. *Oenothera* now plays a much more prominent role than during the summer; however, the preference has shifted from leaves to roots. Acorns did not appear in the diet during the falls of 1992 and 1993.

The winter sampling session took place during a period that was bare from the beginning, but with some snow at the end. *Oenothera* contributed around half of the diet during the entire winter period, roots (27%) were still important but leaves (21%) were also grazed. During the snow-free period other herbs and grasses were consumed, roots and all. During the snow period, leaves of *Elytrigia* and graminid litter were the second most important forage component. Generally, the diet contained fewer plants and more roots (35%) and insects (13%).

The spring specimens had only 6% roots, and 52% above-ground parts of herbs, including *Taraxacum officinale*, *Sonchus* spp. and *Urtica dioica*. As also during the snow period animals in the diet amounted to 13%.

Table 2 shows that the majority of the specimens were obtained in long fallow land and in deserted settlements.

The Chernobyl boars, at least under climatic conditions that have prevailed so far, have a feeding strategy similar to that found by Dardaillon (1987) in the Camargue. They also share the habit of opportunism and omnivory with a trend to herbivory with wild boars of the Belgian Ardennes (Palata *et al.*, 1987).

This study also indicated that rooting for below-ground plant parts is pronounced during autumn and winter, but is limited during spring and summer, whereas Genov (1981) found that summer was the main rooting season. His observations on changes to the plant association from grass to herbs on rooted meadows and pastures seem to be very close to what we have observed regarding Wild boar rooting and the occurrence of *Oenothera biennis*, a weed that is known to prefer stirred soils, e.g. on roadsides and arable land.

4. Acknowledgements

This study is based on data obtained within the project "Behaviour of Radionuclides in Natural and Semi-Natural Environments (ECP5)" under CEC/CIS' Joint Programme on the Consequences of the Chernobyl Accident.

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Table 2. Number of sampled wild boars per season and vegetation type.

VEGETATION TYPE	SUMMER	AUTUMN	WINTER BARE	WINTER SNOWCOV.	SPRING
Pine, whortleberry-green-mossy			1		
Pine, humid bilberry-mossy	1				
Sedge-reed bog	1		2		
Long fallow non-drained land	3		5	1	2
Long fallow drained land		1	1		1
Abandoned settlements	8		6	2	2

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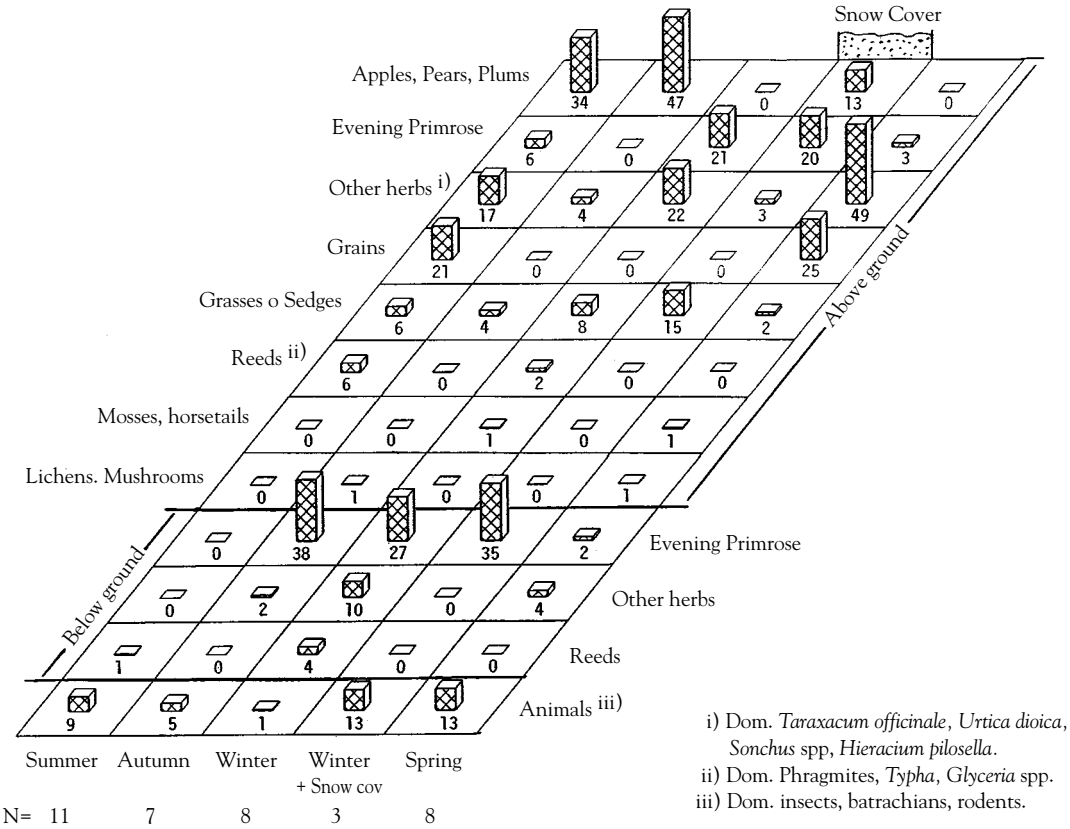

i) Dom. *Taraxacum officinale, Urtica dioica, Sonchus* spp, *Hieracium pilosella*.
ii) Dom. Phragmites, *Typha, Glyceria* spp.
iii) Dom. insects, batrachians, rodents.

