



EUROPEAN COMMISSION
HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL

Scientific Steering Committee

OPINION on :

NECROPHAGOUS BIRDS AS POSSIBLE TRANSMITTERS OF TSE/BSE

**ADOPTED BY
THE SCIENTIFIC STEERING COMMITTEE
AT ITS MEETING OF 7-8 NOVEMBER 2002**

OPINION

BACKGROUND AND MANDATE

Concern has been raised to the theoretical risk that carrion¹ or necrophagous birds could play a role in the spread of TSE and exposure to TSE of humans by contracting the disease, by spreading the agent passively in waste from their food or by exposure of persons involved in handling the birds and the direct release of the agent in the environment. On 9 October 2001 the CMIEET (Multidisciplinary Scientific Committee for Research into Transmissible Spongiform Encephalopathies, Spain), adopted a scientific opinion and report on *Carrion birds as possible vectors of bovine spongiform encephalopathy and on possible alternatives to the use of ruminant carcasses as food for these animals*. The Scientific Steering Committee was subsequently requested to:

- (1) *Evaluate the opinion of the Spanish Scientific Committee on TSEs in relation to necrophagous birds being possible transmitters of BSE and*
- (2) *Advise on the safety with regard to TSE risks for the use of dead ruminants containing specified risk material (SRM) for the feeding of necrophagous birds and, if appropriate, suggest examples of conditions under which such feeding can be carried out safely.*

The opinion hereafter pays special attention to the above mentioned spanish report and is based on the discussions held by the TSE/BSE *ad hoc* Group at its meetings of 25 July and 5 September 2002 (rapporetur: Dr.E.Vanopdenbosch), as well as contributions from Prof.Dr.L.Bolis, Dr.P.Brown and Dr.R.Bradley.

OPINION

1. *Necrophagous birds as possible transmitters of BSE.*

The SSC considers that the evaluation of necrophagous birds as possible transmitters of BSE, should theoretically be approached from a broader perspective of mammals and birds which prey on, or are carrion eaters (scavengers) of mammalian species. Thus, carnivorous and omnivorous mammals, birds of prey (vultures, falcons, eagles, hawks etc.), carrion eating birds (crows, magpies etc.) in general could be considered possible vectors of transmission and/or spread of TSE infectivity in the environment. In view also of the occurrence of Chronic Wasting Disease (CWD) in various deer species it should not be accepted that domestic cattle and sheep are necessarily the only source of TSE agent exposure for carnivorous species. While some information is available on the susceptibility of wild/exotic/zoo animals to natural or experimental infection with certain TSE agents, nothing is known of the possibility of occurrence of TSE in wild animal populations, other than among the species of deer affected by CWD in the USA.

¹ The carrion birds are animals whose diet regularly or occasionally includes the consumption of carcasses, including possibly TSE infected ruminant carcasses.

The SSC therefore took, in addition to the opinion of the Spanish CMIEET, also the following publications into account²:

- SSC Opinion (1999) on the risks of non conventional transmissible agents, conventional infectious agents or other hazards such as toxic substances entering the human food or animal feed chains via raw material from fallen stock and dead animals (including also: ruminants, pigs, poultry, fish, wild/exotic/zoo animals, fur animals, cats, laboratory animals and fish) or via condemned materials.
- SSC Opinion (1999) on the risk born by recycling animal by-products as feed with regard to propagating TSE in non-ruminant farmed animals.
- SSC Opinion (2000) on the Scientific basis for import bans proposed by 3 member states with regard to BSE risks in France and the Republic of Ireland; on the Scientific basis for several measures proposed by France with regard to BSE risks and on the Scientific basis for banning animal protein from feed for all farmed animals, including pig, poultry, fish and pet animals.
- Scrimgeour, E. M., et al., 1996. Disposal of rendered offal. The Veterinary Record, August 31, 219-220. This paper raises the issue of birds as uninfected vectors of infectivity from landfill carcass sites in 1996.
- Tella, J.L., 2001. Action is needed now, or BSE crisis could wipe out endangered birds of prey. Nature, **410**: 408.

The SSC analysed the above literature from the following perspectives:

- The risk of TSE infection and agent replication in birds in general and in necrophagous birds in particular;
- Risk of passive spread of TSE
- Human exposure risk

It concluded as follows:

- The scientific basis (both literature and field data) for advising on the safety with regard to TSE risks, of the use of dead ruminants containing specified risk material (SRM) as bird feed, is very limited. As far as birds are concerned, most data relate to the domestic fowl. No literature could be found on aspects such as microscopic brain examinations in zoo carnivorous/omnivorous birds (often fed on waste bovine material that in the past may have been infected with BSE) nor on the epidemiology of TSEs as possibly influenced by the role of prey animals and carrion eaters (scavengers)³.

