Human Intestinal Parasites in the Past: New Findings and a Review

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Almost all known human specific parasites have been found in ancient feces. A review of the paleoparasitological helminth and intestinal protozoa findings available in the literature is presented. We also report the new paleoparasitologic findings from the examination performed in samples collected in New and Old World archaeological sites. New finds of ancylostomid, Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis, Trichostrongylus *spp.,* Diphyllobothrium latum, Hymenolepis nana *and Acantocephalan eggs are reported. According to the findings, it is probable that* A. lumbricoides *was originally a human parasite. Human ancylostomids,* A. lumbricoides *and* T. trichiura, *found in the New World in pre-Columbian times, have not been introduced into the Americas by land via Beringia. These parasites could not supported the cold climate of the region. Nomadic prehistoric humans that have crossed the Bering Land Bridge from Asia to the Americas in the last glaciation, probably during generations, would have lost these parasites, which life cycles need warm temperatures in the soil to be transmitted from host to host. Alternative routes are discussed for human parasite introduction into the Americas.*

Key words: paleoparasitology - ancient diseases - helminths - protozoa - coprolites - mummies

Parasites are organisms that found their ecological niche living in organisms of distinct species, called hosts. Paleoparasitology is the study of parasites in archaeological material. Paleoparasitologic findings can provide valuable information related to the antiquity of human-parasite relationship, parasite dispersion and human migrations in the past (Wilke & Hall 1975, Horne 1985, Araújo et al. 1988, Araújo & Ferreira 1997, 2000, Reinhard 1990, 1992).

Fecal remains usually are found in archaeological strata during archaeological excavations, in sediment from ancient latrines and cesspits or directly collected from mummies. Specimens are preserved by dry environment or by high concentration of soluble salts (Fry 1985). When feces are desiccated or mineralized, they are called coprolites (Heizer & Napton 1969).

Rehydration of desiccated coprolites is necessary to proceed to paleoparasitological analysis. Water, sodium hydroxide and EDTA solutions have been used to rehydrate specimens, but it was observed that they caused egg distortion and disintegration (Fry 1985). Only after the use of trisodium phosphate solution by Callen and Cameron (1960), rehydration techniques could obtain reliable results. They adapted the technique employed by Van Cleave and Ross (1947) and by Benninghoff (1947) to rehydrate dried zoological and herbarium specimens respectively. Since 1960, rehydration in aqueous 0.5% trisodium phosphate solution has been the standard technique. To disaggregated mineralized coprolites, 5-10% chlorydric acid solution is used (Jones 1983). Parasite remains, mainly eggs and larvae, can be identified quite easily in ancient fecal material after rehydration.

This paper summarizes the available literature about intestinal parasite findings in archaeological material. We discuss some biological aspects of the parasites found and we speculate about human dispersion in the past. We also performed the examination of ancient feces belonging to the collection of the Laboratory of Paleoparasitology of the Escola Nacional de Saúde Pública-Fundação Oswaldo Cruz (Fiocruz), Rio de Janeiro, Brazil.

MATERIALS AND METHODS

Specimens - A total of 894 samples of probable human coprolites and organic material from latrines and cesspits, belonging to the collection of our laboratory, were examined. Their origin are listed in Table I. The samples were dated either by ^{14}C method or by cultural context.

Examination techniques - The specimens were rehydrated by immersion in a 0.5% aqueous solution of trisodium phosphate for 72 h (Callen & Cameron 1960). The rehydrated sample solutions were mixed approximately 10:1 in acetic formalin solution to avoid fungal and bacterial growth. The material was allowed to sediment following the technique proposed by Lutz (1919). A portion of each sediment was used for microscopic examination. The material was placed on a slide and covered with a coverslip and examined for the presence of parasites. Twenty slides for each sample were examined at magnification of X100 and X400. All wet preparations were examined by at least two of the authors. All eggs and larvae were photographed and the eggs were measured.

RESULTS

Presented below is a summary of the paleoparasitological findings available in the literature as well as the unpublished findings of our material. The data are separated by parasite and by chronological order. The archaeological site or the source mummy of the coprolite, country

TABLE I

Origin of the samples examined at the Laboratory of Paleoparasitology of the Escola Nacional de Saúde Pública-Fundação Oswaldo Cruz, from January 2000 to July 2001

Origin of the samples	Samples examined	No. of archaeological sites
Brazil	720	27
Chile	126	14
USA	20	1
Argentina	7	4
Venezuela	7	?
France	5	2
Peru	4	1
Germany	3	1
Belgium	1	1
Egypt	1	1

and date are given in Table II to Table XIV. Table XV shows non-intestinal human helminths. In Table XVI human paleoparasitological finds in the New and Old Worlds are shown, if pre or post-Columbian.

DISCUSSION

One of the most rich source of information about paleoecology is the analysis of ancient human droppings. The analysis of micro and macro remains like pollen, undigested seeds, fibers, small bones, scales and charcoal can reveal important aspects of diet, paleoclimate, agricultural development and prehistoric human occupation of ancient sites (Heizer & Napton 1969, Wilke & Hall 1975, Fry 1977, 1985, Reinhard & Bryant Jr 1992). Dietary habits can also be inferred when parasites with intermediate host life cycles are found in coprolites and in latrine material (Callen & Camaron 1960, Patrucco et al. 1983, Ferreira et al. 1984). Study of the coprolites in a paleontologic context can

reveal interesting epidemiological patterns. Differences in parasitism between prehistorical hunter-gathering from agriculturalist population have been shown, related to sanitary patterns, type of dwelling and diet (Reinhard 1988a).

According to Darwin's theory, species have their origin in only one geographical area. Therefore, the utilization of parasites as biological markers allows a new approach concerning ancient human migrations. The dispersion of parasites in time can be used to trace migrations of their human hosts (Manter 1967, Araújo et al. 1988, Araújo & Ferreira 1997). A better understanding of parasite distribution in ancient world made it also possible to speculate about the antiquity of human-parasite relationship (Araújo & Ferreira 2000).

There are parasites that are specific to a host species and others that are not. Some parasites are found only in phylogenetically related host species. This kind of relationship began with a common ancient host species, early in time. There are species of parasites, however, that do not have such specificity, adapting themselves to several non-related hosts. Such parasites have been acquired by behavioral, social and biological changes, which have propitiated the host-parasite encounter, sometime during evolutionary history (Araújo et al. 2000). *Enterobius vermicularis* is an example of an inherited parasite, which has been present in human ancestors (Hugot et al. 1999), whereas *Diphyllobothrium latum*, for example, although a parasite found in ancient human populations, was acquired by food habits during the conquest of new habitats sometime in the past of mankind.