Figure 1 - Stomach contents of wild boars, Chernobyl 1992-1993. N indicates the number of stomach contents. The values on the figure indicate the weight percentages of the various items.

DIET OF THE WILD BOAR (Sus scrofa L.*) INHABITING THE MONTPELLIER GARRIGUE*

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Abstract: We studied the diet of the Mediterranean Wild boar in two successive years, by analyzing 82 stomach contents collected during the hunting season (September-December) and 138 feces collected near feeding troughs during the rest of the year. The samples came from animals inhabiting a typical Mediterranean garrigue characterized by holly oak *(Quercus ilex)* and situated at the edge of the extensive vine-growing plain of the Hérault department. Food-habits analyses using feces and stomachs sampled during the same period yielded comparable results. The Wild boar is omnivorous, with a definite frugivorous tendancy. Plants represent 96% of the diet. The animal part (3%), however, is underestimated since snails and earthworms are quickly digested. A special investigation of the presence of mollusc mouth pieces and earthworm setae allowed us to calculate the number of individuals consumed. Wild fruits represent 57% of the annual diet, in dry weight. Among fruits holly oak acorns are the staple food (47% in dry weight over the year) and they are consumed as soon, and as long, as available. The amount of artificial food *(Zea mays)* is important (32% of the annual diet). Comparison of good and poor mast years showed that Wild boar may compensate a lack of acorns by feeding on grapes in the vineyards.

Keywords: Wild boar, *Sus scrofa,* Suidae, Feeding habits, Food resources, Stomach contents, Feces, France, Europe.

IBEX J.M.E. 3:174-179

1. Introduction

Several Wild boar diet studies have been carried out in France by Conner (1982), Douaud (1983), Dardaillon (1984) and Sjarmidi (1992), but nothing has been reported on food habits over the annual cycle, because of the methodological problems underlying this type of study (Gerard & Campan, 1988). Elsewhere, authors reported on Wild boar food habits throughout the year (Briedermann, 1986; Genov, 1981a; Genov, 1981b; Palata *et al.*, 1987), but only in deciduous forests.

For several years Wild boar populations have been decreasing in the southwestern part of France. Nevertheless, vineyard growers are filing more and more request for financial compensation owing the Wild boar damage. Therefore, an in-depth study of the Wild boar diet over the yearly cycle, linked to an analysis of their seasonal habitat use, is needed for a better understanding of environment/Wild boar interactions. Such data are necessary for developing ways of reducing depredations on vineyards.

2. Study area

The study area is situated in the Hérault department, 35 km north-west of Montpellier (France) (Fig.1), at the junction of two contrasting areas: the vineyards of the Hérault plain and the garrigue.

In the Hérault valley (236,000 ha), 66% of the agricultural land is occupied by vineyards. Other vegetation types include olive groves (*Olea europaea*), almond groves (*Amygdalus communis*), fallow land, small woodlands and riparian woods. The garrigue (500,000 ha) is an area covered with low scrub vegetation, varying from dense to open communities, depending on soil composition and exposure. Floral composition is Mediterranean, characterized by holly oak (*Quercus ilex*), kermes oak (*Quercus coccifera*), pistachio tree (*Pistacia* sp.), cistus (*Cistus* sp.), prickly juniper (*Juniperus oxycedrus*), amelanchier (*Amelanchier vulgaris*), mock privet (*Phillyrea* sp.), sarsaparilla (*Smilax aspera*), etc. The woodland communities are chiefly holly oak, which is replaced, on deeper soils, by pubescent oak (*Quercus pubescens*). Often such stands are mixed with pines (*Pinus halepensis* or *Pinus pinea*).

Weather is typically Mediterranean, hot in summer, cool in winter and wet in autumn and spring. Changes in weather are marked, showing coefficients of seasonal variation of over 60% (Central weather forecasting office).

3. Material and methods

Samples for food habits analysis came from animals actively feeding in an homogeneous environment. They consisted of 82 stomachs collected during the hunting season (September

through December, 1990 and 1991). To complete the annual cycle (January through August, in 1990 and 1991), we also collected 138 feces around feeding troughs.
Samples were analyzed employing the classical method of washing and sieving. During a first experiment (Chambrillon, 1991) we defined the mesh-sizes (5 mm, 2 mm and 1 mm) of the sieves used to sort food particles, and, for each sample, the minimum fraction that should be analyzed (for stomachs 20% of fresh weight, for feces 30%).
Results are expressed in percent dry weight and in frequency of occurrence in samples.
To solve the problem of the very rapid or complete digestibility of certain invertebrates, we used two other sieves to collect their undigestible fractions: i) one 0.8 mm mesh sieve to retain the mouth pieces of snails; ii) one 40 µm mesh sieve to retain earthworm setae.
The number of individual invertebrates was assessed by counts of these fractions, knowing that there are:
- one mouth piece per snail;
- 1,382 setae per earthworm (mean calculated for 1,000 earthworms collected in the study area).
The analyses of part of Wild boar stomachs (n = 23) and feces (n = 13) collected during the same period gave comparable results. Therefore we pooled the results from both analyses.

