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河南灵井许昌人遗址鬣狗粪化石的初步研究

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摘 要：河南灵井许昌人遗址是我国近年来发掘的最为重要的古人类遗址之一。该遗址中出土了大量的石器、骨器、动物化石、粪便化石等遗存以及人类头盖骨化石等。我们对该遗址出土的鬣狗粪化石进行了类型学及其包含的微体化石等方面研究，从分析统计结果来看，鬣狗粪化石中包含了丰富的古信息，如古寄生虫卵、动物毛发、孢粉、植硅体、真菌等。本文主要针对鬣狗粪化石中古寄生虫卵及动物毛发进行分析，探讨了作为寄主鬣狗罹患的寄生虫病，以及鬣狗的食物来源等情况，为深入理解更新世晚期人类适应环境与气候提供新的证据。

关键词：灵井遗址；鬣狗；粪化石；食性

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A Study of Possible Hyaena Coprolites from the Lingjing Site, Central China

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Abstract: The Lingjing site is one of the most important Paleolithic sites excavated recently in Henan Province of China. Abundant animal bones, lithic and bone tools, fragments of an anatomically modern human cranium and dozens of coprolites from a medium-sized carnivore, most likely a hyaena have been recovered from the site. This paper describes the identification of the microbiological remains preserved in the coprolites. The remains of parasites, fungi and hairs were identified in some of the coprolites. The identification of microbiological remains from the

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coprolites has provided new information on the diet, health of the ancient hyaena species and paleoenvironment in Central China.

Key words: Hyaena; Coprolites; Diet; Lingjing site

1. Introduction

The Lingjing site is located 15 km northwestern of Xuchang, Henan Province in central China. The Xuchang area has been a vital and active region in human settlement and culture development in Chinese history. A large number of archaeological sites have been discovered in the area in recent decades. The occupation of the Lingjing site extends from approximately 100,000 BP to 80,000 BP. The excavation of the site yielded fragments of the cranium of "Xuchang Man", thousands of lithic artifacts, hundreds of identifiable faunal remains, over a hundred of bone tools, and over ten thousand fragments of animal bones. In addition, a number of coprolites were found in the same stratigraphic layer where the Xuchang Man was recovered. These coprolites probably belong to a kind of hyaena based on their shape, volume, weight, size and color.

The location and stratigraphy of the Lingjing Site is depicted in Fig.1. The stratigraphic units were divided into different zones. The Upper layers yield cultural materials dating from the Neolithic to the Shang and Zhou dynasties. The middle part consisted sandy sediments, yielding cultural materials that include carved bone micro-tools, perforated ostrich egg shells, hematite and animal remains. The lower parts (Layers 6-11) yield a large quantity of lithic artifacts, bone tools, animal remains, coprolites and the cranium referred to as Xuchang Man [1].

The site is characterized by lacustrine and shore lacustrine. The site experienced climatic changes from arid to humid. The tools recovered at the site indicate that the human occupation during the Middle Paleolithic period was associated with animal butchering and the manufacture of stone and bone [1].

Compared with the numerous animal fossils and stone implements, the coprolites constitute only a small part of the archaeological record, but they play an important role interpreting the site. They are not only the best sources to observe the information about carnivore feeding activity[2], but also a good representation of the individuals and communities overall health. Since the 1960s, coprolites have been used to obtain information regarding ancient dietary and health [3-6]. It has been formed a new discipline — Paleocoprology. Coprolites from fish, mammals, amphibians, and reptiles have been investigated [7].

Since 1970, coprolite research has been expanded to include studies of phytoliths[8-10], mycology [11, 12], acarology[13] and microbiology[14, 15]. Parasitological extraction and quantification techniques were evaluated[12, 16]. Methods for the extraction of pollen from coprolites have been developed[17, 18]. Lucinda Backwell and her colleagues report fossil hairs of probable human origin in a brown hyaena (Parahyaena brunnea) coprolite from Gladysvale cave in South Africa [19]. This find