Helminths such as nematodes, cestodes, trematodes and acantocephalans keep their morphological parameters almost unchanged when 0.5% Na_3PO_4 aqueous solution is employed to rehydrate desiccated organic remains (Confalonieri et al. 1985, Fry 1985). Protozoa cysts are identified too, although cysts suffer a faster decay, re-

TABLE II

Ancylostomid finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Pedra Furada, Piauí	Brazil	7230 ± 80 BP	Ferreira et al. 1987
Tiliviche, Iquique	Chile	4100 - 1950 BC	New finding
Clairvaux, Jura	France	3600 BC	Dommelier-Espejo 2001
Boqueirão Soberbo, Minas Gerais	Brazil	4905 ± 85 - 1325 ± 60 BP	Ferreira et al. 1982
Chalain, Jura	France	2700 - 2440 BC	Dommelier-Espejo 2001
Daws Island, South Carolina [a]	USA	1700 - 1300 BC	Rathbun et al. 1980
Hulin, Central Moravia	Czech Republic	1600 - 1500 BC	Šebela et al. 1990
Gentio Cave, Minas Gerais	Brazil	3490 ± 120 - 430 ± 70 BP	Ferreira et al. 1980, 1983
Toconao Oriente, San Pedro de Atacama	Chile	2500 - 2100 BP	New finding
Big Bone Cave, Tennessee	USA	2177 ± 145 BP	Faulkner et al. 1989, Faulkner & Patton 2001
Upper Salts Cave, Kentucky [a]	USA	1125 - 290 BC	Dusseau & Porter 1974
Valle Encantado, Neuquén	Argentina	1000 - 500 BP	New finding
Tihuanaco	Peru	890 - 950 AD	Allison et al. 1974
Buldir Island, Alaska [b]	USA	1400 - 1700 AD	Bouchet et al. 1999
Namur	Belgium	18th century AD	New finding
Newport, Rhode Island	USA	18th century AD	Reinhard et al. 1986
Sítio do Meio, Piauí	Brazil	Not available	New finding

a: uncertain diagnosis; *b*: human origin?

TABLE III

Ascaris lumbricoides finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Grand Grotte, Arcy-sur- Cure, Yonne	France	30,160 ± 140 - 24,660 ± 330 BP	Bouchet et al. 1996
Kruger Cave, Rustenburg [a]	South Africa	10,000 - 7000 BP	Evans et al. 1996
Clairvaux, Jura [a]	France	3600 BC	Dommelier-Espejo 2001
Arbon,Thurgau [a]	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Chalain, Jura [a]	France	2700 - 2440 BC	Dommelier-Espejo 2001
Huarmey Valley	Peru	2277 BC ± 181	Patrucco et al. 1983
Somerset	England	4100 - 2600 BP	Jones & Nicholson 1988
Hulin, Central Moravia	Czech Republic	1600 - 1500 BC	Šebela et al. 1990
Gentio Cave, Minas Gerais	Brazil	3490 ±120 - 430 ± 70 BP	New finding
Upper Salts Cave, Kentucky	USA	1125 - 290 BC	Fry 1974
Drobintz girl	Prussia	600 BC	Szidat 1944
Hallstatt	Austria	2300 years	Aspöck et al. 1973
PUM II mummy	Egypt	200 BC	Cockburn et al. 1975
Big Bone Cave, Tennessee	USA	2177 ± 145 BP	Faulkner et al. 1989
Hallein, Salzburg	Austria	2000 years	Aspöck et al. 1974
Bremerhaven	Germany	100 BC - 500 AD	Jansen Jr & Over 1962
Valkenburg on Rhine	Netherlands	42 - 100 AD	Jansen Jr & Over 1966
Winchester [b]	England	Roman Age	Pike 1968
Lindow Man	England	2nd century AD	Jones 1986
Bobigny	France	2nd century AD	Rousset et al. 1996
York [b]	England	2nd - 3rd century AD	Wilson & Rackham 1976
Karwinden Man	Prussia	500 AD	Szidat 1944
Ribe	Denmark	750 - 800 AD	Nansen & Jørgensen 1977
York	England	9th - 10th century AD	Jones 1982
Antelope House, Arizona	USA	900 - 1250 AD	new finding
Elden Pueblo, Arizona	USA	1070 - 1250 AD	Hevly et al. 1979, Reinhard et al. 1987
Winchester	England	1000 years	Pike 1967a
Winchester [b]	England	1100 AD	Taylor 1955
Adak Island, Alaska	USA	840 ± 40 BP	Bouchet et al. 2001
Acre	Israel	13th century AD	Mitchell & Stern 2000
Utrecht	Netherlands	13th - 14th century AD	Boersema & Jansen 1975, Jansen & Boersema 1982
Southampton	England	13th - 14th century AD	Pike 1975
Amsterdam	Netherlands	1370 - 1425 AD	Jansen & Boersema 1972, Jansen & Boersema 1982
Paris	France	14th - 15th century AD	Bouchet 1993, 1995
York	England	14th - 16th century AD	Jones et al. 1988, Jones & Nicholson 1988
Worcester	England	15th century AD	Moore 1981
Oslo	Norway	15th century AD	Schia, 1979
Lübeck	Germany	15th century AD	Herrmann 1985, Herrmann & Schulz 1986
Montbeliard	France	15th - 16th century	new finding
Schleswig	Germany	Medieval Age	Herrmann 1985
Berlin	Germany	Medieval Age	Herrmann 1985
Braunschweig	Germany	Medieval Age	Herrmann 1985
Hameln	Germany	Medieval Age	Herrmann 1985
Höxter	Germany	Medieval Age	Herrmann 1985
Göttingen	Germany	Medieval Age	Herrmann 1985
Marburg	Germany	Medieval Age	Herrmann 1985
Freiburg	Germany	Medieval Age	Herrmann 1985
Breisach	Germany	Medieval Age	Herrmann 1985
Regensburg	Germany	Medieval Age	Herrmann 1985
Landshut	Germany	Medieval Age	Herrmann 1985
Newfoundland [b]	Canada	17th century AD	Horne & Tuck 1996
Marly-le-Roy, Yveline [b]	France	17th - 18th century AD	Bouchet et al. 1998
Williamsburg, Virginia	USA	1720 AD	Reinhard 1990
Namur	Belgium	18th century AD	New finding
Newport, Rhode Island	USA	18th century AD	Reinhard et al. 1986
Wellington	New Zealand	150 - 200 years	Andrews 1976

a: uncertain diagnosis; *b*: human origin?

sulting in artificially low estimations of protozoa as indicated by the infrequent finding of protozoan cysts in coprolites (Gonçalves et al. 2002).

