

## Linshi Native Pig - An Investigation Report on New Genetic Resource of Livestock

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**ABSTRACT** : Linshi Native Pig is a unique local breed recently discovered in the hinterland of Tibet. Its geological distribution, natural environment and ecological conditions have been explored. Using random sampling in typical colony of classification and standard animal-scientific and biogenetic techniques, we examined its contour features, size and weight, reproductive performances, carcass characters, meat quality, fresh-keeping features and the frequency distribution in the 19 structural gene loci encoding enzymes and proteins; according to folklores and Tibetan, Chinese and English history books, the materials and literature of Tibetan Studies, we have analyzed its origin and affirmed the fact that its products have been consumed as Tibetan medicine resources. Our findings make certain that Linshi Native Pig holds great potential value in economy and culture. (*Asian-Aust. J. Anim. Sci.* 2001. Vol 14, No. 9 : 1203-1208)

**Key Words** : Linshi Native Pig, Genetic Resources, Tibetan Studies

### INTRODUCTION

Linshi Pig is a unique local colony recently discovered in the interior of Tibetan Autonomous Region. Relevant research (Li and Chang, 2000; Li et al., 2000a, b; Yangzhou Univ. et al., 1999) carried out by us since 1996 has demonstrated that Linshi Pig is different in physical appearances, ecological features, population history and economic uses from Medog Pig (distributed in areas south of the Himalayas and of sub-tropical ecological type), Niwu Pig (distributed along the upper ranges of Yi'ong zangbo River), Hezuo Pig (distributed in Gannan Prefecture), and Diqing Pig (distributed along the border between Tibet and Yunnan, and on the sides of Hengduan Mountains). Furthermore, Linshi Pig is significantly different from Hezuo pig and Diqing pig in the frequency distribution of 19 structural gene loci. Tibetan Pig (Anim. Sci. Institute of China Agri. Sci. Academy, etc. 1986) is a breed consisting of several native populations (yangzhou Univ. et al., 1999), and Linshi Pig is one of them.

### MATERIALS AND METHODS

#### On-the-spot investigation

*Investigation of the general situation* : According to the feedback of the "registration card of the genetic resources

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clues of livestock and poultry" provided by the counties and cities in the middle ranges of Yarlung Zangbo River of Tibetan Autonomous Region, an investigation of the distribution range, central production area and natural ecological environment of Linshi Pig, the native humanistic and socio-economic background and ways of raising the pigs was carried out in Lhunzhub County and Maizhokunggar County of Lhasa City, and in Gongbogyamda County, Nangxian County and Mainling County of Linshi Prefecture.

*Preliminary investigation* : In the four administrative villages of Cogao, Micuomu, Qiongba, and Zala of Gongbogyamda County in the central production areas, in the townships of Kunggar and Renduogang of Maizhokunggar County, and in Bailin Township of Lhunzhub County, an investigation was conducted in the form of interviews about the history, the number of Linshi Pig, food therapy and medical use of the product, and the economic benefits of raising the Linshi Pig.

*Test by Sampling* : With the method of random sampling in typical colony of classification, test was carried out in Cogao village and Bailin township about the macroscopic features, body measurements, body weights, propagating reproductive performances and carcass characters of Linshi Pig. Meat and blood samples were taken.

#### Carcass measurement

Seven healthy Linshi Pigs (3 males and 4 females), aged between 1.5-2.0 years old, were slaughtered after 36 hours of fasting. After 14 hours of hanging and cooling of the carcass in temperature of -2°C ~ -4°C, the carcass weight, dressing percentage, loin-eye area, lean percentage and ratio of muscle to bone were measured.

#### Evaluation of meat quality

Evaluation was done of the meat color of the transection

of the longissimus muscle on the last pair of lumbar vertebra with the method of colorimetry of five-grade 14 hours after cooling in the room; eating the boiled fresh meat of castrated pig and "Xiaganbu" (a kind of local meat product fermented and dried in low temperature) to taste the flavor; taking samples of longissimus muscle from the 14th~15th thoracic vertebrae and from the 1st~3rd lumbar vertebrae and putting the samples in sealed plastic bags. After being carried in portable refrigerated boxes at about 0°C for 48 hours, the lumbar vertebrae sample was taken out for measurement of water holding capacity with weighing and pressing method, and both samples were measured for shear force with C-LM tenderometer; measuring pH with Horiba pH meter and measuring the amount of liquid ammonia with nesslerization to determine the freshness 4 days after slaughter.