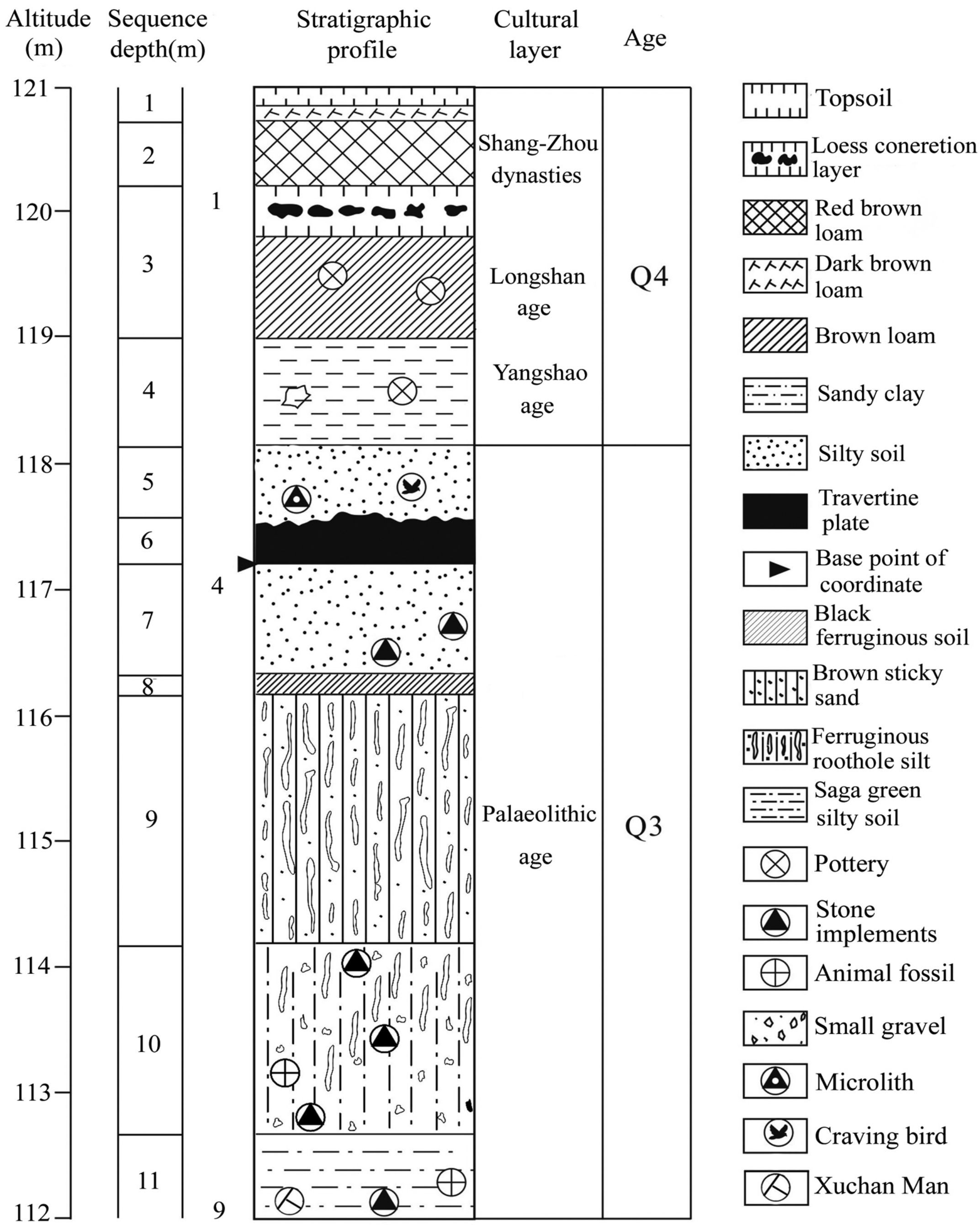

Fig. 1 The location and stratigraphy of Lingjing Site [1]

supports the hypothesis that hyaenas accumulated some of the early hominin remains recovered from South African cave sites in the Sterkfontein Valley.

A few coprolites have been recovered previously from archaeological sites in China [20]. Various inclusions including the remains of parasites and hair have been observed in these specimens. Pollen analysis of hyaena coprolites from the Tuozi Cave at Tangshan, Nanjing suggests that during early Pleistocene the vegetation was grassland or forest grassland and the climate was humid or semi humid[21].

This paper focuses on the study of the coprolites believed from ancient hyaenas in the Lingjing site and specifically on the recovery of pollen, parasites, fungi and hair, with the goal of providing supporting information about the diet, health of the ancient hyaena species, and paleoenvironment during the Middle to Late Paleolithic Period.

2. Samples and methods

2.1 Samples

Since 2011 more than thirty coprolites have been excavated in Lingjing Site. Most of the coprolites were found to be fragmented (Fig.2). Hoof prints on some coprolites left by animals before their desiccation. The geological age for the stratum where the coprolites were recovered is of the late Pleistocene, date between approximately 100,000 and 80,000 BP. A large number of stone implements and animal fossils have been uncovered from this stratum (Fig.1). According to the morphotypes, the coprolite samples belong to a kind of medium sized carnivore – possible a hyaena. Eight coprolite samples were examined for the current study.