In a review, the correct identification of the origin of the specimens poses special problem in the validity of data. When the coprolites are not obtained from a mummified body, it can be difficult to ascertain its origin. The same problem arises when analyzing sediment from latrines. It is possible of misdiagnosis between human and wild or domestic animal fecal material (Fry 1977, 1985, Reinhard & Bryant Jr 1982).

But, if there is no absolute test to determinate the zoological fecal origin, there are some well established criteria for differentiation between human and non-human coprolites. It is possible to select human coprolites based in their size, shape, macro and micro contents, and most important, parasites. The finding of an exclusive human helminth in a sample clearly indicates their origin (Reinhard & Bryant Jr 1982, Fry 1985). When that is not the case, the parasite egg size is a valuable tool to indicate the coprolite origin (Confalonieri et al. 1985).

Interpretation of some parasitic findings can be troublesome. False parasitism should always be considered when eggs from a non-human parasite are recovered in a supposed human coprolite (Taylor 1955). These eggs may have been introduced in human digestive tract by consumption of some definitive parasite host. Zimmerman (1980) reported the finding of eggs from *Cryptocotyle lingua*, a fish trematode, in a 1,600 year old frozen Eskimo mummy. Although eggs from this trematode have been recovered from modern Eskimos, the adult helminth has never been found in humans. Similarly, *Eimeria* sp., probably *E. mira*, a protozoa of red squirrel, has been found in the intestine of the Bog Man from Grauballe, dated between 1540 and 1740 years BP (Before Present). It appears to be due to the ingestion of contaminated meat or offal (Hill 1990). The finding of *Capillaria* spp., a rodent parasite, in human coprolites have been reported (Bouchet 1997). Although very rare in humans, the presence of *Capillaria* eggs in feces may actually indicate the ingestion of an infected liver (Roberts & Janovy Jr 2000). Coimbra Jr and Mello (1981) reported the finding of *Capillaria* eggs in feces of two Indians from the Amazonian region, probably resulting from the habit of animal liver ingestion.

Necator americanus and *Ancylostoma duodenale* are the most frequent ancylostomid parasitizing humans. The former was more frequent in Southern Africa, in the Americas, and in the Pacific Islands. *A. duodenale* was common in northern hemisphere, mainly in southern Europe, northern Africa, in India, in China and in southeastern Asia. But now, as a result of the large human movements throughout the world, their geographic distributions are quite ubiquitous. The worms mature and mate in the small intestine of the host. Eggs, passed with feces, hatch in environment if adequate moisture, shade and warm soil are found. The newly hatched larvae go on to develop eventually into the infective filariform larvae. The life-span of *N. americanus* and *A. duodenale* varies from 4 to 5 years and from 6 to 8 years respectively (Roberts & Janovy Jr 2000, Rey 2001). The species can not be diagnosed reliably when the only remains are eggs, as most cases in coprolites or latrine sediment. Differentiation of *A. duodenale* from *N. americanus* larvae is difficult, especially in rehydrated material.

Ancylostomids have been found in archaeological sites from both New and Old Worlds (Table II). Most finds are from the Americas. Human infection has been present in Amerindians far before Columbus. It strongly suggests some kind of transoceanic contact before 7230 ± 80 years ago (the oldest finding by now) (Araújo et al. 1988, Araújo & Ferreira 1997). Ancylostomids, as well as other helminths that require warm and moist conditions to complete their life cycles outside their host, could not have survived during human migration by land through Bering Strait during the last ice age. Coastal navigation along the southern coast of the Bering Land Bridge is a more feasible route (Dixon 2001). Paleoparasitological finds from that region could support this alternative pathway of peopling of the New World. Unfortunately, from a paleoparasitological view, most ancient coastal areas are currently underwater, due to the rise of oceanic water levels after the Ice Age.

Ascaris is a cosmopolitan helminth. Adult worms live in the small intestine of the host, and, as the ancylostomids, passed eggs need suitable environment to continue development. But *Ascaris* eggs can remain viable in soil for some years, even under tough conditions. The adult life time is estimated to be 2 years (Rey 2001). Table III shows a very wide distribution of *A. lumbricoides* in the Old World, especially in the Middle Ages. It reflects poor sanitation and high population density in enlarging villages.

A. lumbricoides and *A. suum* are morphologically and physiologically similar. They parasitize humans and pigs respectively. It has been suggested that a common ancestor of *A. lumbricoides* and *A. suum* originally parasitized pigs. Later, this ascarid adapted to humans when pigs were domesticated. But that is still an unsolved question (Roberts & Janovy Jr 2000). The finding of *A. lumbricoides* eggs in France (Table III), much earlier than the time of pig domestication, nearly 9000 years ago (Giuffra et al. 2000), suggests that humans were first parasitized. After pig domestication, the parasite adapted to pigs. Similar findings in the New World in pre-European context also suggest this.

Trichuris trichiura adult worms live in the colon and is also a cosmopolitan parasite. Some 70 species of *Trichuris* have been reported from a wide variety of mammals. *T. trichiura* parasitizes humans, and as ancylostomids and *Ascaris*, warmth and moisture are necessary to fully develop the embryos (Roberts & Janovy Jr 2000). *T. trichiura* lifetime is estimated to be up to 6-8 years (Rey 2001). The egg size sometimes can be a reliable tool for identifying the species of *Trichuris* in coprolites of unknown origin (Confalonieri et al. 1985). Paleoparasitological findings (Table IV) show its wide distribution, including the New World in pre-Columbian times. As *A. lumbricoides*, the wide distribution of *T. trichiura* in the Antiquity and in the Middle Ages, reflects human living conditions. For unknown reasons the findings of *T. trichuris* in the New World are more frequent than the findings of *A. lumbricoides*.

