Detection of Parasite Eggs from Archaeological Excavations in the Republic of Korea

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Excavations at two sites dating from 2000 BC-1900 AD in southeastern areas of the Republic of Korea, revealed the remains of several structures. Examination of the contents suspected privies revealed the presence of eggs from 5 kinds of parasite: Ascaris, Trichuris, Clonorchis*, and two species of unknown trematodes.* Clonorchis sinensis *eggs were found in a soil dating from around AD 668-935. This is the first record of* C. sinensis *eggs in archaeological materials in the Republic of Korea.*

Key words: archaeology - excavation - soil - helminth egg - detection - Korea

Parasitological examinations have been a routine tool of paleo-fecal researches in North and South America (Horne 1985, Kliks 1990, Ferreira et al. 1991, 1993, Schmidt et al. 1992, Araujo & Ferreira 2000, Faulkner et al. 2000), Europe (Taylor 1955, Grzywinski 1959, Pike 1968, Herrmann 1988, Jones 1985, Greig 1981, Bouchet 1995, Araujo & Ferreira 2000, Bouchet et al. 2002), as well as Egypt (Ruffer 1910), from the beginning of the century.

In Asian countries, eggs of *Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis, Clonorchis sinensis,* and *Schistosoma japonicum* have been found in corpses dating from 2100 years ago (Chen 1956, Wei 1973, Chen & Hung 1981, Wei et al. 1981, Hu 1984, Yang et al. 1984, Su 1987, Wu et al. 1996). In the Republic of Korea, archaeological studies were carried out, for the first time, during the excavation of the wetland site dating from 100 BC, from which *Ascaris* and *Trichuris* eggs were recovered (Kwangju National Museum; KNM 1997). With the exception of these two kinds of helminth eggs, there have been no reports of parasites from paleo-fecal research in Korea.

Of helminth infections, soil- and snail-transmitted helminths have been the most common and wide-spread parasites among the Korean population over the last century. There has been only one report on the prevalence of human parasites in the Korean peninsula (KNM 1997). This parasitological analysis aided in the determination of the use of the pits as privies, and hence provided further information about the health and hygiene of the inhabitants of the prehistoric and historic archaeological sites of the Republic of Korea.

