A Review of the Evidence of Human Endoparasitism in the pre-Columbian New World Through the Study of Coprolites

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A review of helminth eggs encountered in precontact, human coprolites and palaeofaecal material from mummified human remains of the New World is presented. Included is a brief description of parasites and their effects on the host from the three phyla represented, Nematoda (roundworms), Platyhelminthes (flatworms) and Acanthocephala (thorny-headed worms).

Keywords: COPROLITE, HELMINTH, PALAEOPATHOLOGY, HUMAN ENDOPARASITISM, NEW WORLD, PRE-COLUMBIAN, PALAEOPARASITOLOGY, ACANTHOCEPHALA, NEMATODA, PLATYHELMINTHES

Introduction

In 1829 the English geologist William Buckland coined the term coprolite to describe the fossilized faeces of an extinct group of lizards (Buckland, 1829). From the time of Buckland a large body of literature has accumulated describing coprolites from extinct animals of great geologic age (see Hantzschell et al., 1968). However, archaeologists have been slow to realize the potential of human coprolites from archaeological sites. Harshberger (1896) may have been the first to appreciate the value of human coprolites by suggesting that undigested seeds and bone found in the faeces of prehistoric man might reveal clues as to their diet. Young (1910) is credited with the first report of isolated human coprolites in an archaeological context. Between 1910 and 1960 only a handful of papers were published on coprolites from an archaeological viewpoint. In each case the coprolites were examined in a dry state and poorly or incompletely reported upon, and then only from the viewpoint of dietary remains. The breakthrough came with the work of Callen & Cameron (1955, 1960) who developed a rehydration technique adapted from the work of van Cleave & Ross (1947) where portions of coprolites are soaked in a 0.5% aqueous trisodium phosphate solution for at least 72 h. Callen & Cameron's (1960) paper was a landmark not only because of the technique they introduced but also because it contained the first reference to helminth eggs from isolated human coprolites which they tentatively identified as that of the tapeworm Diphyllobothrium. It should be noted that helminth eggs had previously been isolated from mummified human remains (Ruffer, 1910; Szidat, 1944; Pizzi & Schenone, 1954; Helbaek, 1958) and an ancient latrine pit (Taylor, 1955).

Since those pioneering reports, the number of studies concerning coprolite analysis have rapidly increased while the benefits to both the archaeologist and anthropologist...
have begun to be appreciated (see Bryant, 1974; Wilke & Hall, 1975). Unfortunately, reports concerning the finds of parasite eggs are often appended to archaeological site reports or otherwise widely dispersed in the literature, making it difficult for those interested in disease in ancient man to obtain an overview of the knowledge of endoparasitism in the pre-Columbian New World. This report attempts to pull that information together.

The term helminth is a general one referring simply to a worm, but three groups or phyla which contain disease-causing parasites of vertebrates, including man, are: Nematoda (non-segmented roundworms), Platyhelminthes (flatworms) and Acanthocephala (thorny-headed worms). These ubiquitous, endoparasitic helminths are of great importance because of their common occurrence in man and because, more often than not, their highly resistant eggs are passed out in the faeces in great numbers and, as they are for the most part morphologically distinct, the species of helminth can be identified even after thousands of years.

The Roundworms

Of the roundworms (phylum Nematoda), Enterobius vermicularis holds the distinction of being the oldest-described parasite found in human coprolites. Commonly known as the pinworm because of their sharply pointed posterior ends, these are small nematodes measuring up to 13 mm in length. Pinworms are exclusively human parasites which are found world-wide today with special preference for temperate zones and are perhaps the most common intestinal parasite of man. The adult pinworms live in the intestine where they feed on epithelial cells and bacteria. Fortunately, although a common parasite, they rarely cause damage to man except for a rather severe and stressful perianal itching. Unlike other helminths infecting man, the female leaves the anus after mating to deposit her eggs on the perianal skinfolds. Perhaps the most common mode of infection or reinfection, especially in children, is the direct anus-to-mouth route through contaminated fingers. However, the eggs are very light, resistant to drying and easily become airborne where they can readily become inhaled and swallowed, thus infecting a whole family.