TABLE IV

Trichuris trichiura finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Kruger Cave, Rustenburg [a]	South Africa	10,000 - 7000 BP	Evans et al. 1996
Lapa Pequena, Minas Gerais	Brazil	8000 - 7000 BP	New finding
Clairvaux, Jura	France	3600 - 3500 BC	Dommelier-Espejo 2001
Swifterbant [a]	Netherlands	5400 ± 40 - 5230 ± 40 BP	Roever-Bonnet et al. 1979
Arbon, Thurgau	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Otzal, Tyrol	Austria	3300 - 3200 BC	Aspöck et al. 1996
Chalain, Jura	France	32nd - 25th century BC	Bouchet et al. 1995, Dommelier et al. 1998, Dommelier-Espejo 2001
Boqueirão Soberbo, Minas Gerais	Brazil	4905 ± 85 - 1325 ± 60 BP	Ferreira et al. 1982
Somerset	England	4100 - 2600 BP	Jones & Nicholson 1988
Santa Elina, Mato Grosso	Brazil	4000 - 2000 BP	New finding
Hulin, Central Moravia	Czech Republic	1600 - 1500 BC	Šebela et al. 1990.
Gentio Cave, Minas Gerais	Brazil	3490 ± 120 - 430 ± 70 BP	Ferreira et al. 1980, 1983
Tulán, San Pedro de Atacama	Chile	1080 - 950 BC	New finding
Drobintz girl	Prussia	600 BC	Szidat 1944
Jerusalem	Middle East	7th - 6th century BC	Cahill et al. 1991
Chu Dynasty mummy, Hubei province	China	2300 years	Yang et al. 1984
Hallstatt	Austria	2300 years	Aspöck et al. 1973
Tollund Man, Central Jutland	Denmark	210 BC	Helbaek 1958
Han Dynasty mummy, Hubei province	China	167 BC	Liangbiao & Tao 1981, Cheng 1984
Vilshofen	Germany	150 - 140 BC	Specht 1963
Bremerhaven	Germany	100 BC - 500 AD	Jansen Jr & Over 1962
Han Dynasty mummy, Hunam province	China	2100 BP	Wei 1973
Estrago Cave, Pernambuco	Brazil	2000 BP	Ferreira et al. 1989a
Hallein, Salzburg	Austria	2000 years	Aspöck et al. 1974
Valkenburg on Rhine	Netherlands	42 - 100 AD	Jansen Jr & Over 1966
Winchester [a, b]	England	Roman Age	Pike 1968
Lindow Man, Manchester	England	2nd century AD	Jones 1986
Bobigny	France	2nd century AD	Rousset et al. 1996
Nahal-Mishmar Valley	Israel	160 AD	Witenberg 1961
York	England	2nd - 3rd century AD	Wilson & Rackham 1976
Grauballe Man, Silkeborg	Denmark	3rd - 4th century AD	Helbaek 1958
Karwinden Man	Prussia	500 AD	Szidat 1944
Ribe	Denmark	750 - 800 AD	Nansen & Jørgensen 1977
York	England	9th - 11th century AD	Hall et al. 1983, Jones 1982
Huarmey Valley	Peru	1000 AD	Patrucco et al. 1983
Winchester	England	11th century AD	Pike 1967a, Pike & Biddle 1966
Elden Pueblo, Arizona	USA	1070 - 1250 AD	Hevly et al. 1979, Reinhard et al. 1987
Winchester [a]	England	1100 AD	Taylor 1955
Acre	Israel	13th century AD	Mitchell & Stern 2000
Southampton	England	13th - 14th century AD	Pike 1975
Utrecht	Netherlands	13th - 14th century AD	Boersema & Jansen 1975, Jansen & Boersema 1982
Paris	France	14th - 15th century AD	Bouchet 1993, 1995
York	England	14th - 16th century AD	Jones & Nicholson 1988, Hall et al. 1983
Amsterdam	Netherlands	1370 - 1425 AD	Jansen & Boersema 1972, Jansen & Boersema 1982
Worcester	England	15th century AD	Moore 1981
Lübeck	Germany	15th century AD	Herrmann & Schulz 1986
Oslo	Norway	15th century AD	Schia 1979
Schleswig	Germany	Medieval Age	Herrmann 1985
Lübeck	Germany	Medieval Age	Herrmann 1985
Berlin	Germany	Medieval Age	Herrmann 1985
Braunschweig	Germany	Medieval Age	Herrmann 1985
Hameln	Germany	Medieval Age	Herrmann 1985
Höxter	Germany	Medieval Age	Herrmann 1985

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Archaeological site/mummy	Country	Date	References
Göttingen	Germany	Medieval Age	Herrmann 1985
Marburg	Germany	Medieval Age	Herrmann 1985
Freiburg	Germany	Medieval Age	Herrmann 1985
Breisach	Germany	Medieval Age	Herrmann 1985
Regensburg	Germany	Medieval Age	Herrmann 1985
Landshut	Germany	Medieval Age	Herrmann 1985
Cerro El Plomo, Santiago	Chile	pre-Columbian	Pizzi & Schenone 1954
Inca mummy		ca. 1500 AD	Pike 1967b
Montbeliard	France	15th - 16th century AD	New finding
Murga culture	Peru	Colonial period	Fouant et al. 1982
Newfoundland [a]	Canada	17th century AD	Horne & Tuck 1996
Marly-le -Roy, Yveline [a]	France	17th - 18th century AD	Bouchet et al. 1998
Williamsburg, Virginia	USA	1720 AD	Reinhard 1990
Itacambira, Minas Gerais	Brazil	18th century AD	Confalonieri et al. 1981
Newport, Rhode Island	USA	18th century AD	Reinhard et al. 1986
Namur	Belgium	18th century AD	New finding
New York City, New York	USA	19th century AD	Reinhard 1990
Fayette, Michigan	USA	19th century AD	Faulkner et al. 2000
Pedra Furada, Piauí	Brazil	not available	New finding

a: human origin?; *b*: *Capillaria* sp.?

Enterobius vermicularis is an exclusive human parasite. Organic material containing eggs of this parasite should be of human origin. As *A. lumbricoides*, *E. vermicularis* is cosmopolitan. The adults live mostly in the ileocecal region. The eggs are passed by migrating adult females in the anus and peri-anal area. The eggs can directly infect other host, either by fecal-oral route as through airborne inhaled and swallowed eggs. Its life time is estimated to be up to 2 months (Roberts & Janovy Jr 2000, Rey 2001). For unknown reasons, the finding of *E. vermicularis* in archaeological material outside the New World is scarce (Table V). A hypothetical origin of this parasite in the Americas can be ruled out. *E. vermicularis* has a long history of coevolution with its human host. They have been coexisting together in Africa long time before human dispersion throughout the continents (Ferreira et al. 1997, Hugot et al. 1999).

Strongyloides stercoralis parasitizes humans, other primates, dogs, cats, and some other mammals. It is a parasite of tropical regions, although also found in temperate areas of the world. Having a complex life cycle, with a free-living larvae stage, the female adult worm lives in the small intestine of the host. The eggs usually hatches in the intestinal host lumen. The resulting larvae are passed in feces (Roberts & Janovy Jr 2000, Rey 2001). Table VI shows the findings of *S. stercoralis* in archaeological material. Caution should be exerted in diagnosing this parasite in sediment or coprolites. Free-living and ancylostomid larvae can be misidentified.

Many species of *Trichostrongylus* parasitize the small intestine of many mammals and birds. Some species can infect humans. In some areas in Asia and Africa they are very frequent. In southwest Iran and in a village in Egypt, up to 70% of human population have been found infected (Roberts & Janovy Jr 2000). *Trichostrongylus* eggs are remarkably similar to those of ancylostomids, but usually are larger. Human infection have been detected only in the Americas up to now (Table VI).

