

SANITARY ASPECTS OF OUTDOOR FARMING SYSTEMS

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ABSTRACT

Outdoor pig farming include free access to outdoor area and wide use of natural resources of soil and plants in which animals can express their natural behavior. Some management practices that may improve welfare such as outdoor rearing, holding in groups, use of bedding or other housing systems in which it is difficult to implement good sanitation may increase risk to exposure of pigs to the pathogens from the environment. Presence of pathogens or their vectors in outdoor areas in combination with poor environmental conditions may result in high prevalence of various infectious or parasitic diseases, many of which may be zoonotic. Difficulties in implementation of common biosecurity measures and health management principles in outdoor farming impede effective control of diseases. Use of breeds or strains which are adapted to harsh environmental conditions and exhibit favorable disease resistance such as local breeds or their crossbreds, appropriate feeding including plants and fungi that have detrimental effect on pathogens (parasites), and grazing management with integrated use of medicaments (anthelmintic) can be additional methods of controlling diseases in outdoor farming. The common health problems in outdoor pig farming system and their potential impact on human health are reviewed in this paper.

Key words: outdoor farming / pig / diseases / parasites / zoonosis

1 INTRODUCTION

Outdoor pig farming became more popular in the last 20 years with rise in public interest on animal welfare and products originating from production systems which take care of the environment. It is defined as a system that allows the pigs outside access including contact with soil and growing plants (Honeyman *et al.*, 2001) in which animals can express their natural behavior (Miao *et al.*, 2004). If this production system is coupled with good management practices it can result in acceptable production performance, high quality of pork with superior taste and health benefits for humans due to the high level of unsaturated fatty acids (Simopoulos, 1991) and absence of residues (growth promoters, antibiotics, pesticides) or biological agents (microorganisms, parasites). A successful control of diseases is one of the most impor-

tant roles of management in outdoor farming which can improve pig's health and pork safety. Because, outdoor farming management include free access to outdoor area and wide use of natural resources of soil and plants there is a high possibility of close contact with wildlife. Thus pigs are highly exposed to variable environmental conditions and potential transmission of various infectious or parasitic diseases, many of which may be zoonotic. In addition, cleaning and disinfection are more problematic due to the access to outdoor areas. Therefore, the infection level of pathogenic microorganisms and parasites, the severity of infections, and their effects on production, animal welfare and pork safety depend mostly on the management practices in disease control. The common health problems in outdoor farming system and their potential impact on human health are reviewed in this paper.

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2 CHARACTERISTICS OF SYSTEM IN RELATION TO HEALTH

It is generally accepted that outdoor pig farming system is characterized with low production intensity as a result of extensive use of outdoor areas and low investments in housing, equipment and other costs. Lower input which varies between 40 and 70% of the input for conventional indoor systems (Thornton, 1990) makes it economically very attractive and suitable for pork production using breeds of modest production traits such as local breeds. In addition, outdoor farmed pigs generally manifest a favorable welfare with a better immunological status and ability to cope with infections and are less susceptible to stress during preslaughter handling (Warriss *et al.*, 1983; Barton-Gade and Blaabjerg, 1989). On the other hand, some management practices that may affect pig health and welfare such as outdoor rearing, holding in groups, use of bedding or other housing systems in which it is difficult to implement good sanitation may increase risk to exposure of pigs to pathogens from the environment. Presence of pathogens or their vectors in outdoor areas in combination with poor environmental conditions may result in high pig morbidity and mortality or pose a potential risk for human health.

2.1 MANAGEMENT AND BREEDS

Climatic conditions, land availability, soil characteristics and tradition are main factors that must be considered in outdoor pig management. They comprise the management of housing and feeding including the type of buildings and used materials, space allowance, ground cover, group size, type of feeds and feeding regime, management of mating and disease prevention. Low rainfall area without extreme temperatures, with light permeable soil well covered by grass and other plants is favorable for outdoor farming (Miao *et al.*, 2004). In such conditions, possibility for pathogen survival in environment is reduced. Use of breeds or strains which are adapted to harsh environmental conditions and exhibit favorable disease resistance such as local breeds or their crossbreeds are well accepted for outdoor pig production (McGlone and Hicks, 2000). In relation to housing, availability of outdoor area and feed source, the rearing of local breeds is linked to traditional outdoor farming practices. Those include keeping of pigs all year round in simple huts or natural shelters with free access to large outdoor areas except in the cold and wet season (winter) or vulnerable production stage (farrowing and first 10 days of suckling period) in which pigs could be kept indoors. Outdoor feeding is based on utilization of natural resources of pas-