#### Determination of structural gene loci

Determination was done with starch gel multiloci electrophoresis (Chang et al., 1998) on 42 adult pigs of one typical colony with respective blood lineage from Cogao Village and Bailin Township respectively to measure the frequency of the 19 structural gene loci of the following enzymes and proteins: serum prealbumin (Pa), transferrin (Tf), hemopexin (Hp), ceruloplasmin (Cp), amylase (Am), erythrocyte adenylate kinase (Ak), lactate dehydrogenase (LDH), malate dehydrogenase (MDH), glutamic-oxaloacetic transaminase (GOT), carbonic anhydrase (Ca), esterase (CEs), esterase-D (Es-D), 6-phosphoglucoate dehydrogenase (6PGD), glucose-6-phosphate dehydrogenase (G6PD), phosphohexose isomerase, (PHI), tetrazolium oxidase (TO), phosphoglucomutase (PGM), NADH-diaphorase-I (Dia-I), and NADH-diaphorase-II (Dia-II). Sampling errors of gene frequency were calculated (Chang et al., 2000).

#### Collection and analysis of documents, data and verbal folk accounts

Records concerning the cultural history of domestic animal in Tibetan were searched in 74 documents in Tibetan, Chinese and English languages of history materials, chronicles and Tibetan Studies. Materials and verbal accounts concerning the history of Linzhi Pig were collected through survey, visit, interview and symposium in Norbulinka Museum, the Potala Palace, Zheibong Temple, Sera Temple, the Autonomous Region Hospital of Traditional Tibetan Medicine, clinics of traditional Tibetan medicine in Gongbogyamda County, Cogao Village and Kunggar Township. Relevant meteorological data were searched in Tibetan Autonomous Region Weather Bureau and the Meteorological Observatory of Linzhi Prefecture. All the above data were collected and analyzed.

## RESULTS

#### Distribution and its central area

Linzhi Pig inhabited in the wide areas in the middle valley of the Yarlung Zangbo River between Nyaingentangih Mountains in former times and the Himalayas in eastern Tibet. Nowadays the distribution area has been much reduced and segmented into disconnected places, mainly in the three counties of Gongbogyamda, Nangxian and Mainling of Linzhi Prefecture; and sporadically along the tributary of Niyangqu River in southeastern Linzhi County, in Bailin Township of Lhunzhub County of Lhasa City, and around Renduogang Township of Maizhokunggar County. The main production area is situated along the banks of Cogao Lake in northeastern Gongbogyamda and the upper and lower valleys of the lake. The four villages of Cogao, Micuomu, Qiongba, and Zala of Gongbogyamda County have the largest number of Linzhi pigs (about 3,000 at the end of 1999) and their pigs are of the best quality (most typical, without mixture of other breeds). There are about 4,500 Linzhi pigs in three counties of Gongbogyamda, Nangxian and Mainling and in the periphery of the production area (figure 1).

#### Natural environment and ecological conditions of production area

The total area of the three counties amounts to 26,534 km<sup>2</sup> with an average elevation of 3,524 meters. The production area belongs to plateau temperate zone semi-humid monsoon climate, with an average yearly temperature of 6.4~8.5°C, the highest yearly temperature 28°C (in July and August) and the lowest temperature -17 ~ -16°C (in January and February). There are 155~194 frost-free days in a year and the annual rainfall amounts to 600-650 mm, over 80% of which concentrates from May to September. Species of plants are numerous and medical herbs resources abundant. More than 20

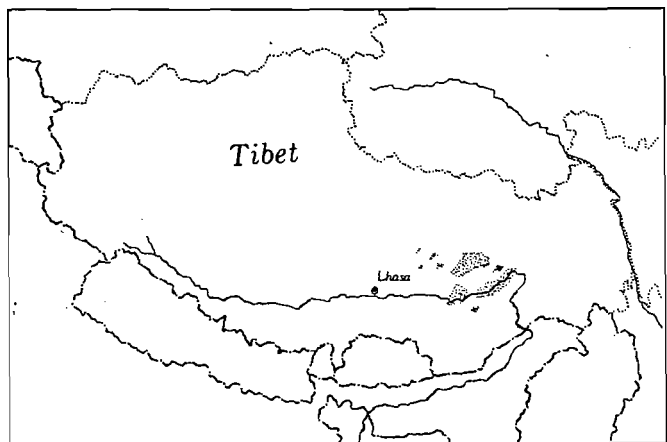


Figure 1. Geographical position of distribution areas of linzhi pig population (the shadow on map is the distribution areas of linzhi pig population)