Fasciola hepatica is a helminth of cattle and sheep. Human infection occurs occasionally, mainly in certain areas of Europe, Africa and Latin America. The adult worm lives in the bile ducts of the host, passing eggs in feces. The eggs hatch in fresh water, and the parasite completes its life cycle in a snail. Infection occurs by ingestion of metacercaria in vegetation or in water. Occasionally human infections with other *Fasciola* species occur (Roberts & Janovy Jr 2000, Rey 2001). Human infection with *Fasciola* spp. have been detected in coprolites and ancient latrines sediment after herding begun (Table VII), and until now only in the Old World paleofeces.

Three species of *Schistosoma* have major medical importance: *S. haematobium*, *S. japonicum* and *S. mansoni*. Only *S. mansoni* is found in the New World. *S. haematobium* is found mainly in Africa and Near East. *S. japonicum* is found in southeastern Asia and west Pacific. *S. mansoni* is found mainly in Brazil, Caribbean and Africa. Adult worms *of S. haematobium* live in veins of urinary bladder plexus of the host, so eggs are passed in the urine. Adult worms of *S. japonicum* and *S. mansoni* live in intestinal veins, and their eggs are passed in the feces. The eggs of *Schistosoma* spp. hatch in fresh water and the parasite complete its life cycle in a snail. Infection occurs when the parasite penetrates through the host skin (Roberts & Janovy Jr 2000, Rey 2001). Table VIII shows that the findings of *Schistosoma* spp. reflect in some degree their modern distribution, except the Americas in regard to *S. mansoni*. The findings in medieval Europe latrines reflects imported cases from Africa, since there is no intermediate host in Europe.

Dicrocoelium dendriticum is a frequent parasite of ruminants. Rarely it is found in humans. The cycle is somewhat similar to that of *Fasciola*, but there are two inter-

TABLE V

Enterobius vermicularis finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Danger Cave, Utah	USA	7837 BC ± 630	Fry & Hall 1969, Fry & Moore 1969
Dirty Shame rockshelter, Oregon	USA	6,300 years	Hall 1976
Tiliviche, Iquique	Chile	4100 - 1950 BC	New finding
Hogup Cave, Utah	USA	4010 BC - 1 AD	Fry & Hall 1969, Fry & Moore 1969
Huarmey Valley	Peru	2277 BC ± 181	Patrucco et al. 1983
Hinds Cave, Texas	USA	2100 - 600 BC	Reinhard 1988b
Tulán, San Pedro Atacama	Chile	1080 - 950 BC	Ferreira et al. 1989b
Caserones, Tarapaca Valley	Chile	400 BC - 800 AD	Araujo et al. l985
Clyde's Cavern, Utah	EUA	2300 years	Hall 1972
Big Bone Cave, Tennessee	EUA	2177 ± 145 BP	Faulkner et al. 1989
Han Dynasty mummy, Hunam province	China	2100 years	Wei 1973
Turkey Pen Cave, Utah	USA	1600 years	Reinhard et al. 1987
Clyde's Cavern, Utah	USA	460 - 1500 AD	Hall 1972
Canyon del Muerto, Arizona	USA	600 AD ± 95	El-Najjar et al. 1980
Rio Zape, Durango	Mexico	600 AD	Reinhard et al. 1989
Big Horn Sheep Ruin, Utah	USA	900 - 1250 AD	Gardner & Clary 1987
Mesa Verde, Arizona	USA	900 - 1250 AD	Stiger 1977
Chaco Canyon, New Mexico	USA	920 - 1200 AD	Reinhard et al. 1987, Reinhard & Clary 1986
Wetherill Mesa, Colorado	USA	1000 years	Samuels 1965
Elden Pueblo, Arizona	USA	1070 - 1250 AD	Hevly et al. 1979, Reinhard et al. 1987
Antelope House, Arizona	USA	1075 - 1250 AD	Fry & Hall 1975, Reinhard et al. 1987
Salmon Ruin, New Mexico	USA	1200 - 1275 AD	Reinhard et al. 1987
Inscription House, Arizona	USA	1250 - 1300 AD	Fry & Hall 1973
Göttingen	Germany	Medieval Age	Herrmann 1985
Greenland	Denmark	1475 AD ± 50	Hansen 1986
Pie de Palo	Argentina	pre-Columbian	Zimmerman & Morilla 1983

TABLE VI

Other Nematode finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Strongyloides stercoralis			
Asru mummy	Egypt	ca. 1000 BC	Tapp 1979
Clyde's Cavern, Utah [a]	USA	400 - 1200 AD	Hall 1972
Chaco Canyon, New Mexico [a]	USA	920 - 1130 AD	Reinhard & Clary 1986
Antelope House, Arizona [a]	USA	1175 - 1250 AD	Reinhard et al. 1987
Amsterdam [a]	Netherlands	1370 - 1425 AD	Jansen & Boersema 1972
Trichostrongylus spp.			
Dust Devil Cave, Utah [a]	USA	6800 - 4800 BC	Reinhard et al. 1985
Tulán, San Pedro de Atacama	Chile	1080 - 950 BC	New finding
Rio Zape, Durango [a]	Mexico	600 AD	Reinhard et al. 1989
Valle Encantado, Neuquén	Argentina	1000 - 500 BP	New finding
Antelope House, Arizona	USA	1175 - 1250 AD	Reinhard et al. 1987
Catarpe 2, San Pedro de Atacama [a]	Chile	1450 - 1525 AD	New finding
Itacambira, Minas Gerais	Brazil	18th century AD	Araujo et al. 1984

a: uncertain diagnosis

mediate hosts, a terrestrial snail and an ant. Although cases of true parasitism occur in humans, many reported cases of human infection are actually false parasitism, as eggs can be found in feces resulting from a recent liver repast (Taylor 1955, Roberts & Janovy Jr 2000). It is virtually impossible to distinguish true and false human parasitism when the only ancient host remains are feces.

Clonorchis sinensis is found in southeastern Asia. It is a parasite of human and some other mammals. The adult fluke also lives in the host bile duct. The eggs are passed in the feces and the parasite completes its life cycle in two intermediate hosts, a snail and some species of fish and crustaceans. The definitive host is infected by eating raw or undercooked fish (Roberts & Janovy Jr 2000). Ancient infection by *C. sinensis* has only been found in mummified corpses from China (Table IX).

Two species of *Taenia* are frequent human intestinal parasites. *T. saginata*, the most frequent, is found in al-

most all countries where beef is eaten. *T. solium* is endemic in Latin America, Africa and some Asian countries. Intermediate hosts of *T. saginata* and *T. solium* are cattle and pigs, respectively. In *T. solium* infection, human can be both intermediate and definite host. Infection occurs when one eats infected beef or pork. Eggs are passed in the human feces (Roberts & Janovy Jr 2000, Rey 2001). In paleoparasitologic analysis, most often the only egg structure found is the oncosphere. In this case it is not possible to distinguish between the two different species of *Taenia* that infect humans. As expected, *Taenia* spp. have not been found in the New World in pre-Columbian time (Table X). Pork and beef were not available.