² The opinion of 9 October 2001 of the CMIEET was originally prepared in Spanish and a translation of the opinion into English is therefore attached to this opinion for ease of reference. At certain places, comments made by the TSE/BSE *ad hoc* Group at its meeting of 25 July 2002 have been introduced and they are highlighted.

³ It would hardly be possible to analyse this possible role with an epidemiological design.

- The possibility of *active replication of PrP^{Sc}* in birds is remote, if existing at all. (Necrophagous and omnivorous) birds are nevertheless able to ingest BSE infectious material and to *spread* the ingested infectious material through dissemination of faeces because it is unlikely that the pathological prion protein would be completely destroyed in the digestive tract. Moreover, plumage, claws and beak may also be contaminated with infectious material, which is then released into the environment.
- Although there is no data on TSE epidemiology indicating any significant role of any such pathways in the spread of scrapie, it cannot be excluded that they could play a part in the transportation of TSE infected materials, given that these birds can cover great distances and may also migrate.

2 *safety with regard to TSE risks of the use of dead ruminants containing specified risk material (SRM) for the feeding of necrophagous birds; examples of conditions under which such feeding can be carried out safely.*

One could theoretically consider implementing rigorous health measures to prevent birds from having access to carcasses of animal species susceptible to TSE, but in view of the very limited human exposure risk this may bring about changes to the ecology created by the traditional practices and could jeopardise the conservation of certain animal species. On the other hand, feeding practices should not lead to an artificial increase of the number of potential TSE transmission sources, and their possible spread. Whereas it is recognised that the removal of fallen animals from remote wild areas is not a realistic option under all circumstances, the SSC considers that feeding programmes of wild species such as necrophagous birds should thus not become an alternative way of disposal of fallen ruminant stock posing a TSE risk nor of specified risk materials.

The SSC considers that the above recommendations are for the time being also valid for other prey animals and carrion eaters (scavengers), for which even less literature is available.

3. The above conclusions are consistent with the opinion of 9 October 2001 of the CMIEET and with its main conclusions.

Annex:

CMIEET	Multidisciplinary Scientific Committee for Research into Transmissible Spongiform Encephalopathies Ministry of Science and Technology
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SCIENTIFIC OPINION:

***REPORT ON CARRION BIRDS AS POSSIBLE VECTORS OF BOVINE SPONGIFORM
ENCEPHALOPATHY
(POSSIBLE ALTERNATIVES TO THE USE OF RUMINANT CARCASSES AS FOOD
FOR THESE ANIMALS)***

Adopted by CMIEET during its meeting held in Madrid on 9 October 2001

Translation into English of:

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OPINIÓN CIENTÍFICA:

***INFORME SOBRE LAS AVES CARROÑERAS COMO POSIBLES VECTORES DE LA
ENCEFALOPATÍA ESPONGIFORME BOVINA
(POSIBLES ALTERNATIVAS AL USO DE CADÁVERES DE RUMIANTES PARA EL
ABASTECIMIENTO DE ESTOS ANIMALES)***

**Adoptada por el Comité Científico Multidisciplinar para la Investigación en
Encefalopatías Espongiformes Transmisibles (CMIEET), Ministerio de Ciencia y
Tecnología, en su reunión celebrada en Madrid, el 9 de Octubre de 2001**

Note:

When producing this report CMIEET concentrated on analysing and discussing information published in scientific reviews. Other technical documents, such as compilations of existing legislation and documents provided by organisations and persons involved in natural resources management, were also taken into consideration.

Please note that opinions expressed by CMIEET are not necessarily binding on the Ministry of Science and Technology.

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I. EXECUTIVE SUMMARY

The eradication of TSEs will require the removal of potential sources of the agent, such as bovine (and ovine) carcasses, from the natural environment. This will result in the elimination, or at least the reduction, of food sources for necrophagous species, for the conservation of which Spain has responsibilities unique in Europe.

There are no studies on the presence of TSE in necrophagous birds, nor is there any solid evidence that such processes affect birds in general. In fact, it has not even been possible to demonstrate birds' sensitivity to BSE under test conditions. This absence of observations can theoretically be explained by the low level of similarity — only 30% — between prion protein sequences of birds and mammals.

The possibility of necrophagous birds' digestive systems being somehow adapted to breaking down and extracting nutrients from prion proteins could be of great importance, not only in the interests of ensuring environmental biosafety but also as a potential final stage in the elimination of TSE risks: there is therefore a case for research into this issue.