2.2 Methods

Analysis of coprolite samples consisted external and internal observation of the feces, including

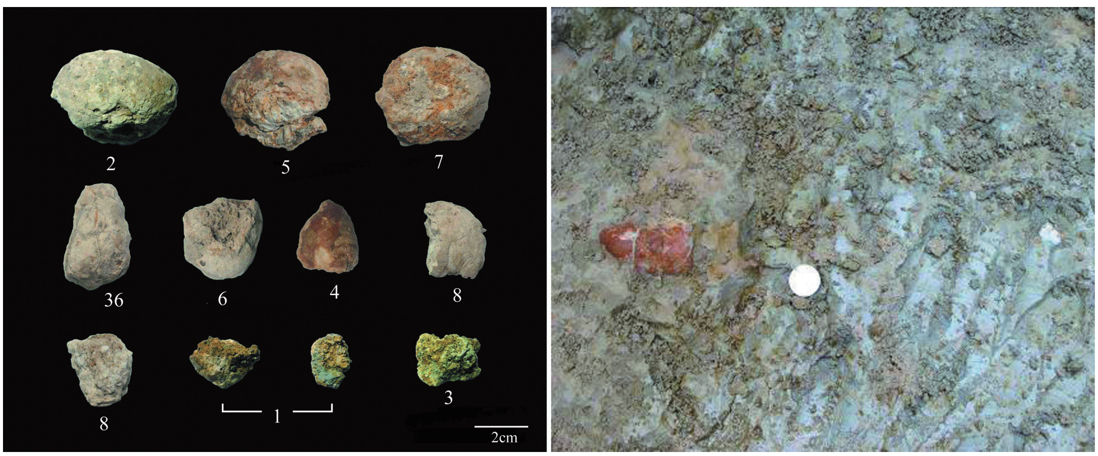

Fig. 2 Left: the coprolite samples examined; Right: the coprolite *in situ* (during excavation) [23]

color, volume, measurement, texture, inclusions observed and the state of preservation. Microscopic examination of the coprolites was conducted by smearing a glass slide directly after dissolution followed by minimal grinding of the samples in water. Depending upon the samples submitted by the excavator, 0.1g to 0.5g portions from the exterior and interior of each coprolite were dissolved separately in purified water. To better separate the microscopic remains from impurities the powered coprolites were put into oscillator and shaken for 2 hours [22]. Comparative analysis of the samples was conducted by directly counting the inclusions observed in each sample. The refractory remains in the coprolites were measured and photographed at 500X or 1000X magnification. The microscope used is Nikon ECLIPSE LV100 POL by Nikon Corporation.

3. Results

3.1 Coprolite morphotypes

The coprolites examined in this study exhibited little variation in terms of size and texture. The external colors of the coprolites are whitish-gray, brownish-yellow and brown. The physical observations of the eight coprolites are presented in Tab.1. Coprolite sample No.1 had broken into three fragments during excavation. Most of the coprolites are relatively hard.

3.2 Paleoparasite remains

During the dissolution in water and microscopic examination, paleoparasite remains from different species were observed in the coprolites. Microscopic observation found that five of the eight coprolites contained paleoparasite remains consisting of parasite larva and eggs (Tab.2). The interior structure of majority parasite eggs was completely gone. However, the characteristic features of the parasites were preserved (Fig.3).

Eggs suspected to belong to *Trichuris* are most abundant types of parasites observed in the eight samples (Tab.2). Five eggs were observed in coprolite sample No.5. Since the analysis used only 0.1-0.5g from each coprolite, it is likely that all of the samples contain considerable quantities of eggs of *Trichuris*.