D. latum and *D. pacificum* are parasites of fish-eating mammals. The former is mostly found in Europe and North America whereas *D. pacificum* is found mostly in the pacific coast of South America. *Diphyllobothrium* spp. have two intermediate hosts, copepods and fishes. Living in

TABLE VII

Fasciola spp. finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Clairvaux, Jura	France	3600 BC	Dommelier-Espejo 2001
Swifterbant [a]	Netherlands	5400 ± 40 - 5230 ± 40 BP	Roever-Bonnet et al. 1979
Arbon, Thurgau	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Chalain, Jura [b]	France	32nd - 25th century BC	Bouchet et al. 1995, Dommelier et al. 1998
Saale-Unstrut Valley [b]	Germany	2500 BC	Dittmar & Teegen 2000
Lovelock Cave, Nevada [c]	USA	500 BC - 1150 AD	Dunn & Watkins 1970
Bremerhaven [b]	Germany	100 BC - 500 AD	Jansen Jr & Over 1962
Hallein, Salzburg [b]	Austria	2000 years	Aspöck et al. 1974
Ribe [b]	Denmark	750 - 800 AD	Nansen & Jørgensen 1977
Odra river [b, d]	Poland	10th - 13th century AD	Grzywinski 1960
Paris [b]	France	14th - 15th century AD	Bouchet 1993, 1995
Lübeck	Germany	15th century AD	Herrmann 1985, Herrmann & Schulz 1986
Braunschweig	Germany	Medieval Age	Herrmann 1985
Hameln	Germany	Medieval Age	Herrmann 1985
Freiburg	Germany	Medieval Age	Herrmann 1985
Marly-le -Roy, Yveline [a]	France	17th - 18th century AD	Bouchet et al. 1998

a: human origin?; *b*: *Fasciola hepatica*; *c*: uncertain diagnosis; *d*: non-human origin?

TABLE VIII

Schistosoma spp. finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Mummies [a]	Egypt	3200 BC and 1198 - 1150 BC	Deelder et al. 1990
Mummy, Tumb of Parannefer [a]	Egypt	1450 BC	Horne & Redford 1995
20th dynasty mummies [a]	Egypt	1250 - 1000 BC	Ruffer 1910
Nakht - ROM I mummy [a]	Egypt	3200 BP	Reyman et al. 1977
Han Dynasty mummy, Hubei province [b]	China	167 BC	Liangbiao & Tao 1981, Cheng 1984
Han Dynasty mummy, Hunam province [b]	China	2100 BP	Wei 1973
Mummies [a]	Sudan	350 - 550 AD	Miller et al. 1992
Montbéliard [a]	France	15th century AD	Bouchet & Paicheler 1995
Montbéliard [c]	France	15th - 16th century AD	Bouchet et al. 2002

a: *Schistosoma haematobium*; *b*: *S. japonicum*; *c*: *S. mansoni*

the host intestine, eggs are passed in feces (Roberts & Janovy Jr 2000, Rey 2001). Human infections with *D. pacificum* and *D. latum* result from the ingestion of raw or undercooked marine and fresh water fishes respectively. Table XI shows that eggs found in archaeological material reflects the modern distribution of *Diphyllobothrium* spp. It is related to the habits of fish consumption by humans.

Although rare, seven species of the phylum Acanthocephala have been reported parasiting human hosts. This phylum accomplishes parasites of fishes, birds, amphibians, mammals, and reptiles. At least two hosts are necessary to complete their life cycle. Depending on the species involved, the first host is an insect, crustacean or myriapod. The definite host passes eggs in the feces (Roberts & Janovy Jr 2000). Ancient human infection have been detected only in the Americas, mainly in USA (Table XIII), probably reflecting insect-eating habits.

The intestinal Protozoa usually live inside the host in the intestinal lumen or inside the intestinal epithelial cells. The infective stage are cysts or oocysts. They are passed in the host feces. Humans most often are parasitized with *Entamoeba* spp. and *Giardia duodenalis* (Roberts & Janovy Jr 2000, Rey 2001). Cysts are not so resistant to decay as helminth eggs are. So, reliable findings of protozoa in coprolites and cesspit material are very rare (Table XIV). But some protozoa glycoprotein antigen, detectable by immunologic test, can still be found, even centu-

TABLE IX

Other Trematode finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Dicrocoelium spp.			
Arbon, Thurgau	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Chalain, Jura	France	3040 - 3000 BC	Dommelier-Espejo 2001
Hallein, Salzburg	Austria	2000 years	Aspöck et al. 1974
Winchester [a]	England	Roman Age	Pike 1968
Winchester [b]	England	11th century AD	Pike & Biddle 1966, Pike 1967a
Winchester [b, c]	England	1100 AD	Taylor 1955
Paris [b]	France	14th - 15th century AD	Bouchet 1993, 1995
Newfoudland [a, b]	Canada	17th century AD	Horne & Tuck 1996
Opisthorchiformes			
Swifterbant [a]	Netherlands	5400 ± 40 - 5230 ± 40 BP	Roever-Bonnet et al. 1979
Arbon, Thurgau	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Chu Dynasty mummy, Hubei province [d]	China	2300 years	Yang et al. 1984
Han Dynasty mummy, Hubei province [d]	China	167 BC	Liangbiao & Tao 1981, Cheng 1984
Glenn Canyon, Utah [c?]	USA	1250 AD	Moore et al. 1974
Paragonimus sp.			
Atacama desert	Chile	2500 BC	Hall 1976

a: unknown origin; b: *Dicrocoelium dendriticum*; c: false parasitism; d: *Clonorchis sinensis*

TABLE X

Taenia spp. finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Nakht - ROM I mummy	Egypt	3200 BP	Reyman et al. 1977
Chalain, Jura	France	32nd - 25th century BC	Dommelier et al. 1998, Dommelier-Espejo 2001
Jerusalem	Middle East	7th - 6th century BC	Cahill et al. 1991
Han Dynasty mummy, Hubei province [a]	China	167 BC	Liangbiao & Tao 1981, Cheng 1984
Bremerhaven	Germany	100 BC - 500 AD	Jansen Jr & Over 1962
Hallein, Salzburg	Austria	2000 years	Aspöck et al. 1974
Ribe	Denmark	750 - 800 AD	Nansen & Jørgensen 1977
Amsterdam	Netherlands	1370 - 1425 AD	Jansen & Boersema 1972
Göttingen	Germany	Medieval Age	Herrmann 1985
Newfoundland	Canada	17th century AD	Horne & Tuck 1996
Marly-le-Roy, Yveline	France	17th - 18th century AD	Bouchet et al. 1998

a: *Taenia solium*

ries after these parasites have been passed in feces. Gonçalves et al. (2002) detected *G. duodenalis* antigen by monoclonal antibody immunosorbent assay in samples dated to about 1200 AD, 1600 AD and 1700 AD, in coprolites and latrine soil from USA and Europe. Only one sample was positive to directed microscopic examination.