There are two alternatives to deal with the immediate problem of food for necrophagous birds: a) keep using bovine carcasses, but on the condition that rapid test results are negative b) replacing them by other species not susceptible to BSE. The first alternative will not result in any substantial increase in costs since tests on all dead bovines have been obligatory since 1 July 2001 (Order of 26 July 2001). The second could create complex logistical problems and be considerably more expensive in regions where numbers of such species are low.

Consideration should be given to a moratorium on the use of sheep carcasses until it can be demonstrated that any cases of scrapie emerging in this country are unrelated to processes caused by the BSE agent.

If we take the global view of the issue of prions in the environment, we should also pay special attention to the possible problems related to other wild species documented as being susceptible to TSEs, such as mustelids (occasional carrion eaters) and cervids. We must also not lose sight of the potential for disaster if the Iberian lynx, a unique and endangered species, were to become involved in a possible wild BSE cycle.

We must also draw attention to the need for detailed studies of costs and of the uncertainties surrounding the numbers of domestic species and carrion animals, and for research into their susceptibility to TSEs and into the role which other wild species may play in the survival and spread of TSEs in the natural environment.

II. SUBJECT MATTER

Carrion birds as possible vectors of bovine spongiform encephalopathy. Possible alternatives to the use of ruminant carcasses as food for such animals

III. DEFINITIONS AND ABBREVIATIONS

Carrion or necrophagous animals: Carnivorous or omnivorous animals whose diet regularly or occasionally includes the consumption of carcasses. Annex I contains a list of the specific carrion birds referred to in this report.

AC: Autonomous Community

TSE: Transmissible spongiform encephalopathy

BSE: bovine spongiform encephalopathy

SRM: specific risk materials

PrP: Prion protein

PrP^C: normal prion cellular protein

PrP^{SC}: Resistant or pathological prion protein associated with scrapie and considered to be responsible for transmissible spongiform encephalopathies

SEO: Sociedad Española de Ornitología (Spanish Ornithological Society)

CNS: Central Nervous System

IV. BACKGROUND

The European programme for the eradication of transmissible spongiform encephalopathies in animals requires all sources of contagion to be monitored and destroyed. This implies that carcasses of animals which may potentially have been infected should be removed from the environment and destroyed under the correct conditions. This measure, which is of primary importance for TSE control, has an unwanted side effect – namely, the disappearance of traditional sources of food for necrophagous species. This group includes mammals and birds, although the latter have received more public attention because of their higher visibility and because some of them are endemic species in danger of extinction (Directives 79/409/EEC and 91/244/EEC, Law 4/1989). In this connection we must point out that Spain is the main reserve for carrion birds in Europe since it is home to more than 80-90% of the populations of these birds (Annex I), plus one unique species, the lammergeier or bearded vulture. Implementing rigorous health measures to remove animal carcasses would bring about changes to the traditional semi-natural equilibrium and could jeopardise the conservation of an irreplaceable part of our natural heritage.

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In this context of biological conservation, we must draw attention to the potential problem of circulation of TSE agents in wild species since some of these species, such as mustelids and cervids, have proven susceptible to TSE. As far as the former are concerned, we must stress that even though these animals rarely feed on carrion they cannot be discounted as possible carriers of TSEs given our lack of knowledge of TSE epidemiology. It should also be borne in mind that there are other land species apart from carrion birds which feed on animal carcasses and whose role has gone ignored until now. These species, some of which are of immense biological value, could also be affected if this food source were to disappear. Finally, although cervids may not appear to present an immediate problem they should be taken into consideration as part of a complete analysis of the issue of TSEs in the natural environment.

V. ANALYSIS OF SCIENTIFIC EVIDENCE AND DISCUSSION

V.1. Information on TSE in necrophagous birds

There is no information of any kind on the presence of TSE in necrophagous birds. This situation does not necessarily mean that they are not affected, since, first, it would be difficult to observe infected birds and, second, no post-mortem studies have been carried out to date. We must not forget that these types of birds are not present in Great Britain, which has seen the highest number of cases, and that so far the Spanish situation cannot be considered very serious. Even so, and if such birds were susceptible to the scrapie agent, one would expect to see over time a higher mortality rate related to the consumption of sheep, which has not so far been recorded. Thus, if the source of BSE were an ovine strain or a pre-existent and very rare process, we could even accept that these species might be resistant to such processes, or at least that they would not play a major role in their spread, since they certainly could have been exposed to these agents at any time.