4. Results

4.1. General composition of the Wild boar diet

The 40 identified food items were grouped into 8 categories (Tab. 1). These data show that the Wild boar is omnivorous, but it has a definite frugivorous tendency.
Natural fruits constitute 57% of the annual diet. Most of the fruits are holly oak acorns, which can be found in 90% of the samples. The lower occurrence of other fruits indicates that the Wild boar consumption pattern is rather opportunistic.
Although vegetal foods are a dominant dietary component and they are present in 100% of the cases, the proportion of animal food should not be neglected. In fact, its part is underestimated, because it is very rapidly or entirely digested. The intake of artificial food (*Zea mays*) is important since it accounts for 1/3 of the annual diet.[1]

[1]Please note that during the two years of study wild boars were fed artificially to capture them (Maillard & Fournier, this volume)

4.2. Monthly changes in the diet

Figure 2 shows the monthly changes in diet from January 1990 to December 1991. Both seasonal and year-to-year variability are evident.
In 1990, acorns were the dominant food item from January to March, as well as later in the year, from October to December. The intake of bait maize was low during the winter months, and more or less constant in the other months. Beginning in June, the diet was much more diversified and several food items became important including mushrooms, animal food and fleshy fruits. Grapes (*Vitis vinifera*) appeared in August. During the summer months, acorns were absent. Only in October they again became important, at the expense of other items.
In 1991, acorns were the dominant food item from the beginning of the year until August. Although in early summer the rest of the diet was much less varied than in 1990, diversity

Table 1: Percentage of dry weight and frequency of occurrence of Wild boar foods.

Category of food (% dry weight)	Plant food (96)						Animal food	Litter
	Natural plant species (64)					Artificially fed maize		
	Fruits (57)			Leaves, steams roots	Mush-rooms			
	Acorns	Other fruits	Grapes					
% dry weight	47	5	5	5	2	32	3	1
% occurrence	90	61	18	96	60	82	88	95

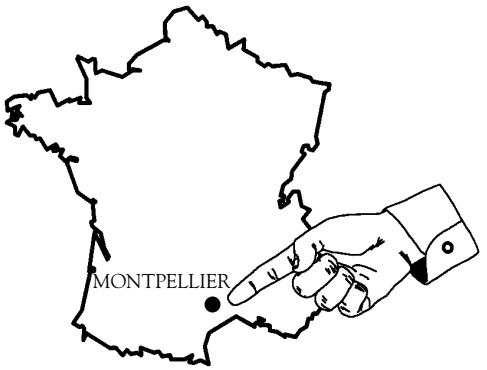

Figure 1 - Study area.

increased in August. Grapes were eaten later and in bigger quantities than in 1990 (t significant for P = 0.05). They constituted 1/3 of the diet in September and October. In comparison, acorns only reappeared in big quantities in November, to the detriment of the other available foods.

Figures 3 and 4 show the seasonal shifts in the consumption of earthworms and snails. Earthworms were absent in summer and although their frequency of intake was high in winter, the quantity intake was more important in autumn. Snails were absent in winter and were mainly consumed in autumn.

5. Discussion and conclusion

There is a direct link between the monthly changes in food resources used by Wild boar and their availability (Tab. 2).

Thus, in the Mediterranean environment, the importance of mast production by holly oak makes it the wild boars' staple food (47% of dry weight over the year for 90% occurrence). They will consume acorns as soon as and as long as available. Many authors stress the fact that the abundance of forest fruits induces an almost monophagic feeding behaviour in the animals (Briedermann, 1965; Palata *et al.*, *op. cit.*; Sjarmidi, *op. cit.*). Conversely, a mast failure forces Wild boar to diversify its diet according to the other food resources available. This is confirmed by the fact that the total number of items ingested per month varies inversely with the quantity of acorns consumed.

A study of the changes in acorn availibility shows that it is linked to the initial quantity of the acorn crop in fall and to the duration of their conservation. A quantitative inventory of the acorn mast production in the study area showed a year to year variability, which may explain the observed differences in diet composition (Fig. 2):

- in 1989, the poor oak mast crop resulted in an acorn shortage as early as June, which was mostly compensated by the many fleshy fruits available in summer (*Amelanchier vulgaris*, *Rubus* sp., *Pistacia terebinthus*, *Prunus* sp, *Smilax aspera*);
- the abundant mast production in 1990 shifted the shortage forward to September 1991. Mast shortage lasted into October 1991, because of the small 1991 acorn crop. Grapes, abundant in early autumn, then constituted the complementary food item.

Jullien *et al.* (1990), Wlazelko and Labudzki (1992) also showed that when the woods bear no fruit, Wild boar will heavily exploit the cultivated areas. In the Mediterranean environment, it appears that successive oak mast crops cannot cover the animals' requirements over 12 successive months.

Maize is an important component of the diet, except when acorns are abundant (December-March). Then maize becomes a secondary food, because mast is the preferred food in all seasons (Vassant, in press).

Animal food, consumed throughout the year (88% occurrence), is probably an indispensable food item. Also, as shown by a correspondence analysis, the intake of earthworms and snails (by number of individuals) is strongly linked to the amount of rainfall, a necessary condition for their accessibility.

These data illustrate the marked frugivorous tendency of the Wild boar in the Mediterranean garrigue. Forest fruit productions have a major influence on feeding activity. When the availability of natural food resources becomes uncertain, opportunistic feeding behaviour incites the Wild boar to exploit vineyards.

6. Acknowledgements

We thank all the hunters who were instrumental in collecting the stomachs of killed wild boars, as well as the many students for their help during the collection of feces in the field. We are grateful to the Director of the "Entente Interdépartementale" (E.I.D.) for the mosquito control and we thank his staff for allowing us to use his laboratories.