Fry & Hall (1969) and Fry & Moore (1969) described eggs of E. vermicularis in coprolites from Hogup and Danger Caves, western Utah. Danger Cave was inhabited from about 10,000 BC to AD 20 while Hogup Cave was inhabited from about 6400 BC to AD 1400. Pinworm eggs were found in Hogup Cave coprolites dated by $^{14}$C to 650 BC $\pm$ 100 and in two coprolites dated to 1250 BC $\pm$ 140 and in one other dated to 4010 BC $\pm$ 100. In Danger Cave similar eggs were found in one coprolite dated to 7837 BC $\pm$ 630.

Fry & Hall (1975) analysed 46 coprolites from Antelope House, a Pueblo site in Canyon de Chelly, Arizona. Seven specimens including those of Pueblo II (AD 1075–1100) and Pueblo III (AD 1100–1140) periods contained eggs of E. vermicularis.

Fry & Hall (1973) reported pinworm eggs at Inscription House, Nitsin Canyon, Arizona dated to the Anasazi Tsegi Phase at AD 1250–1300. Also from Arizona, El-Najjar et al. (1980) found eggs of pinworm in the intestinal content of an adult male mummy excavated at Canyon del Muerto and dated to AD 600 $\pm$ 95 by $^{14}$C. This would place the body in the Basketmaker group who preceded the Pueblo occupants in the area. Hevly et al. (1979) reported pinworms in coprolites from Elden Pueblo, northeastern Arizona dated to c. AD 1100.

Other reports of pinworm eggs in the Southwest included Samuels (1965) in two samples of 1000 year old coprolites from the Mesa Verde site, Colorado. Hall (1976, 1977) reported pinworm eggs from the Dirty Shame Rockshelter, southeast Oregon dating to about 4000 BC. Hall (1972) also reported four coprolites positive for the same parasite in samples dated from about AD 460–1500 at Clyde’s Cavern, Utah.
It would appear that populations of the prehistoric American Southwest were frequently plagued with pinworms from very ancient times. It should be remembered that the adult female exits the anus to deposit her eggs so that these are not often found in faeces except where high numbers of adult worms are concerned and under unhygienic conditions. (Today where pinworm is suspected scotch tape is applied to the perianal area and examined microscopically for adhering eggs). In recent studies where infection rates reach 50–100% direct faecal examination results in only about 5% positive samples (Burrows, 1965). Thus, if pinworm eggs are found in only a few faecal samples from a population, one can infer a relatively high infection rate in the population as a whole.

Until recently no evidence existed for the presence of *Enterobius* in precontact S America. However, Patrucco et al. (1983) have published a report of 52 human coprolites from the site of Los Gavilanes situated on the coast of Peru some 300 km north of Lima. Three occupation levels were discovered. Levels two and three date by 14C to 2780 ± 190 BC and 2277 ± 181 BC, respectively. The oldest level was not dated due to the lack of sufficient organic materials. In one coprolite from the third period of occupation well-preserved eggs of pinworm were found. Ferreira et al. (1986) report pinworm eggs in one of 10 human coprolites (400 BC to AD 800) from the site of Caserones, Tarapacá Valley, northern Chile. Zimmerman (1983) reports what appears to be a pinworm egg from the abdominal cavity of a pre-Columbian mummy from Argentina.

These finds are not unexpected. With the high prevalence of pinworm in the prehistoric Southwest of N America it would have been unusual indeed if pinworm had not accompanied man in his migrations to S America, especially when one considers the direct, simple life cycle of this organism. It is probable that the paucity of reports regarding this organism in S America reflects a lack of coprolite analysis on that continent rather than an actual lack of infection by the organism in question.