[Note: *At its meetings of 25 July and 5 September 2002, The TSS/BSE ad hoc Group noticed that there is no scientific information available on the presence of TSE in necrophagous birds, and agrees that this absence of evidence does not necessarily mean that they cannot be affected. The Group further considered While vultures do not occur in several other Community countries, carrion eaters do, and so if a wider consideration is to given to the possibility of such species providing transport of TSE agents, even as mechanical vectors, a broader perspective of the issue is required.]*

V.2. Information on TSE in birds in general

Various bibliographical searches have only discovered two works describing suspected clinical symptoms, where a confirming diagnosis was not obtained, and one experimental attempt at infection, where transmission was not demonstrated.

In 1991, Schoon *et al.* described three cases where symptoms compatible with spongiform encephalopathies were observed in ostriches in two zoos in northern Germany, in 1986, 1988 and 1989. The birds displayed symptoms of a nervous disorder with ataxia, changes to balance, uncoordinated movements during feeding and microscopic lesions on the brain stem and medulla oblongata similar to those observed in cases of TSE described in mammals. One notable aspect is that the birds' feed included meat from livestock animals which had been the subject of

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emergency slaughter. However, no conclusive diagnosis could be made since it was not possible to rule out toxic or nutritional aetiology. The authors referred to the existence of other animals, in both zoos, which died displaying the same symptoms but could not be examined post-mortem.

In 1996, on a farm in Kent (UK) with cases of BSE in its livestock, a 30-month old hen (allowed the free run of the farm) displayed symptoms of behavioural change: the animal had trouble entering the coop and became panicked and lost its balance in stressful situations. The process lasted at least 10 weeks and during the final phase it displayed noticeable weight loss, progressive ataxia and violent trembling of the body and limbs. The histological lesions observed correspond to neuronal death, more obvious in the Purkinje cells, and minimal vacuolation. Consequent immunohistochemical studies did not shed any light on the aetiology of this process, due to the differences of opinion between the teams which had studied the case (Cawthorne, 1997; Narang, 1997).

Dawson *et al.* in 1991 carried out an experiment on domestic birds, hamsters, pigs and cows, which were intravenously administered with a homogenised preparation of BSE-infected brain tissue. The preparation was also administered, orally, to the pigs and birds. Results confirmed that the disease spread to the cattle and pigs. It was not demonstrated that it had spread to hamsters and birds although tests on these species had not been completed when the results were published. No further references from these authors clarifying these data have been found.

[Note: *On the basis of the above and of previous opinions of the SSC, the TSE/BSE ad hoc Group concluded at its meetings of 25 July and 5 September 2002 that there is no evidence from the world literature that a natural TSE exists in poultry. Unpublished, but completed experimental studies, of the transmissibility of the BSE agent to the domestic fowl have not detected evidence of transmission. These studies included primary parenteral and oral exposures of domestic fowl chicks to BSE affected brain tissue and subpassage of nervous systems tissue (into further chicks, intracerebrally and into a panel of inbred mice) from selected survivors of both primary exposure experiments (G. A. H. Wells, personal communication). . The possibility that poultry, under field conditions, could after oral exposure, act as healthy carriers in the spread of TSE-agents is I hypothetical and no results of experiments conducted as yet are available to support this hypothesis.]*

V.3. Digestive physiology of necrophagous birds with possible effects on the viability of the agent

The fact that necrophagous birds are now able to ingest highly infectious materials suggests that they may over time have developed resistance to many infectious agents (Houston and Cooper, 1975) and may even be able to extract nutrients from them. TSEs documented over the past 200 years could be included in this adaptation. Although the capacity for individual immune response may be an important mechanism for the species as a whole, a highly efficient digestive physiology which destroyed pathogenic agents would be much more significant in the interests of the environment, since this would prevent the passive spread of these agents to sensitive species.

The digestive system of carrion birds presents conditions of extreme acidity, around pH 1-1.2 in the stomach (Houston and Cooper, 1975; Farner, 1967), capable of dissolving bone calcium

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completely. Faecal matter, moreover, is mixed in the cloaca with products consisting almost exclusively of uric acid excreted by the kidneys. While these conditions ensure a high level of sterilisation in respect of the vast majority of biological pathogenic agents, their effect on prions has not been fully confirmed, since prion proteins are more sensitive to alkalinity (pH > 10 quickly deactivates them) than to acidity. It is for this exact reason — this possibility of deactivation by alkalis such as NaOH or sodium hypochlorite — that the effects of acid pH do not appear to have been investigated. The bibliographical research carried out for this report found only references to slight deactivation of the scrapie prion at pH 2-10 (Mould *et al.*, 1965) and even at pH 0.1 for one hour in hydrochloric acid (Brown *et al.*, 1986). However, these observations contradict the widely recommended practice when handling of material for histology, namely that it should be deactivated using formic acid (Brown *et al.*, 1990, Taylor, 1995, Taylor *et al.*, 1997). This last point suggests that levels of deactivation in acid media may vary depending on other factors. In this connection, one could extrapolate that conditions in the digestive tract of carrion birds probably provide these helpful factors both as a means to extract nutritious proteins and as a form of protection against biological agents.