Table 2: Summary table of the main food items available to Wild boar (Fournier-Chambrillon *et al.*, in press).

	J	F	M	A	M	J	J	A	S	O	N	D
Acorns	■	■	■	■	▒	▒	▒	▒		▒	■	■
Vineyard grapes							▒	■	■	■	▒	
Wild fruits						▒	■	■	■	▒		
Mushrooms	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Earthworms	■	■	■	▒	▒				▒	▒	■	■
Snails			▒	▒	▒	▒	▒	▒	▒	▒	▒	

■ Constant availability ▒ Random availability

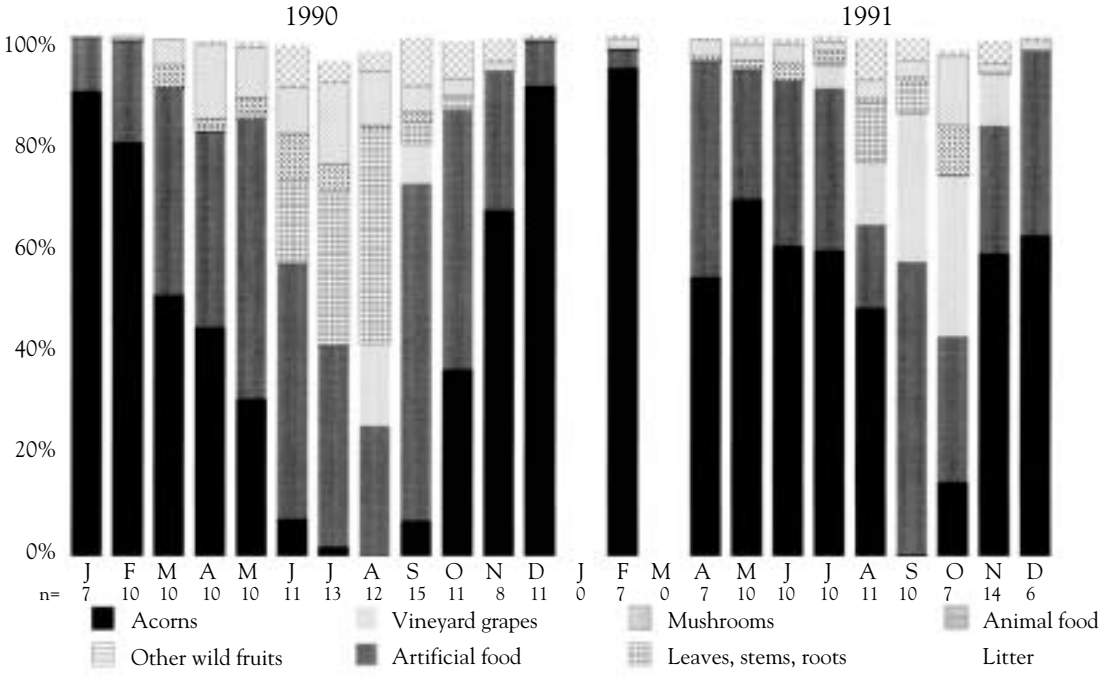

Figure 2 - Monthly changes in the Wild boar diet.

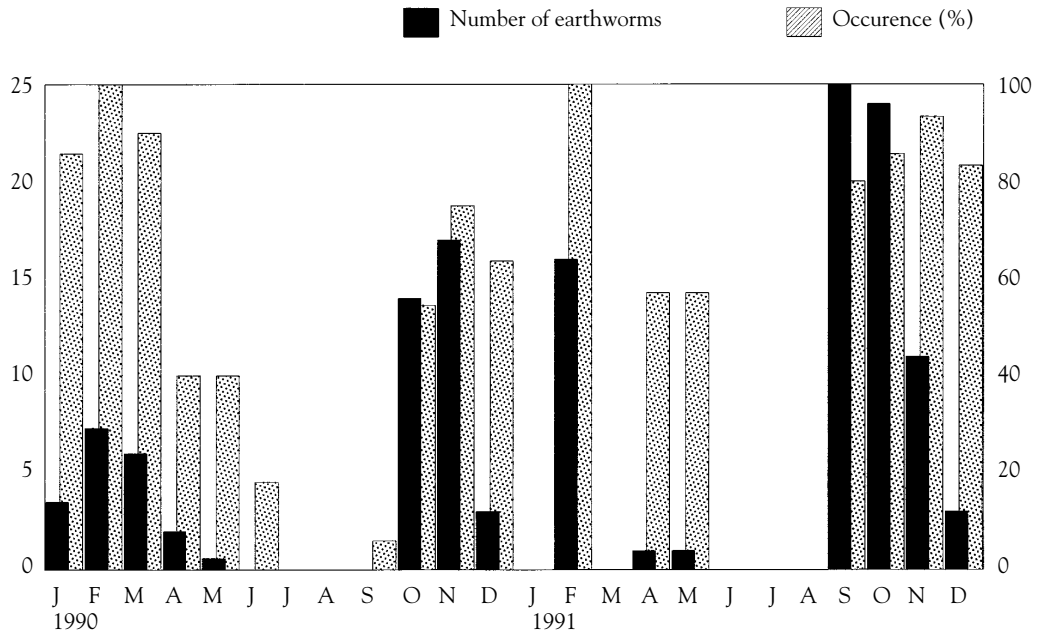

Figure 3 - Monthly earthworm consumption by Wild boar. Occurence = % of wild boar's stomachs containing earthworms.