It is interesting to note that evidence of pinworm is absent from coprolite studies in prehistoric Europe (Jones, 1982). Jones credits this lack of evidence to the egg-laying habits of this species. However, it may be that these eggs are not resistant to the wet environments in which most eggs on that continent are found. Pinworm eggs have been found, however, in an exquisitely preserved corpse of the Han dynasty (206 BC to AD 220) from China (Wei, 1973; Hall, 1974).

*Trichuris trichiura*, commonly known as the whipworm because of its thin anterior body, like the pinworm, is not a serious pathogen of man. However, overwhelming infections can lead (rarely) to a rectal prolapse and even death has been reported in such cases in children (Schmidt & Roberts, 1981). In heavy infections diarrhoea with mucus is common. Although many individuals with heavy *Trichuris* infection are malnourished and anaemic there appears to be no direct causal relationship (Katz et al., 1982).

The whipworm lives in the colon of man and fertilized eggs are passed in the faeces. The eggs must remain on the ground in favourable conditions of humidity, preferably on sandy, loamy soil with a temperature of 20–30°C so embryonation can occur in 18–25 days. No intermediate host is found in the life cycle but infection occurs when embryonated eggs contaminate food or drink.

Pizzi & Schenone (1954) were the first to describe *Trichuris* from ancient man of the New World. Eggs of whipworm were found in a faecal remnant in the dilated anus of an 8–9 year old Inca mummy found frozen at the 5400 m (17,712 ft) level in the Andes on Cerro el Plomo peak, central Chile. They believed no reports of this worm were extant in antiquity of the Old World and suggest a New World origin for this nematode. They were apparently unaware that Szidat (1944) had found whipworm eggs in the bog mummies of the Drobintz Girl (600 BC) and Karwinden Man (AD 500) excavated from bogs in E Prussia (Polish Lakeland). Although Pizzi and Schenone date the Chilean
mummy to about AD 1500, i.e. of precontact date, in a recent reexamination of the mummy no indication could be found to definitely assign the body to that period (Horne & Quevedo, 1984). Since the work of the above authors several reports of whipworm eggs in antiquity from the Old World have been published and these finds were recently reviewed by Jones (1982). There is no doubt that man was infected with *Trichuris* long before contact with the New World.

Ferreira *et al.* (1980) report the finding of whipworm eggs in coprolites from Brazil. The cave deposits from the northwest of the State of Minas Gerais, central Brazil, were carefully excavated and showed two living levels, the oldest dating to 6670 \pm 100 BC while the second dated from 1540 \pm 120 BC to AD 1530 \pm 70 by \(^{14}C\). Twenty-two coprolites dating from these time periods were examined and seven were found positive for helminth eggs, including *Trichuris trichiura*. Later excavations at the same cave and of the same period as the above coprolites, revealed the mummy of an 8–10 year old child (sex not indicated). An examination of the intestinal contents demonstrated eggs of whipworm, confirming the human origin of *Trichuris* in coprolites of the former study (Ferreria *et al*., 1983a). Another recent study by Patrucco *et al.*, (1983), on coprolites from the Peruvian coast dated c. AD 1000, revealed the presence of *T. trichiura* eggs in two of three coprolites from that level.

Despite the considerable number of coprolites which have been analysed in N America, especially the American Southwest, *Trichuris* eggs have only been reported once. Hevly *et al.* (1979) reported finding *Trichuris* eggs in soil samples from latrine areas of two rooms at Elden Pueblo, Arizona dated to c. AD 1100. No measurements of the eggs are given and since various species of *Trichuris* infect a wide variety of mammals care should be taken in assigning these eggs to a human host. With evidence for the pre-contact existence of human trichuriasis in S America, why the lack of evidence in N America? Perhaps the answer lies in the habitat requirements for this particular organism. One must remember that the majority of coprolite analysis has occurred in arid regions in the southwestern United States. Although necessary conditions (20–30°C) would appear to be ideal, three vital factors are missing—high rainfall and humidity, dense shade and moisture-retaining soil. It is suggested that the same arid conditions which preserved the coprolites in that area led to the demise of this organism, or in fact prohibited it from getting a hold in that region. It may be that *Trichuris* did flourish in other regions where such harsh, arid conditions did not exist or even in more hospitable areas of the Southwest, but in such areas the evidence may well have perished. In the Old World, *Trichuris* along with *Ascaris lumbricoides*, the next nematode to be discussed, are the most commonly encountered in ancient human faeces (Pike, 1967; Jones, 1982).