As far as proteolytic enzymes of the digestive system such as trypsin and pepsin are concerned, these do not appear to be capable of effectively destroying prions under test conditions (Taylor, 2000), although it cannot be ruled out that under the specific conditions of a combination of proteolytic factors in carrion birds' digestive system their activity could be completely efficient.

No specific information has been found concerning these points, so any studies on this subject should be considered as being of great interest. If the existence of such a mechanism with an effect on pathological prion proteins were to be confirmed it would be of great relevance as it would offer a complementary ecological and low-cost alternative for the destruction of SRM.

V.4. Evaluation of uncertainties surrounding the possibility of necrophagous birds becoming infected by or spreading the BSE agent

As far as carrion birds are concerned there are principally three types of risks associated with TSE: a) the risk that they contract the disease, b) the risk of spreading the agent passively in waste from their food, and c) exposure of persons involved in handling carrion and the direct release of the agent into the natural environment.

a) Contracting the disease

If these birds were to contract the disease, the agent would be much more widely spread since the majority of these birds are migratory. According to studies carried out in the Iberian Peninsula, approximately 50% of young griffon vultures migrate to Africa, some to settle and some to return. Kites and Egyptian vultures are also migratory species, spending winter (80% of the European population of red kites) and summer respectively in Spain.

The existence of a prion protein in birds has been demonstrated, although research has shown that it has a very low level of similarity — around 30% — to that found in mammals (Gabriel *et al.*, 1992; Wopfner *et al.*, 1999). However new research is necessary since the limited number of birds tested did not allow categorical conclusions to be reached (Wopfner *et al.*, 1999).

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Moreover, other aspects must be taken into consideration. Studies of different species of mammals show that, for example, PrP in pigs is very similar to PrP in cattle: the potential for infection is therefore very high. But while pigs are easily infected by intercerebral contact they are not infected orally, which clearly suggests that other factors contribute to the development of PrP^{SC} in an animal (Wopfner *et al.*, 1999).

The potential for transmission can therefore be considered as relatively low, and given the knowledge of the epidemiology of these diseases, would not require special measures to be taken as it suggests that it can only be passed on once the infected animal has died — only once in a lifetime, in other words.

b) Passive spread

Passive spread can take place in two ways:

- through ingestion of infectious tissue and capacity to destroy the pathological prion protein in digestive processes
- through transport in the crop, plumage, claws and beak

Large carrion birds do not normally consume bovine central nervous tissue, but do consume their intestines and, occasionally, ovine CNS tissue (or at least the spinal medulla).

In any case it must be stressed that some less specialised species, such as corvids — which, moreover, are very numerous — are more likely to contribute to spread since one of their favourite foods is eyes, clearly considered to be specified risk material. Some species of rodents could more realistically constitute carriers than could carrion birds since they can more easily consume nervous tissue, which is more highly contaminated.

As has already been pointed out, and although all seems to indicate the opposite, the capacity of carrion birds' digestive system to destroy prion proteins has not yet been formally demonstrated: if the principle of precaution is to be applied, it must be assumed that they can act as passive vectors until it can be proven otherwise. These birds may play a relatively important part in dissemination, given that they can cover great distances and may even migrate long distances. Consequently, the potential for transmission can be considered medium to high since one single meal could be scattered as faecal matter over several areas. Moreover, transmission would take place each time an individual bird ate infected tissues, which could happen several times during its life.

As far as the transportation of contaminated material in the crop, feathers, claws and beak is concerned, only the first appears to be of any importance since it is part of the species' normal method of storing food, but might be more exceptional in other cases (except in that of the bearded vulture). Material transported in the crop is fed to chicks during the reproductive phase, if it is not digested, and thus, leaving aside any occasional wastage, enters a digestive cycle similar to that of adults but with the added security of by-products being confined to the nest and surrounding areas. The potential for transmission in this manner should be considered to be low.

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In all cases, the only reasonable step to take would be to monitor known and accessible sources of agents, namely cases of TSE in domesticated animals.