tures (grass) and woods (acorn, chestnuts, fauna in the soil) with addition of some grain or concentrates dependent on the production stage and nutritional requirements of pigs. In Mediterranean countries traditional *silvopastoral* system is well developed which involves indigenous breeds that are extensively pastured in natural forests of oak and chestnut, sometimes in extreme conditions in mountain zones. In such conditions health problems are mainly attributed to a direct contact of outdoor pigs with wild boar or other wild animals that act as reservoir of parasite or pathogenic microorganisms (rodents) some of which could be dangerous to public health, or to the ingestion of feed contaminated by pathogens (soil fauna, seeds, scavenged of rodents or other wild animals etc.). In addition, the absence of hygienic measures which are usually carried out indoors may contribute to the emergence of diseases.

3 HEALTH PROBLEMS IN OUTDOOR FARMING SYSTEM

Previous papers reported that pigs in outdoor farming showed a superior health status due to less respiratory problems and lower incidence of enteric diseases (Thornton, 1990; Tubbs *et al.*, 1993) which are the most common diseases in intensive indoor farming. In addition, lower incidence of periparturient diseases (mastitis, metritis and agalactia – MMA, 24.5%) and torsion or distension of abdominal organs was reported (Karg and Bilkei, 2002). On the other hand, for outdoor pigs, the same authors report high incidence of deaths caused by urogenital disease (32.4%), heart failure (21.8%), and locomotor problems (33.1%). In other studies, free access to soil area or deep bedding has been connected with low prevalence of foot and limb lesions (Kilbride *et al.*, 2009) as well as with osteochondrosis (Van Grevenhof *et al.*, 2011). Skin lesions linked to the unusual behavior such as tail biting, belly nosing and aggressive biting are also found to be less frequent in outdoor farming (Cagienard *et al.*, 2005; Turner *et al.*, 2006). On the contrary, lesions and scars caused by sun burning, ectoparasites activity or scratching is common in outdoor pigs. Respiratory problems in outdoor farming systems occur sporadically and in relation to occurrence of acute pleuropneumoniae of multifactorial origin. The most common causes of pneumonia are *Mycoplasma hyopneumoniae* and/or *Actinobacillus pleuropneumoniae* with simultaneous lung tissue damage due to the migration of larval stages of internal parasites or other factors that may compromise lung integrity. The poor air quality in pigs' environment is high correlated to incidence of pulmonary problems in pigs. Outdoor pigs are generally less exposed to harmful

air condition, such as high dust content, ammonia and/or hydrogen sulphide concentration. In addition, lung health problems may arise due to high concentrations of respirable endotoxin (Moller, 2000), as pig lungs are highly sensitive to endotoxin level (Olson *et al.*, 1995). Hence, its presence in bioaerosol where chopped straw is used for floor bedding may lead to pulmonary problems (Kijlstra and Eijck, 2006). Gastrointestinal problems in outdoor pigs are associated with the occurrence of diarrhea in piglets and digestive disturbance in older pigs related to endoparasite invasion. Besides crushing or trauma inflicted by sow, diarrhea in pre-weaned period is the main cause of morbidity and mortality in outdoor reared piglets. It is characterized by a sudden appearance, rapid spread and high mortality rate of piglets. Causes include clostridial infection, coccidiosis, *E. coli* and occasionally viral diseases (Rotavirus, transmissible gastroenteritis; Straw *et al.*, 1999). Post-weaning diarrhea is associated to high susceptibility of piglets to viral and bacterial infections due to stress at weaning. Late weaning (>7 weeks), which is a common practice in outdoor farming, can reduce the weaning stress. Older piglets show trend to a lower severity of diarrhea and a lower mortality rate. The most common pathological agents of diarrhea in post-weaning piglets include *E. coli*, salmonellosis, *Campylobacter*, *Brachyspira hyodysenteriae* and Rotavirus (Straw *et al.*, 1999). It seems that viral infections (Rotavirus) are diseases with a low risk of incidence in outdoor kept piglets. Routine vaccination with *Clostridium perfringens* and *C. enteritis* may lead to low neonatal diarrhea in organic pig production (Feenstra, 2000).