types of medical herbs such as bulbs of fritillary, Chinese caterpillar fungus, pseudo-ginseng, rhizoma gastrodiae, goldthread, root of hairy asiabell, red-spotted stonecrop, snow lotus (*Saussurea involucreata*) etc. and food and medical fungus such as glossy ganoderma, fuling, (*Poria cocos*), hedgehog hydnum, tremella, edible tree fungi, and pine mushroom, etc. grow wild in forests and grassy mountains, mostly in precipitous and almost intact dense forests and valleys.

Linzhi Pigs are not raised in pigsties. Except some parturient and lactating pigs that stay in the yards of their owners to get extra fossil occasionally, all the year round they ramble in the forests, feeding on wild root tuber, stem tuber, fallen fruit and fallen flower, including many medical herbs hardly accessible to humans. In most cases, small groups of several or more than ten pigs are formed with one or two female ones of prime age as the leaders, staying in two or three fixed hidden shelters. Occasionally they go back home for food. Old males mostly live alone. Linzhi Pig adapts well to the ecological environment of the production area; no record or memory of epidemic disease among the pigs was ever found in the history of the production area.

#### Brief research of the origin

The head-shape, body size and body type of the Linzhi Pig are similar to those of the local wild boar. Some of the adult male pigs have fangs exactly like those of the boars. Incidences of hybridization are still frequent nowadays in places where boars abound. Consequently, it is certain that Linzhi Pig resulted from local Tibetan farmers' and herdsmen's domestication of the native boars. According to the "Red History" (Gonggedomji, about 1363) and the "New Red History" (Suonanchaba, about 1538), in the 2nd Century BC, Niechi Zanpu, head of Yarlom Tribe, established Tu Bo (ancient Tibetan regime) with Yarlomsoka (today's central part of Nedong County) as the center. Today's three counties of Gongbogyamda, Nangxian and Mainling were all in the central part of activities. Since the Zhigong Zanpu period eight generations later, Tu Bo "started to cultivate the land, to smelt gold and silver and to construct bridges" (Gonggedomji, about 1363), and "people at that time follow rules of agriculture" (Suonanchaba, about 1538), so the economic foundation was formed for domesticating boars. "Jiu Tang Shu" (the Old Tang Dynasty History) records that "Tu Bo is frigid in climate and cultivates no Keng rice (Chang's note: a late variety grown commonly at that time). There is highland barley, bean, wheat, buckwheat and the livestock are mostly yaks, pigs, dogs, goats, sheep and horses. The people follow their animals and do not dwell all the year round in their houses, yet they have towns and cities. Their capital is called Luoxie City. The houses have flat roof, the highest reaches dozens of Chi" (Chang's note: a traditional unit of length in

China) (Liu, 945). It demonstrates that at that time the middle valley ranges of the Yarlung Zangbo River with Lhasa as the center already had developed agriculture with settled farmers, and pigs were domesticated animals of the local residents. Linzhi Pig has evolved from the wild boar in the middle valley ranges of the Yarlung Zangbo River-domesticated pigs around Yarlom.