[Note: *At its meetings of 25 July and 5 September 2002, the TSE/BSE ad hoc Group considered that with the advent of the BSE epidemic, necrophagous birds may now have the potential to ingest highly BSE infectious materials and that this could contribute to spread of infectious tissue, as it is unlikely that the pathological prion protein will be destroyed completely in the avian alimentary tract. Further possible mechanical transport of agent could also occur in the crop, plumage, claws and beak. Theoretically, the transportation of BSE or TSE infected materials could play a relatively important part in dissemination, given that such birds can cover great distances and may even migrate long distances. Therefore this potential source of transmission should be eliminated, as far as is possible, by testing of all possibly TSE affected dead bovines and small ruminants and by the effective destruction of all SRM and all animals found to be positive.]*

c) Exposure of persons involved in handling carrion and direct release of the agent into the environment

Persons involved in handling and transporting animals with BSE can be exposed to risk. Moreover, if the security of the methods of transport cannot be guaranteed, there may be losses during the journey. Moreover, leaving contaminated material in the natural environment implies leaving an extremely resistant agent — and one which, it has been suggested, may contaminate aquifers — uncontrolled.

This potential source of transmission could be almost completely eliminated through tests on all dead bovines and the effective destruction of all found to be positive.

[Note: *The TSE/BSE ad hoc Group at its meetings of 25 July and 25 September 2002 considered that necrophagous birds transporting BSE infected materials could, possibly, lead to exposure of persons involved in their handling and transporting. This risk can be considered to be negligible, but potential sources of transmission should be eliminated as previously suggested.]*

V.5. Practical proposals for action regarding the use of carcasses from other species to feed these birds

a) Consumption figures, vulture numbers and current status of middens

It has been determined that a single adult in captivity needs 2.5 kg of food/week for slight weight gain (Mendelsohn and Leshem, 1983) whereas in the wild and during breeding periods this figure can reach 3.5 kg/week. The 1999 vulture count carried out by the SEO (*Sociedad Española de Ornitología*, Spanish Ornithological Society), showed that there were some 20 000 pairs, with these species alone requiring some 10 000 tonnes of food each year (which corresponds to 15% of the biomass generated by dead domesticated animals not intended for human consumption). To this group must be added all of the non-breeding individuals (chicks, young birds, single adults and older birds). It must be stressed that in Spain, ovine, bovine and porcine livestock (Camiña, 1995, 1996, 2001b) would appear to be the main source of food for these species in terms of numbers — with variations according to the species and the region — while bovines as a species provide the largest proportion of food to carrion birds in terms of biomass (Camiña, 2001a).

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Aragón, Castilla-León, Andalucía, Navarre and Castilla-La Mancha are home to 80% of the population of Spain's four species of vulture. It would be necessary to carry out a detailed study of the feeding areas of these groups relative to the numbers of domesticated animals to determine the potential impact of the removal of ruminants, an impact which is already being felt in some areas (Camiña, 1995), and of the current systems for the disposal of carcasses from each of the domesticated species.

At present there is a network of controlled and authorised or traditional middens, with the latter being making up the vast majority. Only La Rioja has passed legislation regulating the operation of middens. In other areas, such as Valencia, similar legislation has been drafted but has been put on hold because of the outbreaks of swine fever, and Castilla-León and Andalucía are planning activities along the same lines. By way of an example, SEO/Birdlife sources (Camiña, 2001a) state that there is one active, controlled feeding area in the Basque Country, three in La Rioja (at least another four have been closed), and two in Extremadura. Illegal middens are much more numerous and for this reason reliable information is not available. Suffice it to say that SEO/Birdlife, through exhaustive research in other provinces, knows of at least 51 uncontrolled middens in just two areas of Castilla-León and a further 100 in Aragón. We must point out that since the first cases of BSE appeared in Spain most of the controlled middens have suspended their activity while awaiting new regulations and this could place the populations of carrion birds in serious danger, both directly through lack of food and indirectly by forcing them to attack living animals which will create an impression of danger and lead to uncontrolled retaliatory action from the affected sectors.

The midden system, therefore, could have great health and ecological value if developed under suitable conditions with the appropriate financial and legal support, and could potentially lower the costs of disposal of SRM. Comparative studies of this matter should therefore be carried out.

b) Proposals for feeding carrion birds:

1.- Continue to use bovines:

Given that all dead animals on farms must be tested for BSE pursuant to the new regulations for the control and eradication of this disease (Order of 26 July 2001), carcasses of animals for which rapid test results are negative can still be used to feed carrion birds through the simple provision of drop-off points where the intestines would be removed (assuming that the head had already been removed for the BSE tests) and kept for a few days until the results of the rapid tests are known. Carcasses could then be transported to the carrion birds' feeding areas.