Tab.1 The measurement of the complete and partial coprolite samples

Sample	Length（mm）	Width（mm）	Weight（g）	Sample	Length（mm）	Width（mm）	Weight（g）
1	26.88	19.16	18.57	4	23.62	21.84	7.33
	21.85	16.57		5	39.26	31.69	23.16
	28.16	23.4		6	21.87	20.1	4.9
2	40.91	33.06	31.45	7	41.16	35.01	30.83
3	28.87	20.55	7	8	32.78	19	17.28

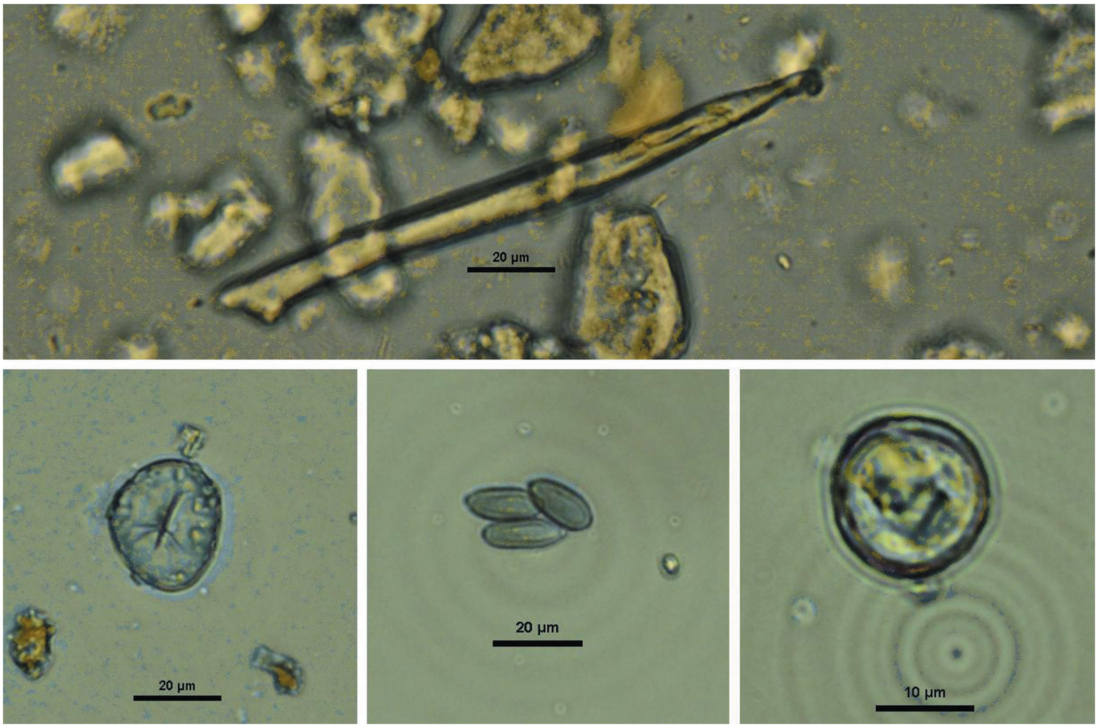

Fig. 3 (1)Upper image is the suspected male hookworm (Ancylostoma duodenale); (2) Bottom left is a possible cyst of Giardia; (3) Bottom middle ones are eggs of Trichuris trichiura; (4) Bottom right one is a oocyst of coccidium.

Tab.2 The measurements of parasite remains detected in coprolites

Coprolite	Sum	Taxon	Sum	Lenght(μm)		Width(μm)	
				Range	Mean	Range	Mean
1	2	Male Hookworm (*Ancylostoma duodenale*)	1	130	/	3~10	7
		Unidentified egg	2	/	/	/	/
4	1	Unidentified egg	1	/	/	/	/
5	22	Egg of *Trichuris*	5	16~18	17	6~7	6.2
		Cyst of *Giardia*	1	28	/	21	/
		Oocyst of *Coccidium*	1	13		13	
		Unidentified egg	14	/	/	/	/

Parasitism is an evolutionary path many organisms has taken and a kind of relationship among the creatures[24], depending on the proper environment and host's behavior [16, 25]. Parasites are classified as ectoparasites and endoparasites by their interaction with its hosts and on its life cycles. This study is mainly engaged in the paleo-endoparasite and its possible connection with the inhabitation environment and the health of Xuchang Man and the animals present in the area around the Lingjing site.

Parasites can threaten their hosts' and the public’s health, and cause animals' sterilization or death. One coprolite sample in this study contained a suspected male hookworm (*Ancylostoma duodenale*). The presence of *Ancylostoma* is the first occurrence in a Paleolithic archaeological coprolite from China. The suspected male *Ancylostoma duodenale* is a pathogenic factor in regard to humans and animals. It displays the ability to affect humans and animals through reproduction and infects hosts in various ways through physical contact, drinking and accidental ingestion.

The size of the hookworm preserved in coprolites is far smaller than those living in nowadays. Today the adult male *Ancylostoma duodenale* averages up to 1cm in length. The hookworm from Lingjing site is only 130μm, only one seventh the size of the modern species. It is presumed that evolutionary changes have occurred over the last 80,000-100,000 years and the body sizes of hookworms may have increased in length.