Two other important factors for creating Linzhi Pig are the unique local ecological environment and the pig-raising civilization embodied in the rearing manner and the breeding system. Since ancient times, the production area has been a vast territory with vast pastures, dense forests, comparatively small area of cultivated farmland and a sparse population. It is rich in natural feed resources. Pig-raising by putting them out freely in such natural environment is economic because it is low in cost and labor-saving. Moreover, the pig becomes the intermediate link of converting and utilizing medical plant resources in special ecological environment. Yarlom Tribe was originally a branch of ancient Qiangs. During the times of King Narisongzan and King Songzangangbo (A.D. 629-650), "Tu Bo occupied all the land of Yangtong Nationality, Dangxiang Nationality and the ancient Qiangs" (Liu, 945) absorbing elements of Qiangs in its own civilization of animal husbandry. According to records in "Hou Han Shu" (the Later Han Dynasty History), ancient Qiangs in the Huangshui River and Yellow River Valleys had entered the period of agriculture and animal domestication from the period of hunting as early as the times of Li Gong of Qin Dynasty (479-470. B.C.) (Fan about 445). There is an account in "Wei Shu (the Northern Wei Dynasty History) that ancient Dangchang-Qiangs (who lived in the South-North Dynasties in what is now Aba Prefecture, Gannan Prefecture, Huangnan Prefecture and the east part of Guoluo Prefecture) "were all settled people who kept yaks, goats, sheep and pigs for food" (Wei, 554). That is to say, there existed customs of pig-raising which relied on settled agriculture. From the period of Warring States to early West Han Dynasty, the Ranmang Yis moved about along what is now the border between Maowen County and Aba Prefecture of Sichuan Province in search of pasture. There were "six tribes of the Yis, seven tribes of the Qiangs and nine tribes of the Dis... who inhabited and sojourned about along the mountains... The land there is hard and saline and cannot grow rice, millet, sesame or beans except wheat, yet is suitable for animal husbandry. There are antelope that can be used to treat poison. There are also deer that feed on medical herbs. Wastes in the intestines of pregnant doe have the function of curing serious diseases" (Fan, 445). These facts demonstrate that the nomadic way of raising Linzhi Pig in reliance on settled agriculture and the wisdom of local residents of collecting and converting medical plant resources in special ecological environment through pigs

not only have the background of natural ecology and economic development but also have profound historical and cultural origins. These conditions have resulted in the features of Linzhi Pig and at the same time confined the expansion of its scale.

### Body shape and appearances

The hair on the whole body of Linzhi pig is light black or dark gray. A small number of them have brown hair. Hair on the forehead, cheeks, neck, back, sides and limbs above cannon is long and mixed with white long hair; the end of hair is usually reddish; some pigs have white marking on the forehead. In the areas from between the eyes to the temples and on the top there are reversed hair clusters, connecting bristles. The pig has bundle-shaped switch touching hock. The skin is light black, the head-type narrow and shallow, with short forehead and long snout. It has straight face without wrinkles, small and erect ears with spread auricle and sparse hair, and the ears turn easily. The pig has narrow eyes and cone-shaped snout with three vertical wrinkles on the ridge side at the end and one-three horizontal wrinkles. The neck is shallow, narrow and short, well connected with the head and shoulders. The trunk is short with straight back line. A small number have sunken back line. The abdomen is round with comparatively straight underline. The shoulders are erect, the front trunk deep and short. The pig has small flanks with shallow pits of flank. The croup slanting and narrow. The limbs are thick and strong with slightly thin cannons. The pastern is strong and foot texture hard and stiff. The body-shape is compact (figure 2).

### Body measurements and body weight

Body measurements and body weight of male and female pigs of Cogao Township are shown in table 1.

### Reproductive performances

Linzhi Pig enters sexual maturation at 4-6 months of age and is in perennial estrus with an estrous cycle of 13-24 days and an estrous duration of 3-4 days. The gestation period lasts 111-118 days, usually one birth a year, mostly given in July-October. A sow (3-5 births) gives birth to an

average number of 5.75 piglets each time. The birth weight is 0.4-0.6 kg and an average survival number at 2-4 months old is 4, a weaning rate of 69.57%. The weaning weight is 2.53-3.10 kg and the weaning weight of litter is 7.5-15 kg. The mating ratio of male to female is 1:25-30. The average reproductive age is 2-3 years. About 1/4 of old male pigs are released into mountain forests.

### General carcass characters

The average slaughter weight of a male pig is 25.0±8.4 kg and the carcass weight 17.0±5.6 kg with a dressing percentage of 67.8±20.0%. The loin-eye area is 14.67±5.80 cm<sup>2</sup> and the lean percentage 53.82±7.40%. The backfat thickness is 1.71±0.11 cm and the ratio of muscle to bone 3.46±0.21. Carcass characters of female pig are: slaughter weight 36.0±9.0 kg, carcass weight 24.5±6.3 kg, dressing percentage 68.1±16.5%, loin-eye area 13.39±4.47 cm<sup>2</sup>, lean percentage 51.05±6.85%, and backfat thickness 2.0±0.09 cm.