3.1 PARASITIC DISEASES

An overview of common parasites found in pigs in relation to type of farming is presented in Table 1. Outdoor pig farming poses a higher risk to both endo- and ectoparasitic invasion due to the favorable conditions for development and survival of different stages of parasites in surrounding environment. Possibility to contact with wild animals as a potential reservoir of parasites or intermediate host of parasite is high. The deleterious effects of parasites on pig's health include organ damage with clinical signs of disease and reduced performances. Because parasitic infections have predominately subclinical character they usually remain undetected except reduced feed conversion ratio and poor growth rate are noted.

Coccidiosis could be an important cause of diarrhea in pigs over 7 days of age in both indoor and outdoor farming system. It is caused by *Isospora suis* and *Cryptosporidium* spp. whereas in older pigs it is associated with *Eimeria* species. Leite *et al.* (2000) found coccidia

oocysts in 78% of faecal samples in outdoor kept pigs in which anthelmintic administration was not implemented. In addition, Rodriguez-Vivas *et al.* (2001) reported higher prevalence of *Isospora* in outdoor than in indoor kept sows (94% vs. 41%). Sows kept outdoors excreted more oocysts from *Isospora* than sows kept indoors. *Cryptosporidium* infection can occur together with *Isospora* infection, as well in older animals (Xiao and Herd, 1994; Quilez *et al.*, 1996). Ryan *et al.* (2003) found *Cryptosporidium* spp. more often in outdoor herds (17.2%) than in indoor herds (0.5%) and more common in animals between 5 and 8 weeks of age (69.2%) than in younger animals. The same authors suggest that the opportunities for transmission of *Cryptosporidium* are much greater in outdoor herds through the contamination of the environment to which the pigs have access. Besides swine specific *Cryptosporidium* species, pigs can also be infected with the zoonotic *Cryptosporidium parvum* or „cattle“ species. Therefore, pigs may pose potential reservoirs of infection for humans and other animals (Morgan *et al.*, 1999). Several studies showed high prevalence of helminthes infestation in outdoor pig farming (Carstensen *et al.*, 2002) and emphasized that endoparasites (Roderick and Hovi, 1999) or both ekto- and endoparasites (Leeb and Baumgartner, 2000) were the biggest health problem in outdoor pigs. Intestinal nematodes are the most common type of parasites in adult pigs kept outdoors, especially on heavily used pastures or in areas where domestic pigs and wild boars are in frequent contact. Primarily, they compromise host nutritional status, but also malnutrition in turn may predispose the animal to intestinal nematode infection (Koski and Scott, 2001). Outdoor diet is often composed of feeds rich in insoluble dietary fibre and relatively low digestibility which favor establishment and fecundity of worms (Petkevicius *et al.*, 1996; 1999).

Ascaris suum is one of the most common parasites found in both indoor and outdoor pigs. Health problems can occur in heavy invasion with young animals while adult pigs are reservoir and contaminant of pasture due to fecal excretion of high amounts of eggs. Other intestinal parasites (*Trichuris suis*, *Oesophagostomum* spp., *Hyostromylus rubidus* and *Strongyloides ransomi*) commonly found in wild boar can also pose a problem in outdoor pigs at extensive use of pasture or woodland. Because, parasites and their eggs or larval stages are highly sensitive to environmental condition such as temperature, radiation, moisture, type of soil and vegetation, seasonal and geographic variation could be observed. In hot and dry areas or during dry summer season eggs survival is reduced due to high temperature and effect of desiccation. Even *A. suum* and *T. suis* eggs, which are very resistant to environmental factors, may be dramati-

cally reduced in such conditions (Larsen and Roepstorff, 1999). In addition, low temperatures, more moisture and greater sequestration of eggs in the soil by rain and earthworms could reduce number of eggs deposited in cold mounts (Miao *et al.*, 2004). Roepstorff and Murell (1997a) reported that transmission of both *O. dentatum* and *H. rubidus* was reduced during low temperatures in winter. The same authors (Roepstorff and Murell, 1997b) reported that free-living infective larvae such as *O. dentatum* and *H. rubidus* are more sensitive to environmental conditions than eggs of pig parasites.