Whipworm and hookworm are kinds of soil transmitted parasites. A characteristic of whipworms is that they are directly transmitted from the host species. When they finish their early life cycle in a relative proper environment, they can infect new host [26]. The whipworm also lives in the tropical, subtropical and temperate zone. According to botanical and faunal evidence, the Lingjing Site had a warm and moist climate at the time of the early human occupation. Whipworm and hookworm provide additional evidence of the presence of a humid climate at the site. The presence of these parasites also suggests an occupation of the site during the late spring or summer.

A cyst of Giardia was found in coprolite sample No.5. Cysts of Giardia also adversely affect their hosts [24]. The cysts can then infect other individuals after the larva/larvae emitted from the testate of cysts through soil or water.

3.3 Animal hair

Four animal hairs were found in the Sample No.5 coprolite. The four hairs are most likely derived from a Feline based on the microstructures of the hairs: the features of the Scale and the Cortex layer, and the index of Medullary layer. All of the hairs have lost their hair ends and roots. The remnant lengths of Feline hairs are more than 600μm, with the longest hair being over 1,000 μm (Fig.4).

Hair is peculiar to mammals and is formed by the keratinize epidermic cell [27]. The identification of mammalian species' hair has had an application in many disciplines, including zooarchaeology, paleontology and anthropology[28]. Hair is a good tool from distinguishing animal species due to differences in the microstructure of different hair types[29]. The diversity of microstructures of animal hair is an important field of study and is based on the scale, the cortex layer, the medullary layer and the Inner-root sheath of hair fiber. The types of these indexes vary sharply from species to species.

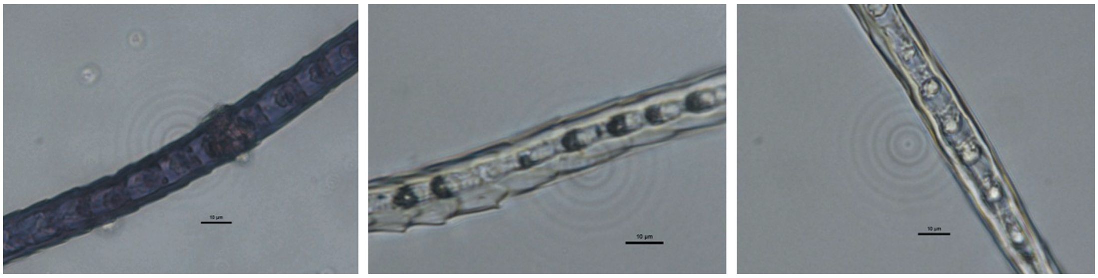

Fig.4 The hairs was found in sample No.5

The animal hairs reported here is the first discovered dating between 100,000 BP to 80,000 BP from archaeological coprolites in China. The 2006 excavation report of Lingjing site points out there are 18 species of animal fossils that have been identified based on faunal fossil remains. There is a finding that the fossils of Pachycrocuta and *Viverra cf. zibetha*. Hyenas are fond of carrion. It is possible that a living or dead *Viverra cf. zibetha* contributed to the diet of the hyaena, as the excavation report points out that the fauna indicated a warm and moist climate during the humans' occupation[1]. The retention of body heat by body hair is very important to animals experiencing wet or cold conditions. It is possible to infer that the *Viverra cf. zibetha*. was a very adaptable species in such circumstance and served as the source of the hairs in the coprolite.

4. Discussion and Conclusion

The result of analysis of the eight coprolites shows an assemblage of well-reserved ancient micro-biological remains. As shown in our previous study, the pollen and fungal spores show that the character of the paleoenvironment matches the fauna of the site. Furthermore, because of the hyena's carnivorous diet, the pollen and fungal spores found in the Hyaena coprolites most likely originated from the prey or carrion consumed by the hyena[23]. It is noteworthy that the parasite and fungi remains found in the coprolites provide significant support for the research about the dietary, individual health, and environment in Lingjing region. One coprolite sample contained animal hairs which were identified to family level based on their microstructures and features, indicating the consumption of a feline by hyaenas.

In summary, all refractory remains examined in the coprolite samples provide evidence about the archaeological meanings of Lingjing site and the Xuchang Man and the animals recovered there. And the researches on the paleo-parasitology and fungi of coprolites provide a new thinking on the archaeological study. Not only the coprolites can provide their hosts' information, but also the micro-contents of the coprolites can supply much useful information.

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