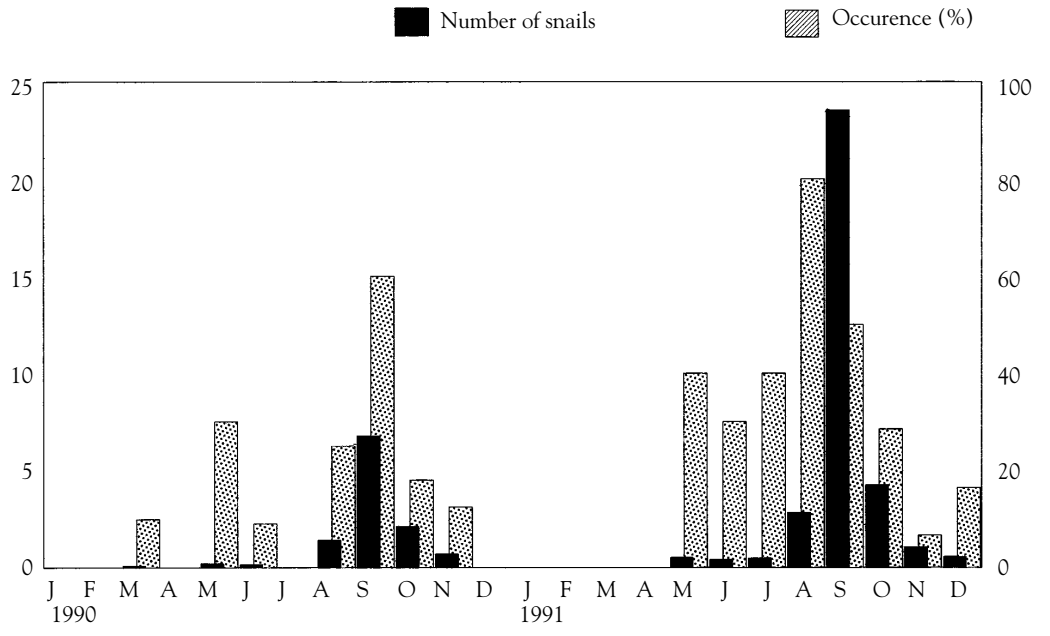

Figure 4 - Monthly snail consumption by Wild boar. Occurence = % of wild boar's stomachs containing snails.

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THE AUTUMN DIET OF THE WILD BOAR (Sus scrofa) IN AN ALPINE VALLEY. PRELIMINARY RESULTS

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Abstract: The autumn and winter diet of 20 wild boars killed during the hunting seasons 1989-1992 in the Varaita valley (Cuneo province, NW Italy) was studied. Chestnuts are the main food, they may represent up to 90% of the stomach content.

Keywords: Wild boar, *Sus scrofa,* Suidae, Feeding, Stomach contents, Chestnuts, Acorns.

IBEX J.M.E. 3:180-183

1. Introduction

The diet of Wild boar (*Sus scrofa*) has been studied by various european authors in different regions (plains and hills), but little is known about the wild boar's diet in the alpine environment, also because these animals have only recently settled in those areas.
In this research our attempt is to, partly, provide for such lack of information. Having conducted research work in a limited period of time (during the hunting season: September - December) the results obtained only refer to the wild boar's autumn diet.

2. Study area

The Varaita valley (Cuneo province, Western Alps, Italy NW) covers an area of 42,000 ha with an E-W orientation (Fig.1); altitude ranges from 400 m to 3,841 m (mont Monviso) above sea level. The annual rainfall is 800-1,000 mm in average (150 mm in summer). The valley edges are mainly wooded with dense underbrush; the Chestnut (*Castanea sativa*) is dominant between 400 and 1,000 m, the Oak (*Quercus petreae*) is present. The Larch (*Larix decidua*), pure or mixed with Beech (*Fagus sylvatica*), is common even at low altitudes; the Cembrian pine (*Pinus cembra*) is widespread.

3. Material and methods

During the hunting seasons through 1989-1992, seventy-two (72) stomachs, belonging to wild boars, were collected in Varaita valley (Fig.2).
Twenty (20) specimens have been analysed, up to now, thirteen (13) belonging to males, seven (7) to females.
In order to prepare the samples we used Sjarmidi's method (1992) that suggests the following procedures:
1 - weighing of whole stomach content;
2 - washing of material through four consecutive sieves of decreasing mesh size (2.0 mm, 1.0 mm, 0.5 mm, 0.2 mm);
3 - drying of stomach content in air-bath at 70-80°C for a period of twenty-four hours;
4 - weighing dried material in order to establish water percentage (Tab. 1);
5 - analyses of quality and quantity of samples.

Analyses were conducted on two different classes of fragments (2-4 mm and >4mm).
Fragments of food items were identified using a reference collection of plant and animal materials and counted under dissecting microscope. The fragments were classified in sixteen food categories which were used to calculate the occurence percentage of food category in all twenty stomachs and the percentage of food category in the total dry material.
ANOVA test was used to compare the differences between male and female diet.

4. Results

The occurence percentage and the percentage in total dry weight for each food category are shown in figure 3. Studies were also conducted in order to verify a difference in usage of food resources between males and females (Fig. 4).