Paleoparasitological analysis of human mummies, human coprolites and cesspit material have been demonstrating the diversity and antiquity of human parasitism. In Africa, the following parasites have been detected in ancient human feces: *S. stercoralis, S. haematobium, Taenia* spp., *Echinococcus granulosus, Trichinella spiralis, Dracunculus medinensis*, filarial worm, and possibly *A. lumbricoides* and *T. trichiura*. In Europe, ancylostomids, *A. lumbricoides, T. trichiura, E. vermicularis, Fasciola* spp., *F. hepatica, S. mansoni, S. haematobium, Dicrocoelium* spp., *D. dendriticum*, Opisthorchiformes, *Taenia*

spp., *Diphyllobothrium* spp., *D. latum, G. duodenalis, E. granulosus, T. spiralis*, and possibly *S. stercoralis* have been found. In Asia, *A. lumbricoides, T. trichiura, E. vermicularis, S. japonicum, C. sinensis, Taenia* spp., *T. solium, Diphyllobothrium* spp., *D. latum, E. histolytica, G. duodenalis, Chilomastix mesnili*, and *E. granulosus* have been found. In Oceania, *A. lumbricoides* has been found. In South America, ancylostomids, *A. lumbricoides, T. trichiura, E. vermicularis, Trichostrongylus* spp., *Paragonimus* spp., *Diphyllobothrium* spp., *D. pacificum, Hymenolepis nana*, Acanthocephala, *Entamoeba* spp., *G. duodenalis, Cryptosporidium parvum, Cyclospora cayetanensis, Isospora belli, Sarcocystis hominis*, and possibly *E. coli* have been found. In North America, ancylostomids, *A. lumbricoides, T. trichiura, E. vermicularis, Trichostrongylus* spp., Opisthorchiformes, *Taenia* spp., *D. latum, D. pacificum, Hymenolepis* spp., Acan-

TABLE XI

Diphyllobothrium spp. finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Coast [a]	Peru	10,000 - 4000 BP	Reinhard & Barnum 1991
Tiliviche, Iquique [a]	Chile	4110 - 1950 BC	Ferreira et al. 1984
Clairvaux, Jura	France	5600 BP	Dommelier-Espejo 2001
Arbon, Thurgau	Swiss	3384 - 3370 BC	Dommelier-Espejo 2001
Chalain, Jura [b]	France	32nd - 25th century BC	Bouchet et al. 1995, Dommelier et al. 1998
Huaca Prieta	Peru	3000 BC	Callen & Camaron 1960
Huarmey Valley [a]	Peru	2700 - 2850 BC	Patrucco et al. 1983
Northern [a]	Chile	4000 BP	Reinhard & Aufderheide 1990
Saginow valey, Michigan [b, c]	USA	300 BC - 200 AD	McClary 1972
Bremerhaven [b]	Germany	100 BC - 500 AD	Jansen Jr & Over 1962
Karwinden Man [b]	Prussia	1500 BP	Szidat 1944
Adak Island, Alaska [a]	USA	840 BP ± 40	Bouchet et al. 2001
Acre [b]	Israel	13th century AD	Mitchell & Stern 2000
Oslo [b]	Norway	15th century AD	Schia 1979
Lübeck	Germany	15th century AD	Herrmann 1985, Herrmann & Schulz 1986
Schleswig	Germany	Medieval Age	Herrmann 1985
Hameln	Germany	Medieval Age	Herrmann 1985
Freiburg	Germany	Medieval Age	Herrmann 1985
Regensburg	Germany	Medieval Age	Herrmann 1985
Buildir Island, Alaska	USA	1400 - 1700 AD	Bouchet et al. 1999
Montbeliard [b]	France	15th - 16th century	New finding
Namur [b]	Belgium	18th century AD	New finding

a: *Diphyllobothrium pacificum*; b: *D. latum*; c: uncertain origin

TABLE XII

Other Cestode finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Hogup Cave, Utah	USA	5330 - 1250 BC	Fry 1977
Santa Elina, Mato Grosso [a]	Brazil	4000 - 2000 BP	New finding
Danger Cave, Utah	USA	20 AD	Fry 1977
Elden Pueblo, Arizona [b]	USA	1070 - 1250 AD	Reinhard et al. 1987
Antelope House, Arizona [c]	USA	1175 - 1250 AD	Reinhard et al. 1987
Glen Canyon, Utah	USA	1250 - 1300 AD	Fry 1977
Newport, Rhode Island	USA	18th century AD	Reinhard et al. 1986

a: *Hymenolepis nana;* b: *Hymenolepis* sp. + taeniid cestode; c: *Hymenolepis* sp.

thocephala, *G. duodenalis*, *E. granulosus*, *T. spiralis*, and possibly *S. stercoralis*, *Fasciola* spp. and *D. dendriticum* have been found (Tables II-XV).

Ancylostomids, *A. lumbricoides*, *T. trichiura* and *E. vermicularis* have been found in the Americas much earlier than colonial times (Tables II-V). It can be inferred that humans have been infected by some parasites before the peopling of the New World, as already mentioned by Darling (1920) and Soper (1927) regarding ancylostomid in-

fection. For the above-mentioned helminths, except probably for *E. vermicularis*, their main gate to the Americas was not a land route through Beringia (Araújo et al. 1988, Araújo & Ferreira 1995, 1997, Reinhard 1992). To some helminths, such as ancylostomids and *T. trichiura*, soil temperature is crucial to evolve to an infective stage. Therefore, transmission was discontinued when infected prehistoric migrants moved through the cold northern territories, from Siberia to the Americas.

TABLE XIII

Acanthocephala finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Danger Cave, Utah	USA	9500 BC, 8000 BC, 2000 BC and 20 AD	Fry & Hall 1969
Hogup Cave, Utah	USA	8000 BC - 2000 BC	Fry & Hall 1969, Fry 1970
Dirty Shame Rockshelter, Oregon	USA	4850 BC	Hall 1976
Boqueirão Soberbo, Minas Gerais	Brazil	4905 ± 85 - 1325 ± 60 BP	New finding
Danger Cave, Utah	USA	1869 ± 60 BC and 20 ± 240 AD	Moore et al. 1969
Gentio Cave, Minas Gerais [a]	Brazil	3490 ± 120 - 430 ± 70 BP	New finding
Clyde's Cavern, Utah	USA	2300 years and 400 - 1200 AD	Hall 1972
Black Mesa, Arizona	USA	900 - 1100 AD	Gummerman et al. 1972
Glen Canyon, Utah	USA	900 - 1300 AD	Fry 1977, Fry & Hall 1969

a: human origin?