3.2 ZOONOTIC PARASITES

Outdoor pigs could be an important source of numerous zoonotic diseases in humans (Table 2). The occurrence of some zoonotic parasites in outdoor pigs (e.g. those transmissible to humans' through meat consumption) is closely related to the exposure of pigs to contact with wild animals (wild boar, rodents, and birds) or their excreta in shared areas. Outdoor pigs are representing an important source of zoonotic parasitosis such as toxoplasmosis, trichinelosis and *T. solium*-cysticercosis invasion in humans. Toxoplasmosis is a parasitic disease caused by intracellular protozoa *Toxoplasma gondii*. In humans (especially in pregnant women and immunocompromised patients) it can cause numerous health problems (Cliver *et al.*, 1990) after consumption of tissue cysts from intermediate host such as pigs. Pigs become infected after intake of sporulated oocysts by feed, water or soil (Cliver *et al.*, 1990). At farms, the prevalence of *T. gondii* is highly dependent on the production stage and farming system (Wang *et al.*, 2002, Venturini *et al.*, 2004). Lower prevalence was observed in fattening than in breeding pigs (Wang *et al.*, 2002) and under the intensive management (Van der Giessen *et al.*, 2007). Several studies reported that *T. gondii* seroprevalence was higher in farms with outdoor access which may favor contact of pigs with cats and wildlife that carry the parasite (Davies *et al.*, 1998; Van der Giessen *et al.*, 2007; Garcia-Bocanegra *et al.*, 2010). In such situations the higher probability of ingestion of feed and water contaminated with sporulated oocysts or tissues cysts of infected animals such as rodents, birds and/or other pigs could be expected (Venturini *et al.*, 2004; Dubey *et al.*, 1995). The presence of cats which scavenge other animals on farms and pastures contribute to the spread of *T. gondii* due to shedding of oocysts (up to 20 million oocysts units/day during primary infection and 1 million oocysts units/day during secondary infection; Jiang *et al.*, 2012).

Trichinelosis is another parasitic disease in which humans can be infected if they consume meat or meat

products from animals that contain encapsulated larval stage of the parasite. *T. suis* is the most common species found in domestic pig and the most significantly contributes to foodborne disease in humans (Mead *et al.*, 1999). *Trichinella britovi* could be responsible for Trichinellosis in humans as well. The natural hosts implicated in life cycle of *Trichinella* are carnivores and scavenger animals. Pigs and human are implicated in domestic cycle while wild boars (De Bruyne *et al.*, 2006), wild carnivorous (Blaga *et al.*, 2007), as red foxes and rodents are implicated in sylvatic cycle of parasite.

Potential risk factors for pig infestation are feeding raw waste products or animal remains, and exposure to infected rodents or wildlife. Pigs which have free access to outdoor areas could consume small dead mammals or other wild animal carcasses contaminated with *Trichinella* species which represents the link between domestic and sylvatic cycles.

The prevalence of Trichinellosis significantly decreased in the past 30 years. Pozio *et al.* (2007) reported that 21.9% of 198 countries had detectable *Trichinella* spp. in swine herds and its presence was linked to endemic areas. Some authors (Murrell and Pozio, 2000; Van der Giessen *et al.*, 2007) emphasize that with increase in organic and free range pig production also increase the risk of *Trichinella* infestation which could lead to a re-emergence of *Trichinella* in Europe (Dupouy-Camet, 2006).

3.3 ECTOPARASITES

Whereas ectoparasites are of minor importance in intensive pig production, in outdoor farming systems they can have a major impact on the productivity and welfare of pigs (Arends *et al.*, 1990; Rehbein *et al.*, 2003). Through the damage of skin or other subcutaneous tissues, they cause hypersensitivity due to stimulation of immune system by salivary or faecal antigens, including the changes in behavior (Berriatua *et al.*, 2001). In addition, some ectoparasites can contribute to the spreading of other pathogens (protozoa, bacteria, viruses and some helminthes such as tapeworms and round worms). The common ectoparasites in outdoor pigs are mange, lice, fleas and ticks. Their prevalence is associated with farming system and housing condition. In pigs, the most common cause of mange is *Sarcoptes scabiei* var. *suis*, while demodectic mange (*Demodex phylloides*) occurs occasionally. Sarcoptic mange is widespread in both indoor and outdoor pigs and is usually linked to poor housing conditions. In outdoor pigs the occurrence of mange is more common during winter season and early spring due to restricted outdoor access and poor housing condition.