### Meat quality

Meat color: of 6 samples, 5 got 3 marks and one got 4 marks. Flavor: 12 judges (9 Tibetans, 2 of whom natives and 3 Han nationality people) unanimously concluded that the boiled meat and "Xiangangbuo" have rich fragrance without any offensive smell of ordinary pork. Water holding capacity is 95.45±1.43% and Shear force is 1.33±0.09 kg for loin sample and 1.39±0.14 kg for chest sample. Freshness preserved: after storage and transportation (the 4th day after slaughter), the pH value is 6.1412±0.1270 (5.9800-6.2980) and Nessler's-titre is 10. Five samples showed transparent light yellow and one sample transparent pale yellow, all of which were within the range of fresh meat and are in agreement with local belief that Linzhi Pig meat lasts long.

### Gene frequency of structural gene loci

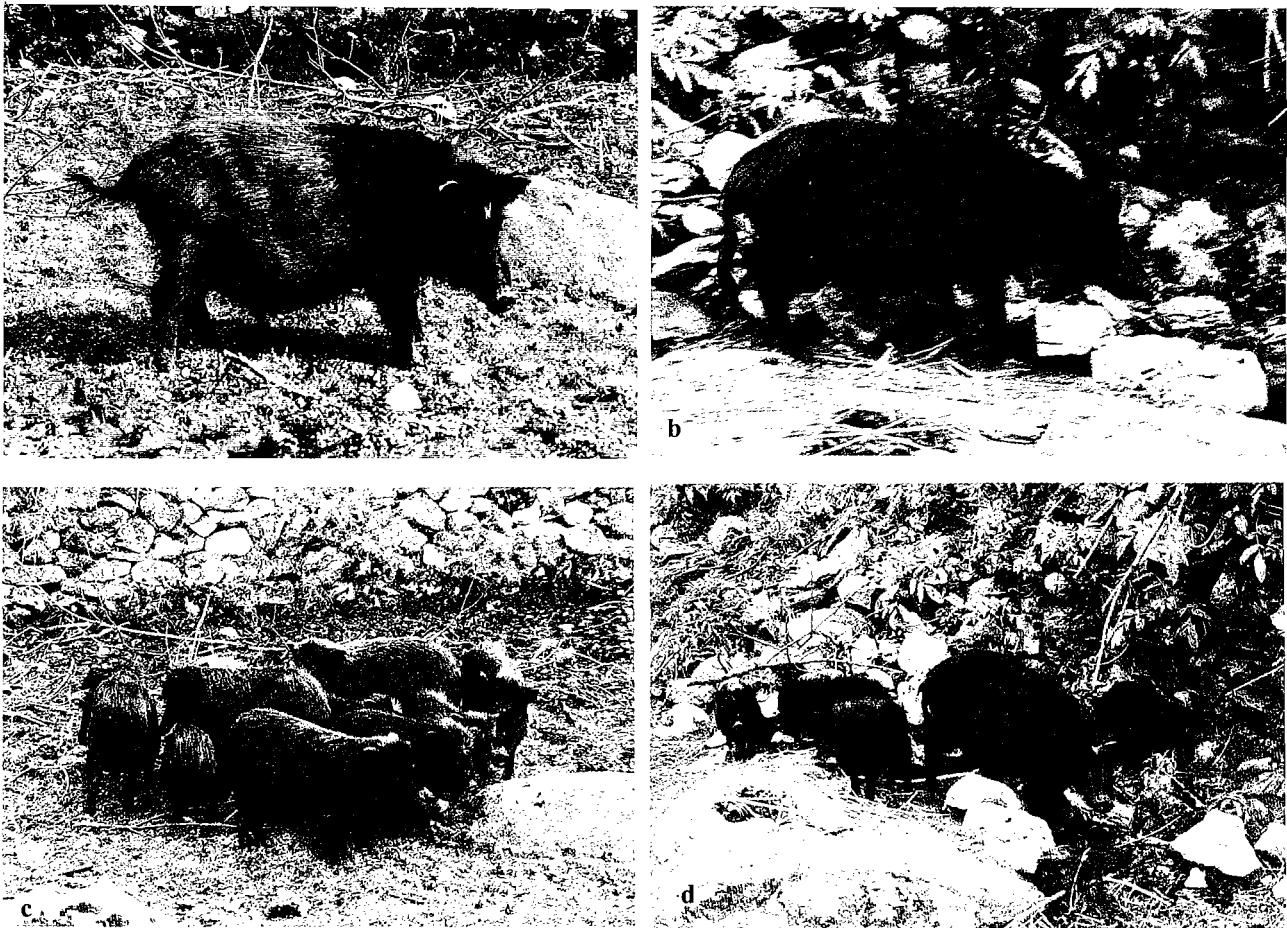
Of the 19 loci, seven are identical monophasic types internationally unnamed respectively: AK, LDH, MDH, GOT, TO, Dia-I and Dia-II; four loci of Es-D, G6PD, PHI and PGM are fixed by genes of Es-D<sup>A</sup>, G6PD<sup>B</sup>, PHI<sup>B</sup> and PGM<sup>B</sup> respectively; the frequency distribution of the genes