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MATERIALS AND METHODS

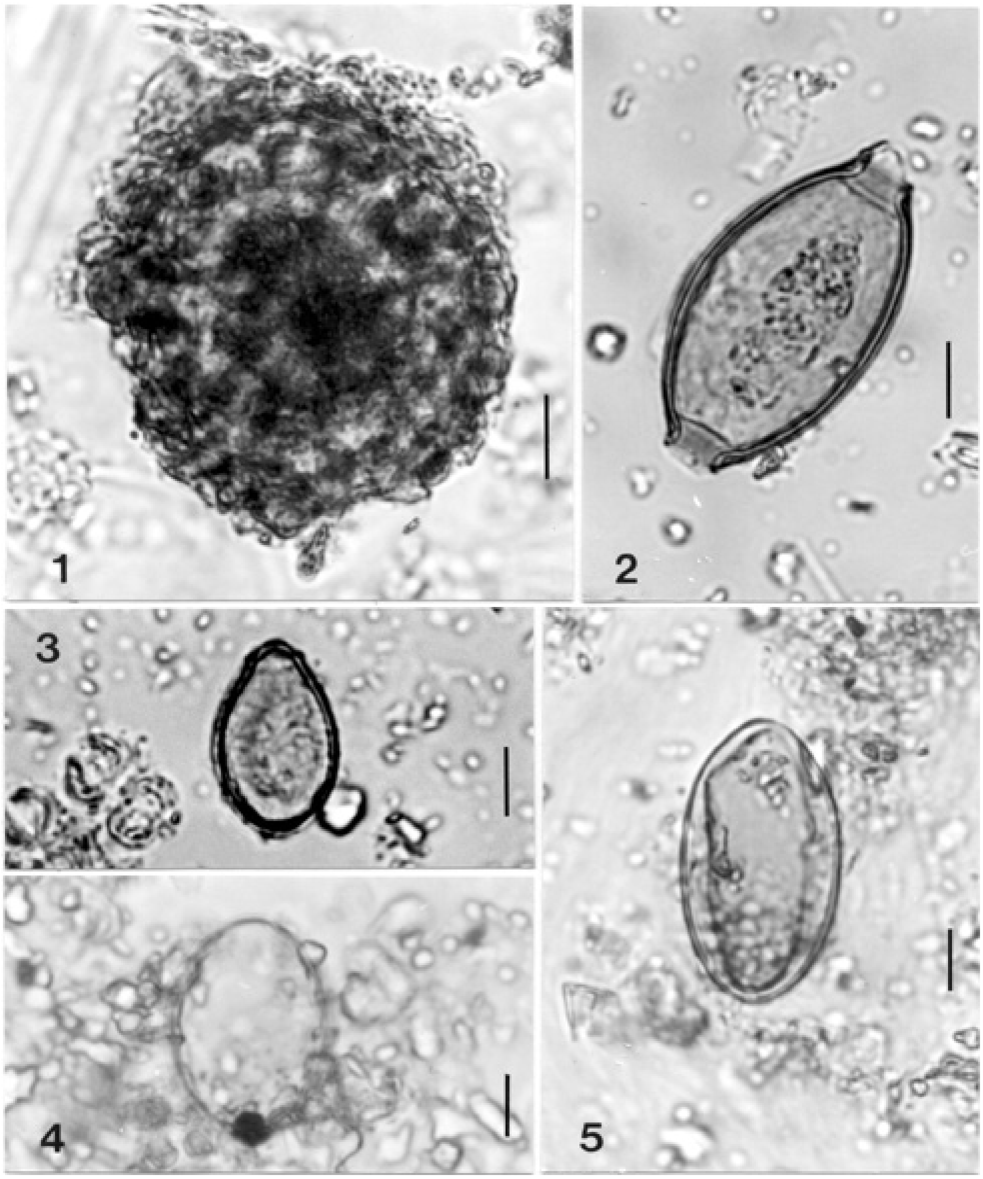
We excavated earthen wares dating from 668-935 AD (the Unified Shilla Dynasty) from Chilgok-gun, Taegu-city, and several pieces of ware and hunting tools dating from 2000-1000 BC (Bronze Age), 100 BC-650 AD (Three Kingdoms of Shilla, Koguryo and Paekje), and 1400-1900 AD (Chosen Dynasty) from Ulgin-gun, Kyungsangbuk-do.

One hundred and six pit soil samples were examined from 47 zones in two areas. From one area, located in Chilgok-gun, Taegu-city (Site A), 20 samples from 30 zones, and from another located in Ulgin-gun, Kyungsangbuk-do (Site B), 86 pit samples from 17 zones, were examined.

For the purpose of the helminthological study, approximately 100 g of soil materials were removed from each pit, stored in tightly sealed vinyl bags and transferred to our laboratory. Each of 10 g sample was placed in a 50 ml centrifuge tube. All samples were rehydrated in 0.5% trisodium phosphate solution (Van Cleave & Ross 1947, Pike 1968), and to ensure rehydration, were completely immersed and shaken vigorously in the solution on a daily basis for one week. The rehydrated soils were filtered through several layers of gauze, and usually accomplished by washing the material with trisodium phosphate solution. After the disintegration the samples were precipitated for one day, with the upper turbid layer being discarded. The soil was dissolved in 20 ml trisodium phosphate solution, and a 20 µl sample pipetted onto a microscopic slide, covered with a cover glass (22 × 40 mm) and scanned at × 100 magnification to determine the presence of eggs or larvae. At least 10 slides were prepared from each sample. Measurements of eggs were obtained using a stage and ocular micrometers following appropriate calibration.