This system (without the BSE testing) had already been successfully operating in some Autonomous Communities before the BSE crisis, and the only cost increase would be generated by the removal of the intestines and the refrigeration of the carcasses until the results of the rapid tests are known. The cost of these tests would be covered in line with European BSE regulations. In this way, processing and incineration costs would be kept low and a natural form of recycling would be encouraged. Additionally, this would be a much more local solution than transport to processing plants, and this in turn could limit the spread of other epidemiological risks linked to the infectious causes of death of domesticated animals. The social impact of this measure would

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undoubtedly be greater than of any other. Food supply needs, behavioural guidelines and the use of space by carrion eaters would all need to be worked out beforehand to determine the final cost, since the procedure could be limited to a specific number of cases.

The potential for BSE spread would be low.

This measure could be adopted by those ACs with high numbers of carrion eaters and low numbers of other domesticated species.

2.- Complete elimination of use of bovines:

Carrion birds would be fed exclusively on carcasses of species not susceptible to BSE and all bovine carcasses would be systematically destroyed. This would also require an estimate of the feeding needs and the level of supply which would be possible with other species.

This system would make the carrion eaters' diet much less varied and we cannot say whether this would present any problems for them, although this cannot be ruled out either.

Costs for this alternative would mainly be generated by the transport of carcasses of these species to the appropriate middens and could be relatively high. This system could, furthermore, increase the risk of other infectious disorders spreading to far-flung areas. In any case, the costs for the removal and destruction of bovines would remain.

The potential for the spread of BSE under this system would be minimal.

This method could be used in those ACs or areas where other domesticated species not susceptible to BSE (especially equines and porcines) are present in high numbers.

3.- Use of ovines:

At the present time, and in spite of the absence as previously mentioned of known risks linked to carrion birds' consumption of small ruminants with scrapie, a moratorium should be declared on the use of sheep remains (at least those considered to be SRM) as a food source until the possibility of the BSE agent being masked by the scrapie agent has been ruled out. For this reason, SRM sheep remains (feeding sheep's feet to bearded vultures, as is done in some Autonomous Communities, is probably not a high-risk practice as far as BSE spread is concerned) should not be considered clear of uncertainties unless they have been subject to BSE testing, which would be far more expensive than tests on bovines since the volume of foodstuff per test would be 10 times lower.

In terms of numbers, sheep make up a significant proportion of carrion birds' diet, and the existence of a solid basis for ruling out the presence of the BSE agent in small ruminant livestock in Spain would therefore be of great relevance to ensure the safety of their use. This becomes even more important when one considers that these animals are present in very high numbers and that their carcasses tend to remain in far-flung and somewhat inaccessible areas.

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4.- Other considerations:

The carcasses of animals which die in inaccessible areas present a major complication, difficult to resolve under any system. In most cases death is not detected until a long time after it has taken place, since inaccessibility makes it difficult for owners to check on their animals. In most cases the carrion birds themselves are the first indicators that an animal has died. These circumstances arise in traditional rearing conditions which are well integrated in the natural environment and which also have a high ecological value. For this very reason they should be considered as exceptions and it can be assumed that the uncertainty surrounding BSE will also be very low given the low probability of exposure to the BSE agent through protein-rich and expensive feedingstuffs. To prevent this exception becoming a way to escape the control regulations, clear guidelines on the conditions under which the non-performance of tests because of inaccessibility can be accepted should be drawn up.

V.6. The potential role of other wild species in the spread of TSEs

There are other species of animal, some of which are considered to be protected fauna, which have been documented as susceptible to TSEs, such as mustelids: these may present another, much more realistic, factor of uncertainty as far as the persistence and spread of TSEs is concerned, since they occasionally feed on carcass remains.

One notable example is the existence of a transmissible encephalopathy in minks, which has not to date been diagnosed in wild animals (Williams *et al.*, 2001). Cases have been observed both in Europe and in North America and have been associated with the inclusion in these animals' diets of sheep with scrapie (Marsh and Hanson, 1979, revised by Williams *et al.*, 2001) and, in other cases, of cattle (Marsh *et al.*, 1991, revised by Williams *et al.*, 2001). This disease has a morbidity rate of 60-100% and a mortality rate of 100% during outbreaks. Animals show behavioural changes, become aggressive and develop ataxia and somnolence. Microscopic lesions are typical of TSEs. In experiments, mink spongiform encephalopathy has been transmitted by intracerebral injection to cattle, sheep, goats, ferrets and laboratory animals.