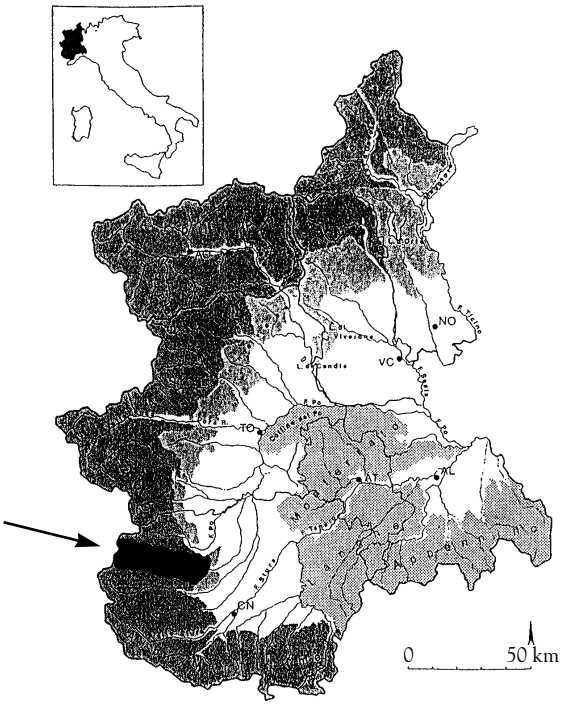

Figure 1 - Study area.

Table 1: Sex and age of the shooted wild boars, fresh and dry weight of their stomach contents and percentage of water.

SEX	AGE (MONTHS)	FRESH WEIGHT (g)	DRY WEIGHT (g)	% WATER
M	9	891	231.541	74
M	7	408	121.244	70
M	40	127	24.290	81
M	30	291	69.697	76
F	15	808	184.562	77
F	20	1442	334.429	77
M	11	473	107.448	77
F	6	228	82.591	64
M	29	183	35.327	81
F	5	405	82.036	80
M	23	1383	304.639	78
F	21	1713	443.121	74
M	17	455	88.420	81
M	12	1007	219.735	78
M	6	500	120.189	76
F	8	577	135.826	76
M	6	692	154.144	78
M	15	1795	368.613	79
M	15	1082	227.121	79
F	10	291	62.241	79

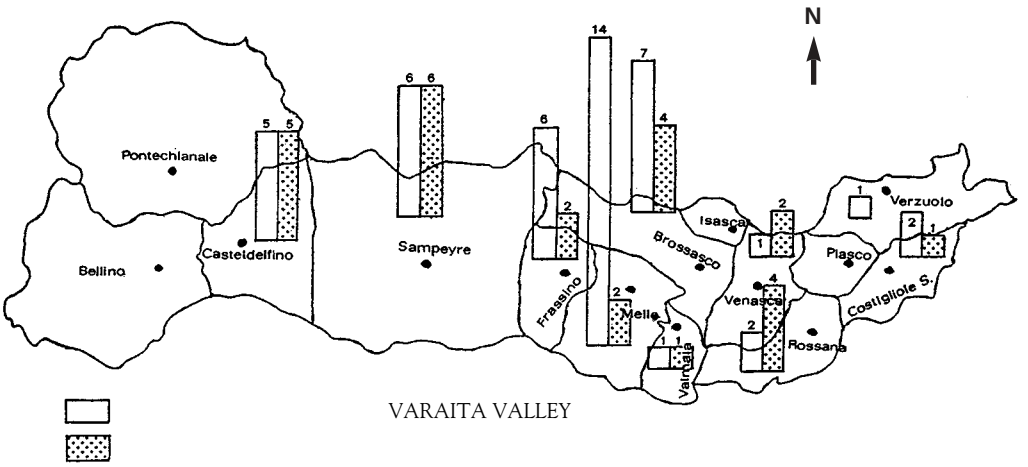

Figure 2 - Stomachs collected during hunting seasons 1989-1992.