RESULTS

Of the 106 pit soil samples examined, 10 contained helminth eggs from two sites (Table, Figs 1-6). These eggs were identified as those of *A. lumbricoides* (Fig. 1), *T. trichiura* (Fig. 2), *C. sinensis* (Fig. 3), and two unknown trematode sp. (Figs 4, 5).



Helminth eggs recorded in soils from suspected privies. Fig. 1: *Ascaris lumbricoides* (bar = 10 µm). Fig. 2: *Trichuris trichiura* (bar = 10 µm). Fig. 3: *Clonorchis sinensis* (bar = 10 µm). Fig. 4: unknown trematode sp. I (bar = 10 µm). Fig. 5: unknown trematode sp. II (bar = 10 µm).

TABLE

Recovery of helminth eggs in soils from archeological excavations in the Republic of Korea

Localities	Chilgok-gun [a] (Site A)	Ulgin-gun (Site B)	Size (µm) [b]
No. zones (pits)	20 (20)	17 (86)	
No. egg positive zones	5	5	
Helminth eggs			
Ascaris lumbricoides	2	0	55.0 ± 3.7 × 49.4 ± 2.2
Trichuris trichiura	1	0	49.0 ± 2.7 × 24.8 ± 0.8
Clonorchis sinensis	3	0	27.7 ± 2.3 × 18.8 ± 4.8
Unknown trematode sp. I	0	2 [c]	34.8 ± 2.8 × 26.5 ± 4.9
Unknown trematode sp. II	0	1 [d]	40.0 × 22.5

a: dating from AD 668-935; *b*: length ± S.D. (standard deviation) × width ± S.D.; *c*: dating from AD 1400-1900; *d*: dating from BC 100-AD 650.

From Site A (Chilgok-gun, Taegu-city), we recovered eggs of *A. lumbricoides*, *T. trichiura* and *C. sinensis* from several cm to 5 m below the ancient (668-935 AD) remains. Of the samples collected, eggs of *A. lumbricoides*, *T. trichiura* and *C. sinensis*, from pit no.1, eggs of *C. sinensis* from pit nos. 3 and 6, and *A. lmbricoides* from pit no. 11, were recovered. The egg counts per gram of soil sample were approximately 2,800 for *A. lumbricoides* 2,100 for *T. trichiura* and 2,100 for *C. sinensis,* in pit no. 1, and 2,200 for *C. sinensis* in pit no. 3.

From Site B (Ulgin-gun, Kyungsangbuk-do) we recovered two kinds of eggs from unknown trematode species from several cm to 5 meter below the prehistoric remains (2000 BC-1900 AD), and at the existing site. Eggs of 2 unknown trematode species (I and II) were recovered from pits nos. 21and 59, and eggs of unknown trematode species II from pit no. 62. Parasitological data from the excavated soil samples confirmed that the archaeological Sites A and B were, in ancient times, privies.

DISCUSSION

Paleoarchaeological analyses have been performed to provide some clues as to the dietary behaviors, nutrients and health conditions and the natures of occupation to supplement other archaeological evidence. Desiccated, or mineralized, coprolites and soils, recovered from archaeological sites, are routinely analyzed for parasites. Parasites and/or eggs have been found in archaeological materials, usually from the periods associated with humans (Araujo & Ferreira 2000).

From only their morphology and size, it is impossible to know if *Ascaris* sp., *Trichuris* sp. and *C. sinensis* eggs are of human or animal origin; but those of *A. lumbricoides* from humans can be differentiated, with much difficulty, from *Ascaris suum* found in pigs, and those of *T. trichiura* can be differentiated, with much difficulty, from *Trichuris suis* (Jones 1982). It is known that the trematodes, e.g. *C. sinensis* and *Metagonimus* sp., can infect humans and other mammalian hosts (e.g. wild animals), but it is impossible to know the natural definitive host, based on the size of eggs. The possibility that the recovered trematode eggs, from the excavated areas, coming from either infected wild animals and/or humans can not be excluded. At the archaeological sites in question, other remains proved the existence of human habitation, therefore these parasite eggs could well have originated from humans.