Similar conditions affect the emergence and spread of lice (*Haematopinus suis*) and fleas. On the other hand, high prevalence of ticks is connected with extensively grazing on pastures and woods. Colebrook and Wall (2004) reported that the high prevalence of tick in Mediterranean region suggests greater importance of these parasites there rather than in northern European countries.

3.4 OTHER ZOONOTIC DISEASES

Additionally to zoonotic parasites, pigs represent an important reservoir of many bacterial pathogens for humans of both infectious or food poisoning characters

(Table 2). For example, *Brucella suis* caused disease in pigs that could be transmitted to humans. Brucellosis occurs primary in domestic and feral pigs, while wild boar (*Sus scrofa*) and/or European hare (*Lepus europeus*) could be assume as a natural reservoir of *B. suis*. The disease spreads by semen during coitus and by ingestion or inhalation of bacteria in reproductive fluids, placenta, aborted fetuses, urine or milk. Therefore, outdoor farming which includes natural mating and grazing in a large group and together with other species of domestic animals increases the possibility of direct contact among pigs from different owners as well as with wild boar (Cvetnić *et al.*, 2003). In addition, previous study on Turpolje pig in Croatia (Salajpal *et al.*, 2010) suggests

Table 1: Common parasites found in pigs in relation to type of farming (modified according to Nansen and Roepstorff, 1999)

		Domestic pig				
	Wild boar	Outdoor	Indoor	Location	Clinical signs	Mode of Infection
Endoparasites						
<i>Hyoststrongylus rubidus</i>	+	+		Stomach	Emaciation Anaemia	Ingestion of infective larvae
<i>Ascaris</i>	+	+	+	Small intestine	Reduced performance Liver damage	Larvae by percutaneous, oral, transcolostral, prenatal
<i>Strongyloides ransomi</i>	+	+		Small intestine	Diarrhea	Larvae by percutaneous, oral, transcolostral, prenatal
<i>Oesophagostomum dentatum</i>	+	+	(+)	Large intestine	Reduced performance	Ingestion of infective larvae
<i>Trichuris suis</i>	+	+	(+)	Large intestine	Diarrhea Dehydration	Ingestion of infective eggs
<i>Metastrongylus elongatus</i>	+	+		Lungs	Coughing Pneumonia	Ingestion of infected earthworms
<i>Stephanurus dentatus</i> *	+	(+)		Kidney	Wasting Blood in urine	Larvae by percutaneous, oral, possibly prenatal, and ingestion of infected earthworms
<i>Isospora suis</i>				Small Intestine	10 day old scour	Ingestion of infective oocysts
Ectoparasites						
Sarcoptic mange (<i>Sarcoptes scabiei</i>)	+	+	+	Skin	Irritation Thickened skin Skin rash	Direct contact
Demodectic mange	+	+		Skin	Rash Small nodules	Direct contact
Ticks	+	+		Skin	No lesions,	Direct contact
Lice	+	(+)	(+)	Skin	Evident on the skin (behind of the ear) No lesions	Direct contact
Flies	+	(+)			Skin lesion, Small papules	Direct contact

+ regulary occurrence, (+) rarely (conditioned) appearance, * in Southern USA, S. America, Not in Europe

that occurrence and high prevalence of brucellosis in domestic pigs can be closely related to enzootic occurrence of *B. suis* in wild boars present in the same grazing area. Besides wild boar, rodents are another important reservoir of many other pathogens such as *Leptospira*, *Salmonella*, *Yersinia*, *Erysipelotrix rhusiopathiae* and *Brachispira hyodysenteriae* (Feenstra *et al.*, 2000). The prevalence of leptospirosis in outdoor pigs is mostly related to regional or local climatic conditions (Boqvist *et al.*, 2012). In area with wet and muddy soil where *Leptospira* may thrive and where wild vectors or reservoir are present, outdoor pigs can be highly exposed to infection.