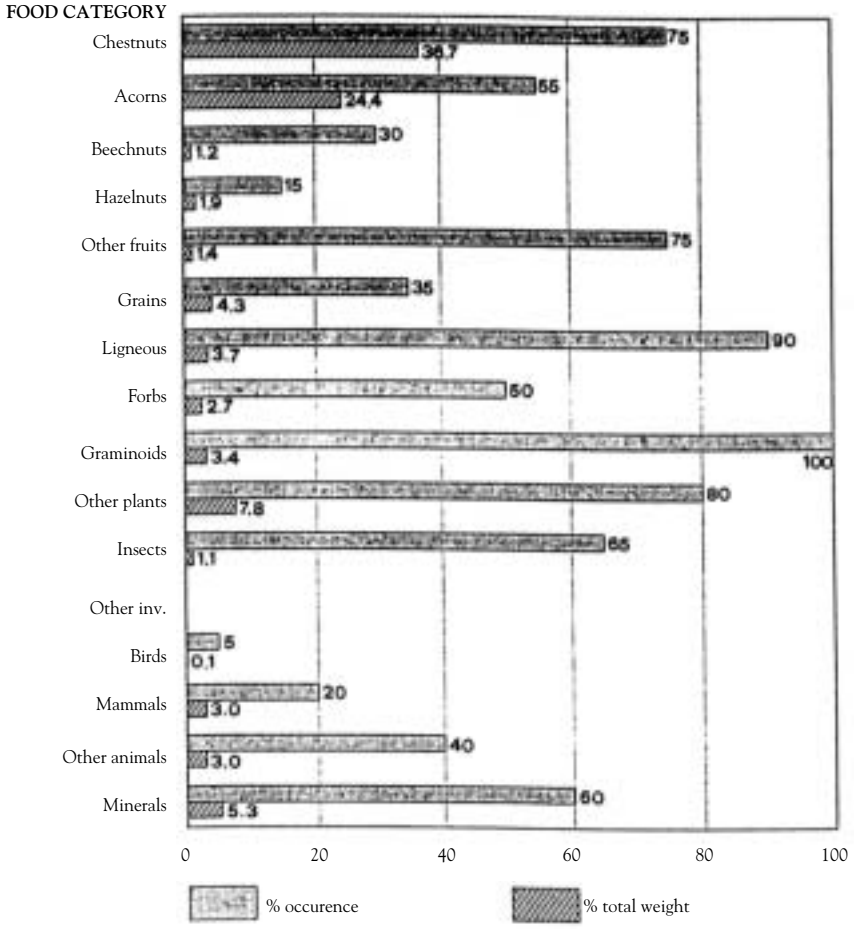

Figure 3 - Diet composition according to stomachs contents.

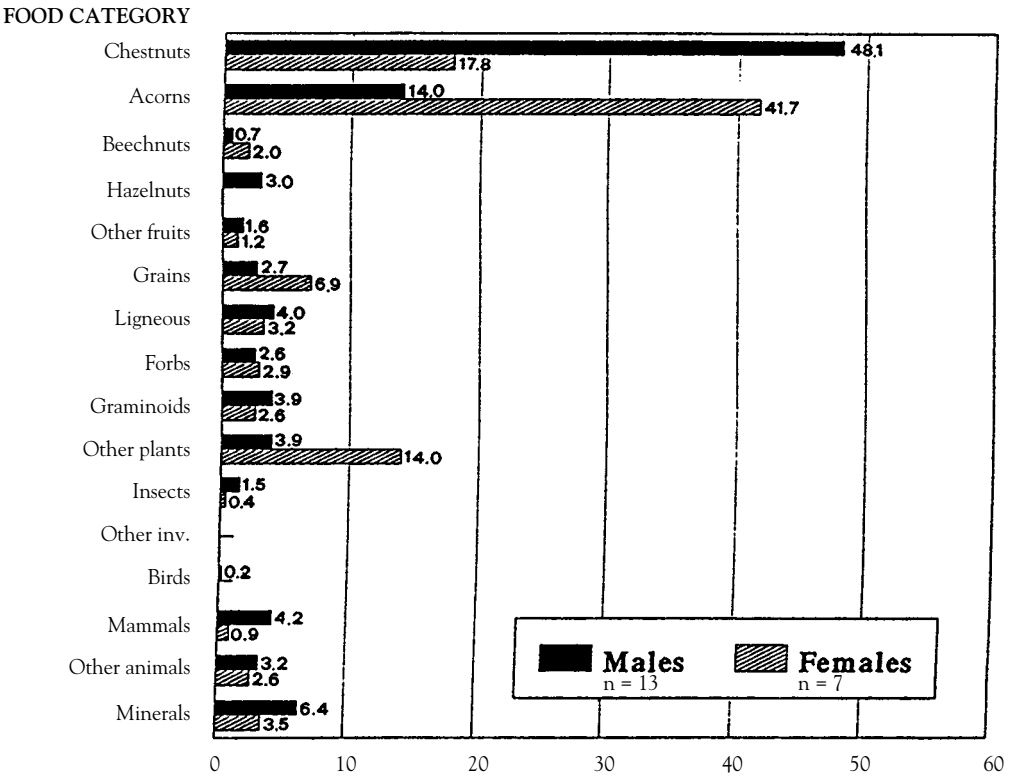

Figure 4 - Diet composition for males and females according to stomach contents.

5. Conclusion

This research has been conducted on stomach contents that were taken during the hunting season and therefore refer to a short time of the year. However we can draw the following points:

- Wild boar is an omnivorous species, it can modify its diet according to the food available in its environment (Genov, 1981);
- plant food covers the main part of the diet (87.5%) while animal matter occurs in lower percentage (7.2%), according to Dardaillon (1987), Sjarmidi *et al.* (1991), Klaa (1991). Acorns and chestnuts were preferred by Wild boar during the study period (61.1% of diet), according to Dardaillon (*op. cit.*) and Sjarmidi (*op. cit.*);
- although graminoids occurred in all analysed stomach contents, they represented only 3.4% of the diet;
- we didn't find any meaningful statistical difference in food choice between males and females, because of a great variability within the quantities of food found in the stomach contents.

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STOMACH CONTENTS OF JAPANESE WILD BOAR IN WINTER

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Abstract: Stomachs of wild boars were collected from hunters in the central Japan. 134 contents were analysed and measured their volumes and weights. Some correlations were seen between the volume and the dry weight of stomach content. Vegetable items of the foods, such as rhizomes, were found in 95% of the samples, whereas animal items, such as earthworms, were found in 30%. Caloric estimation showed the animals lived under poor nutritional conditions in winter.

Keywords: Wild boar, *Sus scrofa leucomystax,* Suidae, Energetics, Metabolism, Asia.