In western countries it has been reported that *Ascaris* sp. and *Trichuris* sp. are the most commonly encountered eggs of parasites (Taylor 1955, Pike 1967, 1968, Jones 1982, Aspock et al. 1996). They have been reported from as early as the Neolithic, up to Roman and Saxon eras, in England, Germany, Australia, Holland, Poland, Denmark and Israel.

In Asia, the excavation of eggs from parasites from archaeological materials has been reported in several sources from Korea and China (Chen 1956, Wei 1973, Chen & Hung 1981, Wei et al. 1981, Hu 1984, Yang et al. 1984, Su 1987, Wu et al. 1996, KNM 1997). In the Republic of Korea only one paleoparasitological study has been carried out, and the helminth eggs, *Ascaris* sp. and *Trichuris* sp., were found during the excavation of the wetland sites of Shinchang-dong, Kwangju-city in the southwestern area, dating from 100 BC (KNM 1997). In China, paleoparasitological studies were performed on ancient corpses in 'Tomb No. 1' of the Chu Dynasty at Guo-Jia-Gang, Jingmen City, Hubei Province in the middle stage of the Warring Stages (475-221 BC) (Hu 1984, Yang et al. 1984, Su 1987, Wu et al. 1996), and Western Han Dynasty (206 BC-220 AD) excavated from tomb No. 1 at Ma-Wang-Dui in Changsha City (Wei 1973) and tomb No. 168 at Phoenix Hill in Jinagling City (Chen & Hung 1981, Wei et al. 1981), and from tomb of Ming Dynasty (1368-1644 AD) in Guangzhou (Chen 1956).

In Korea, the egg positive rate of soil-transmitted helminths in nationwide inhabitants was, until the end of the 1950s, over 80%, but decreased to 65.4% (*T. trichiura*) and 54.9% (*A. lumbricoides*) by 1971, and to 0.2% and 0.3% by 1992 (Chai & Lee 1993). In China, the eggs of *A. lumbricoides* and *T. trichiura* were found in corpses excavated from an ancient tomb dating over 2000 years (Wei 1973, Hu 1984, Yang et al. 1984, Su 1987, Wu et al. 1996). According to the data of recent nationwide survey of soil-transmitted helminths, the infection rate of *A. lumbricoides* and *T. trichiura* was 47 % and 20%, respectively, in China (Xu et al. 1995). The archaeological findings from two countries, China and Korea, may be correlated with the recent prevalence of soil-transmitted helminths.

A Chinese archaeologist first found the eggs of *C. sinensis,* in 1956, from coprolites of a Ming Dynasty corpse (buried in 1513) in the suburbs of Guangzhou (Chen 1956). Since then, in 1975, *C. sinensis* eggs have been found from a corpse of the West Han Dynasty in Jiangling, Hubei Province (Chen & Hung 1981, Wei et al. 1981), and from a tomb of the Chu Dynasty (Hu 1984, Yang et al. 1984, Su 1987, Wu et al. 1996). In a recent Chinese nationwide survey, the infection rate of *C. sinensis* was still 0.037% (Yu et al. 1994). In our study we found *C. sinensis* eggs from the soil of an archaeological excavation in the Republic of Korea. The nationwide prevalence of this parasite was 4.6% in 1971 and 2.2% in 1992 (Chai & Lee 1993).

Of the two areas examined, Site A (Chilgok-gun, Taegu-city) is located at the upper basin of the Nagdong River. The *C. sinensis* egg positive rate of the inhabitants in this area was 14.1% (Seo et al. 1981). According to these previous results and other archaeological excavation data, this area had already suffered an endemic of chonorchiasis over 1200 years ago, where the inhabitants may have eaten raw freshwater fish. The presence of *C. sinensis* eggs found in this present study is the third record of a liver fluke infection in archaeological material worldwide. The results from both this and previous studies, suggests that clonorchiasis has been prevalent over the last 2300 years in Korea and China.

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