*Ascaris lumbricoides* is commonly known as the giant roundworm because it can attain a length of up to 30 cm. This parasite is found worldwide today with an estimated 650 million people infected (W.H.O., 1965–8). Embryonated eggs, ingested as a contaminant of food or drink, hatch in the small intestine where the larvae penetrate through the gut wall and pass via the circulation through the liver, heart and finally the lungs. Here the larvae break through the lung tissue and actively pass up to the trachea and are swallowed, while adulthood is attained in the small intestine. Each female produces approximately 200,000 eggs per day which are passed out in the faeces (Katz *et al*., 1982). The eggs of *Ascaris* are extremely resistant to cold and arid conditions and are known to have remained viable in the soil for up to 6 years (Mueller, 1953). Heavy infection with this parasite can lead to perforation of the gut or fatal blockage. Juveniles in the lung can lead to congestion and, in some cases, fatal pneumonia (Schmidt & Roberts, 1981).

Fry (1974) reported finding helminth eggs in palaeoecal specimens from Upper Salts Cave, Kentucky which he tentatively identified as those of *Ascaris* sp., probably *Ascaris*
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**H. lumbricoides.** Hall (1978) tentatively identified the same eggs in a Middle Pueblo III site at Antelope House, northeastern Arizona dated to about AD 1150. Hall, after careful study and consultation retracted the identification (Cockburn, 1979; Jansen, 1979). Hevly et al., (1979) report eggs of what they believed to be *Ascaris lumbricoides* from pit floor sediment of Elden Pueblo at AD 1100. More recently, Patrucco et al. (1983) also reported the finding of *Ascaris* eggs from the site of Los Gavilanes on the Peruvian coast in coprolites dated to 2277 ± 181 BC. It is felt that these identifications of *Ascaris* in the precontact New World should be accepted with caution. It has often been suggested that *A. lumbricoides* was originally a parasite of pigs which adapted to humans when pigs were domesticated and lived in close association with humans. In the Old World several reports of *Ascaris* come from various ancient sites but date to the post-domestication period (Pike & Biddle, 1966; Pike, 1967; Jones, 1982; Gooch, 1983). It is also well known that pigs were not included in the meagre array of animal domesticates of the precontact New World.

Allison et al. (1974) reported an interesting case from southern Peru. Hookworms (*Ancylostoma duodenale*) were found attached to the intestinal wall of a mummy of the Tiahuanaco period dating to AD 890–950. No eggs were found. Ferreira et al. (1980) reported eggs of the family Ancylostomidae corresponding in size to the hookworm *Necator americanus* in human coprolites from Brazil with a minimum age of 360 years by ^14C, i.e. of precontact date. They also suggested that nematode larvae found in the coprolites correspond to the same species. [For a discussion of this report see Klits (1982) and Ferreira et al. (1983b).] Duseau & Porter (1974) describe larvae of a nematode of uncertain date from Upper Salts Cave, Kentucky which could not be identified with certainty. Hookworm or a member of the genus *Strongyloides* (threadworm) were suggested as possible candidates. Hall (1972) mentions larval nematodes which could not be identified with certainty in coprolites (AD 400–1200) from Clyde’s Cavern, Utah. However, with the abundance of free-living saprophytic nematodes in the soil, larval forms must be identified with great care.