There is no information at present on the existence of TSEs in populations in the wild, and (unpublished) research on a small group of individual animals has so far produced only negative results. Serious consideration should be given to studying a number of samples high enough to produce a reliable estimate.

As stated above, attention should also be paid to the possible role of opportunist and occasionally carrion-eating micro-mammals, which may feed on the highly contaminated nervous tissues inaccessible to other species.

Other carrion-eating species of the canid and felid types are not considered as important from the epidemiological point of view since either they have been demonstrated to be not very susceptible to TSEs (canids) or it is known that their natural diet does not include ruminant remains (felids). One special case could be the Iberian lynx, which belongs to the group of felids which has proven susceptible to the BSE agent and whose involvement in a possible TSE cycle,

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however improbable, could prove disastrous for the preservation of a species which is unique in Europe and extremely endangered.

Moreover, in 1967 the first cases of a spongiform encephalopathy in cervids were described in the United States. Clinical cases are still detected both in wild animals and in animals in captivity. The lesional symptoms are similar to those observed in cases of BSE, as are the lesions themselves and the immunohistochemical reactions. Of special note is the observation of small fibres, typical of scrapie, in brain and spleen preparations (Williams *et al.*, 2001). No similar observations have been made elsewhere, but this calls for special attention in the new context of a BSE epidemic.

These species could play a role both through their own habits and as a source of food for carrion species.

VI. CONCLUSIONS

The conservation of a unique biological heritage must be reconciled with TSE eradication programmes to ensure the security of susceptible humans and animals. Spanish society has already shown its clear readiness to invest resources in nature conservation. In these times it is reasonable to assume that it will show a similar readiness to protect carrion birds from the threat presented by the disappearance of their food sources. For this reason the following steps must be taken immediately:

- 1.- Ensure that carrion birds do not constitute an element of uncertainty with respect to the spread of BSE by eliminating sources of contagion:
 - a) Only use bovines which have tested negative for BSE (Order of 26 July 2001 amending Royal Decree 3454/2000) for feeding carrion birds, or stop feeding them this species
 - b) Declare a moratorium on the use of sheep to feed carrion birds until it can be clearly established that they are not affected by BSE
- 2.- Keep in mind the uncertainties surrounding land-based carrion-eating species

The alternative of continuing to use bovines provided they have first been subjected to tests draws directly upon current legislation concerning the eradication of BSE and would mean fewer changes and costs relative to the pre-BSE situation, which makes it a more advisable alternative. In any case each AC should assess the specific and particular situation in each of the carrion bird habitats in its territory. The Central Government must develop strategies for coordination between the ACs on food for carrion birds, since these species can move far beyond the boundaries of the Autonomous Communities.

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VII. REFERENCES RELATING TO THE SCIENTIFIC AND TECHNICAL DOCUMENTS USED IN THE PRODUCTION OF THIS REPORT

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ANNEX I. CARRION BIRD NUMBERS

1. Carrion birds

Griffon vulture (*Gyps fulvus*): 17 500 breeding pairs, representing 85-95% of Europe's population

Black vulture (*Aegypius monachus*): 1200 pairs, 98% of Europe's population

Egyptian vulture (*Neophron percnopterus*): 1300 pairs, 80% of Europe's population

Bearded vulture (*Gypaetus barbatus*) (endangered). The entire European population has been reduced to 77 pairs in the Spanish Pyrenees and 23 in the French Pyrenees

2. Birds which occasionally eat carrion

Spanish imperial eagle (*Aquila adalberti*): 130 pairs. (100%) Spain is the only place in the world where this endangered species is found

Golden eagle (*Aquila chrysaetos*): 1200 pairs, 20% of Europe's population

Red kite (*Milvus milvus*): 9000 pairs, 18 % of Europe's population

Black kite (*Milvus migrans*): 3500 pairs, 7%, although 80% of Europe's population overwinters in Spain

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ANNEX II. SPECIFIC INFORMATION REQUIRED

It is extremely important to consolidate the hypotheses put forward in this report, which will call for some observations to be expanded upon and some points to be verified. For this reason, specific research into the following areas will need to be carried out as soon as possible:

- an inventory of feeding points for carrion birds, carcass dumps and middens
- a comparison of the cost of disposing of carcasses by processing and incineration against BSE testing and feeding carrion birds
- research into the true incidence of scrapie in Spain and characterisation of the strains of the agent involved in all cases.
- Research into carrion birds' susceptibility to TSEs and their capacity for destroying pathological prion proteins through digestion.
- Research into other potential factors for TSE transmission in the environment

The ecological impact of any health measures for the control and eradication of TSEs.