Salmonella spp., *Campylobacter* spp. and *Listeria monocytogenes* are among the top bacterial pathogens causing foodborne illness which may appear in meat of both indoor and outdoor pigs. *Salmonella* and *Campylobacter* are common inhabitants of gastrointestinal tract in pigs and does not present a problem for animal. In humans, these bacteria cause typical gastrointestinal symptoms after consumption of meat contaminated during improper slaughtering procedures. Because their prevalence is mostly dependent on biosecurity measures on farm and during and/or after the slaughter, the differences among farming system are not so evident. *Listeria monocytogenes* is another ubiquitous bacterium with high persistence in environment. Sources of contamination for pigs are feed, soil, water, farm equipment and human (boots, cloths). In relation to farming system, higher inclusion of raw feeds (non-processed) or silage as an important source of *Listeria* in livestock (Bunčić *et al.*, 1991; Fenlon *et al.*, 1996) can contribute to increase of *Listeria* prevalence in outdoor farming system. In addition, Fen-

lon *et al.* (1985) listed wild birds as a carrier of *Listeria monocytogenes* and a risk factor for pig contamination.

4 DISEASE CONTROL IN OUTDOOR FARMING SYSTEM

Disease control in outdoor pig farming is closely related to the management of housing and feeding and to climatic conditions and the possibility of contact with pathogens or their vectors. In such conditions implementation of common biosecurity measures and the health management principles ("one way" pig flow, "all in/all out" policy, etc.) as recommended methods are difficult.

Use of breeds or strains of favorable disease resistance, appropriate feeding including plants and fungi that have detrimental effect on pathogens (parasites) and grazing management with integrated use of medicaments (anthelmintic) can be additional methods that contribute to the control of disease in outdoor system. Previous studies indicated differences in disease resistance or tolerance among native and modern breeds of several species such as sheep (Goosens *et al.*, 1999; Amarante *et al.*, 2004), cattle (Glass *et al.*, 2005), chicken (Hassan *et al.*, 2004) and pig (Reiner *et al.*, 2002) emphasizing possibility of their use in outdoor farming. Traditional outdoor systems are based on using of local breeds which are well adapted to the wide use of natural feed resources (acorn, chestnuts, soil fauna etc.) from environment, some of which have a protective role. It is well known, however that outdoor farming is more often associated with parasite-related diseases (Hovi *et al.*, 2003) some of which are sensitive to high condensed tannin level in plants

Table 2: Common zoonotic agents associated with wild and farmed pigs

	Wild boar	Outdoor	Indoor	Mode of Infection for human
Bacteria				
<i>Brucella suis</i>	+	+	(+)	Contact with pathogens, Meat consumption
<i>Campylobacter</i> spp.	(+)	+	+	Contact with pathogens, Meat consumption
<i>Salmonella</i> spp.	(+)	+	+	Contact with pathogens, Meat consumption
<i>Listeria monocytogenes</i>	(+)	+	+	Contact with pathogens, Meat consumption
<i>Erysipelotrix</i>	+	+	+	Contact with pathogen
Parasites				
<i>Toxoplasma gondii</i>	+	(+)		Contact with pathogens, Meat consumption
<i>Trichinella</i> spp.	+	(+)		Meat consumption
<i>Cryptosporidium</i> spp.	+	(+)		Meat consumption
<i>Taenia solium</i>	+	(+)		Meat consumption
<i>Ascaris suum</i>	+	(+)		Meat consumption

+ regularly occurrence, (+) rarely (conditioned) appearance

feed (gastrointestinal nematode) or some other bioactive compound. By grazing in oak woods, especially during acorning or season when alternative forage availability is scarce, pigs may consume huge amounts of tannin rich plant material and reduce total faecal egg count output in pigs infected with large roundworm (*Ascaris suum*) and other gastrointestinal parasites (Salajpal *et al.*, 2004). Control of parasitic diseases in outdoor farming is based on breaking of life cycle of parasites by grazing management and use of antihelminthics (Nansen and Roepstorff *et al.*, 1999). Pasture rotation, stocking rate and mixed or alternative grazing are important factors in grazing management which influence the prevalence of parasite infections. Extensive use of pasture (low stocking rate, seasonal use of pasture) or frequent pasture rotation reduces the risk of infection. Insufficient effects of these management practices may occur in parasites with long-live eggs such as *A. suum* (Roepstorff *et al.*, 2001).

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