IBEX J.M.E. 3:184-185

One hundred and forty-one (141) stomachs of Japanese Wild boar *(Sus scrofa leucomystax)* were collected in the central Japan in winter of 1970 to 1971. No content was found in seven stomachs, so 134 contents were analyzed, after measuring their volumes and weights (Asahi, 1975). The correlation between the volumes of stomach contents and the recorded body weights was not clear, but some relations occured with the dry weights of stomachs contents (Fig. 1).

The vegetable items were found among 95% of specimens (Fig. 2). Most of them were fibrous tissue and sludge, so, the identifications of food species were very difficult. The subterranean stems and roots included Japanese thatch grass

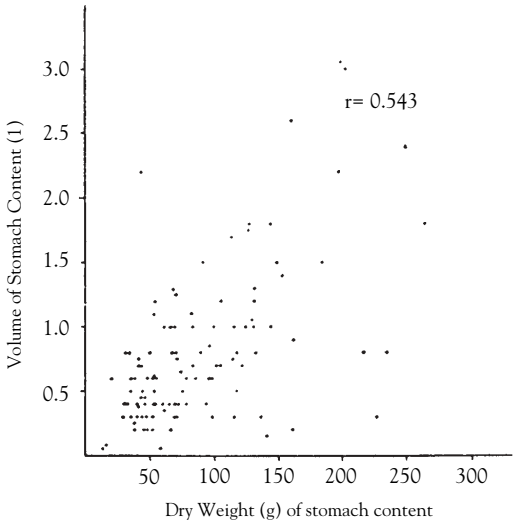

Figure 1 - Relation between dry weight (in g) and volume (in l) of stomach content

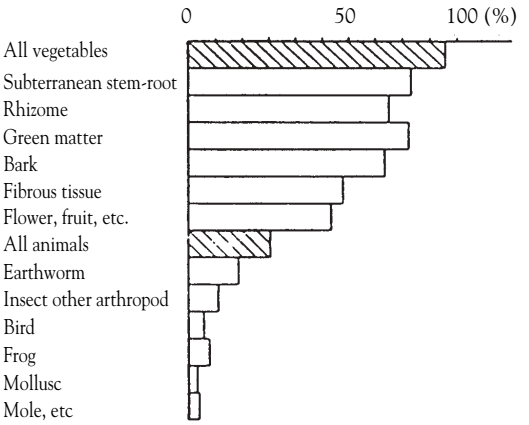

Figure 2 - Occurence of each food item

(*Imperata cylindrica,* Graminaea). Starch-grains of rhizomes were microscoped, that most of them were potatoes (*Solanum tuberosum,* Solanaceae, cultivated), arrow-roots (*Puearia lobata,* Leguminosae) and wild yam (*Discora* sp., Araceae). In green matters, leaves of Japanese thatch grass, eurya (*Eurya japonica,* Theaceae), etc, and in seeds, rice (*Oryza sativa,* Graminaea, cultivated) and wild grapes (*Vitis* sp., Vitaceae) were seen.

The animal items were found among 30% of stomachs (Fig. 2). They were chiefly earthworms. Insects were beetles and their larvae. In frogs, tree frog *(Hyla japonica)* and forest green tree frog *(Rhacophorus arboreus)* were seen, and in birds, feathers and bones of chicken were seen.

After separation for each item, they were measured the volumes, fresh and dry weights (Tab.1).

Table 1. Dry weight (mg) of stomach contents' various food items: average and values of two specimens (see text).

	SR	Rh	Gr	Ba	Fi	FS	P	A
Average	817.1	728.1	88.6	614.7	1425.2	427.2	3285.0	81.9
V-103	250	2040	10	8400	6880	0	9353	23
B-7	0	0	114	3152	4203	0	6680	105

SR: subterranean stem and root; Rh: rhizome; Gr: green matter; Ba: bark; Fi: fibrous tissue; FS: flower, fruit, and seed; P: other plant matter; A: animal matter.

We could estimate the caloric nutrition value in food, if 4 kcal/g dry weight for the vegetable items, and 5 kcal/g for the animal items (Tab. 2). To the flowed-away sludge, we would consider 0.4 kcal/g in fresh weight, that were estimated as the difference from the total contents which were initially measured. The average dry weight and energetic value of the stomach contents of the specimens were 817.1 g, and 86.3 kcal. But, in those cases, the average value was meanless, I think. The maximum contents in the specimen V-103 was 3050 ml in volume and its caloric value was 380 kcal. And, the maximum nutritional calorie (509 kcal) was found in the specimen B-7 of which total content was 3000 ml.

Table 2. Estimation of caloric nutrition (kcal): average and values of two specimens.

	BW(kg)*	BM** (kcal/day)	Daily need (kcal/day)	Stomach content (kcal)	(% to need)
Average	38.9	1090	2180	86.3	4.0
V-103	60.0	1509	3020	380	16.6
B-7	60.0	1509	3020	509	16.9

*BW = Body weight, **BM = Basal Metabolism

If we assume that the needs of Wild boar would be: 2 x 70 x BW $^{0.75}$ kcal/day, where BW is the body weight (after Brody, 1945, and Kleiber, 1961), an animal weighing 60 kg requires 3020 kcal/day. The maximum estimated calories from stomach contents was only 16% of this daily need. Yamamoto (1974) had ever estimated the caloric nutritions of Japanese black bear *(Selenarctus thibetanus japonicus)* by the same method. It showed that the stomach contents of this animal may satisfy about the half of daily need.

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