**Table 1.** Body size of Linzhi Pigs

	Age (month)	Size of sample	Withers height (cm)	Body length (cm)	Heart Girth (cm)	Body weight (kg)
Male	10	10	38.30±2.87	63.80±7.78	56.10±3.23	16.12±3.81
	12	17	46.42±2.83	72.90±2.83	65.89±4.49	24.51±3.78
	34	13	49.07±2.46	77.90±4.21	73.75±5.79	37.40±4.27
	36	13	52.13±1.95	89.15±3.43	84.73±3.09	49.72±2.70
Female	10	51	42.83±2.28	70.68±2.24	65.00±4.24	22.98±3.98
	12	59	46.22±2.64	76.49±6.59	71.76±5.41	29.23±2.78
	36	36	50.24±3.50	86.22±4.17	80.47±4.52	41.64±3.14

**Table 2.** Estimators P and their errors V(P) of gene frequencies in 8 loci

Locus	Allele	P	V(P)	Locus	Allele	P	V(P)
Pa	A	0.982	$3.28 \times 10^{-4}$	Am	A	0.246	$3.10 \times 10^{-3}$
	B	0.018	$3.28 \times 10^{-4}$		B	0.557	$4.08 \times 10^{-3}$
Tf	A	0.022	$3.45 \times 10^{-4}$	Ces	C	0.145	$2.06 \times 10^{-3}$
	B	0.913	$1.27 \times 10^{-3}$		x	0.052	$7.02 \times 10^{-4}$
	C	0.065	$9.74 \times 10^{-4}$		A	0.145	$2.06 \times 10^{-3}$
Hp	1	0.272	$3.28 \times 10^{-3}$	Ca	B	0.790	$2.73 \times 10^{-3}$
	2	0.395	$3.96 \times 10^{-3}$		C	0.065	$9.75 \times 10^{-4}$
	3	0.123	$1.81 \times 10^{-3}$		A	0.974	$3.60 \times 10^{-4}$
	x	0.210	$2.73 \times 10^{-3}$	B	0.026	$3.60 \times 10^{-4}$	
6PGD	A	0.597	$3.97 \times 10^{-3}$	Cp	B	0.829	$2.32 \times 10^{-3}$
	B	0.373	$3.88 \times 10^{-3}$		C	0.145	$2.06 \times 10^{-3}$
	C	0.030	$3.74 \times 10^{-4}$		x	0.026	$3.60 \times 10^{-4}$

**Figure 2.** The Linzhi Pig

a. Male, b. Female, c. A pack in dried river course, d. A small family on hillside

on the rest 8 loci is illustrated in table 2.

### RESOURCES EVALUATION

Linzhi Pig adapts extremely well to the grazing conditions of the forests and pastures in the high elevation

and semi-humid monsoon climate. It grows, develops and propagates normally and turns out exceptionally high quality products under the circumstances of thin air, changeable weather, dangerous geographic situation, rough care and very low-standard feeding. For hundreds of years, the pig has been a means of livelihood for native people, a

link in the local agricultural ecological cycle and a constituting element of agricultural and animal husbandry economy. The genetic resources of Linzhi Pig of controlling its adaptability, meat and fat characters and medical function of its products are worthy of protection, thorough research, development and utility as common natural and cultural heritage of all human kind and raw materials for breeding domestic pigs in the 21st century and in future. The semi-wild living conditions of Linzhi Pig provides rare materials for the study of the origin of domestic animals.

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