TABLE XIV

Protozoa finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Entamoeba spp.			
Nahal-Mishmar [a]	Israel	160 AD	Witenberg 1961
Huari	Peru	Pre-Columbian	Fouant et al. 1982
Alto Ramírez	Chile	Pre-Columbian	Fouant et al. 1982
Atacamenha	Chile	Pre-Columbian	Fouant et al. 1982
Cabuza	Chile	Pre-Columbian	Fouant et al. 1982
Tihuanaco	Chile	Pre-Columbian	Fouant et al. 1982
El Plomo, Santiago [b]	Chile	Pre-Columbian	Pizzi & Schenone 1954
Inca mummy	?	ca. 1500 AD	Pike 1967b
Giardia duodenalis			
Andes	?	3000 - 500 BP	Allison et al. 1999
Big Bone Cave, Tennessee	USA	2177 BP $\pm$ 145	Faulkner et al. 1989
Nahal-Mishmar	Israel	160 AD	Witenberg 1961
Antelope House, Arizona	USA	1200 AD	Gonçalves et al. 2002
Lübeck	Germany	1600 AD	Gonçalves et al. 2002
Namur	Belgium	18th century AD	Gonçalves et al. 2002
Chilomastix mesnili			
Nahal-Mishmar	Israel	160 AD	Witenberg 1961
Cryptosporidium parvum			
Andes	?	3000 - 500 BP	Allison et al. 1999
Cyclospora cayetanenis			
Andes	?	3000 - 500 BP	Allison et al. 1999
Isospora belli			
Andes	?	3000 - 500 BP	Allison et al. 1999
Sarcocystis hominis			
Andes	?	3000 - 500 BP	Allison et al. 1999

a: *Entamoeba histolytica*; *b*: *E. coli*?

TABLE XV

Non-intestinal human helminth finds, locality, country and date from ancient remains

Archaeological site/mummy	Country	Date	References
Echinococcus granulosus			
Mummies	Egypt	?	Tapp 1984
Mt. Scopus, Jerusalem	Middle East	538 BC - 70 AD	Arieli 1998
Shultz site, Michigan *a*	USA	300 BC - 200 AD	McClary 1972
Jerusalem	Middle East	1st century AD	Zias & Mumcuoglu 1991
Cambridgeshire	England	1st - 2nd century AD	Wells & Dallas 1976
South Dakota	USA	600 AD	Williams 1985
?	Swiss	Medieval Age	Baud & Kramar 1991
Winchester	England	Medieval Age	Prince 1975
Naestved	Denmark	1450 AD	Weiss & Moller-Christensen 1971
Kodiak Island, Alaska	USA	before 1740 AD	Ortner & Putschar 1981
Orkley	Scotland	?	Brothwell l978
Trichinella spiralis			
Nakht - ROM I mummy	Egypt	3200 BP	De Boni et al. 1977
Utqiagvik, Alaska	USA	440 ± 70 BP	Zimmerman & Aufderheide 1984
Toledo	Spain	19th century AD	Bellard & Cortés 1990
Dracunculus medinensis			
Tumb of Parannefer, Valley of the Nobles	Egypt	1450 BC	Horne & Redford 1995
Manchester mummy # 1770	Egypt	Greek or Roman period	Tapp 1979
Filarial worm			
Natsef Amun - Leeds mummy, Karnak	Egypt	1100 BC	Tapp & Wildsmith 1992

a: uncertain origin

TABLE XVI

Paleoparasitological finds from human remains, in the New and Old World, pre and post-Columbian

Human paleoparasitological finds	New World		Old World	
	Pre-Columbian parasite finds	Post-Columbian parasite finds	Pre-Columbian parasite finds	Post-Columbian parasite finds
Ancylostomids	Y	Y	Y	Y
Ascaris lumbricoides	Y	Y	Y	Y
Trichuris trichiura	Y	Y	Y	Y
Enterobius vermicularis	Y	NF	Y	NF
Strongyloides stercoralis	?	NF	Y	NF
Trichostrongylus spp.	Y	Y	NF	NF
Fasciola spp.	?	NF	Y	?
Schistosoma spp.	NF	NF	Y	Y
Dicrocoelium spp.	NF	?	Y	NF
Opisthorchiformes	Y	NF	Y	NF
Paragonimus spp.	Y	NF	NF	NF
Taenia spp.	NF	Y	Y	Y
Diphyllobothrium spp.	Y	Y	Y	Y
Hymenolepis spp.	Y	NF	NF	NF
Acanthocephala	Y	NF	NF	NF
Entamoeba spp.	Y	NF	Y	NF
Giardia duodenalis	Y	NF	Y	Y
Chilomastix mesnili	NF	NF	Y	NF
Cryptosporidium parvum	Y	NF	NF	NF
Cyclospora cayetanenis	Y	NF	NF	NF
Isospora belli	Y	NF	NF	NF
Sarcocystis hominis	Y	NF	NF	NF
Echinoccus granulosus	Y	Y	Y	?
Trichinella spiralis	NF	Y	Y	Y
Dracunculus medinensis	NF	NF	Y	NF
Filarial worm	NF	NF	Y	NF

Y: yes; NF: not found

The new findings presented here confirm ancylostomid and *T. trichiura* infection before Columbus's arrival. Dixon (2001), based on geological and archaeological data, hypothesizes that the first settlers used a sea-route along the southern coast of the Bering Land Bridge. Humans had vessels and were able to navigate near-shore waters prior to 14,000 BP (Dixon 2001). Whether by transoceanic route or coastal navigation, prehistoric settlers brought such soil-transmitted helminths to the New World, in a journey no longer than the life-span of these helminths.

As more sensitive techniques become available, as detection of parasite DNA by polymerase chain reaction and immunological antigen detection by monoclonal antibody assays, more parasitic infections will be detected. New paleoparasitological findings are been reported throughout the world, updating continuously the knowledge of parasite distribution in the past. A more complete and accurate parasitic infection understanding in antiquity will improve our knowledge about biological and social aspects of health and disease process during the evolution of human species. Coprolites, in Patrick Horne's words, one of the "least-attractive of man's relics", are helping scientist to disclose some still unclear aspects of parasitism and human dispersion in ancient times (Horne 1985).

We apologize for any data omission in the review. We would appreciate any aditional paleoparasitological finding sent by colleagues.

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