Humans are definitive hosts to only two species of the Family Ancylostomidae (hookworms)—*N. americanus* first discovered in Brazil, then Texas, but later found indigenous in the region from Africa south of the Sahara to southern Asia (Manter, 1967) and *A. duodenale* common in southern Europe, northern Africa, India, China and southeastern Asia as well as scattered locales of the United States, Caribbean Islands and S America (Manter, 1967; Schmidt & Roberts, 1981). Both hookworms have an identical life cycle somewhat like that of *Ascaris*, except the larvae hatch in moist, warm soil and must penetrate the skin so as to enter the circulation before passing to the lungs and eventually the small intestine. The worms cause grave damage to the intestinal wall, which leads to blood loss and resultant anaemia.

Hookworms, with *Necator* now prominent in the tropical and subtropical regions of the New World, have long been believed introduced by the slave trade (Manter, 1967; Schmidt & Roberts, 1981). However, in the 1920s both Darling (1920) and Soper (1927) believed that evidence of hookworms in isolated populations in S America might tell us something of early man’s migrations. It was suggested that *A. duodenale* would indicate a migration from northern Eurasia while *N. americanus* would suggest a southern Asian migration. Soper (1927) discovered that native Indians in a very remote area of Paraguay, where previous contact with white man was highly unlikely, to be infected by both types of hookworm in a ratio of *Ancylostoma:Necator* of 13:1. This led Soper to believe that *Ancylostoma* was endemic in the population before Spanish contact. However, both authors felt that these organisms could not have survived man’s migrations through temperate N America. Darling (1920: 221) suggested a transpacific contact from Asia or Indo-China as a result of “storm-tossed fishermen.”
Evidence for transpacific contact from Asia was absent until the work of Estrada & Meggers (1961) and Meggers & Evans (1966) who suggested that Japanese fishermen arrived on the coast of Ecuador by 3000 BC with a later incursion of southeastern Asian culture into the same area by about 200 BC. This led Manter (1967) to suggest that *Ancylostoma* was introduced earliest (3000 BC) while *Necator* was introduced later (200 BC). However, as with *Ascaris*, the evidence for the precontact existence of hookworm disease in the New World is indeed scarce.

The Flatworms
The flatworms (Phylum Platyhelminthes) includes the important Class of human and animal parasites the Trematoda or flukes. These vary greatly in size and shape as well as internal anatomy and can be divided into three groups based on their habitat: blood, tissue and gut lumen. Flukes have a functional intestinal tract for the digestion of host tissues while nourishment is also attained by active transport through the tegument (body wall). These organisms are normally found in tropical and subtropical zones and only rarely in temperate areas. The trematode life cycle is complex including at least two intermediate hosts the first of which, of those which cause disease in man, is a mollusc. Trematodes have caused inordinate misery through the ages by causing diseases both in man and his livestock. Direct evidence for infection of man dates to 20th Dynasty Egypt (1250–1000 BC) with the discovery of the blood fluke *Schistosoma haematobium* in the mummified remains of two individuals (Ruffer, 1910) and more recently in a young male individual of the same period (Hart et al., 1977).

Reports of trematode infection in the ancient New World are few in number. Hall (1976) reported *Paragonimus* (lung fluke) eggs, probably *P. caliensis* in human coprolites from the Atacama Desert of northern Chile dated to c. 5900 BC. Exoskeletal fragments of freshwater crayfish or shrimp were found in the same coprolites. (See also PaleoPathology Newsletter 1976 no. 15: 2 and 1978 no. 21: 4 for further discussion of this find).

*Paragonimus* measures 10–12 mm in length and 5–7 mm in width. The adults live encapsulated in the lung and pass eggs into these tissues which break out of the alveoli, are coughed up, swallowed and passed out in the faeces. The eggs must reach freshwater to embryonate. These hatch and produce free-swimming forms which seek out a specific snail while a second stage passes out of the snail to find a freshwater crab or crayfish where it undergoes further development. The infected crustacean is then eaten to infect man. The larvae develop in the intestine, penetrate the diaphragm and enter the lungs to begin the cycle again. Depending on the severity of the infection and amount of bacterial superinfection *Paragonimus* can cause serious illness.

Another trematode egg *Cryptocotyle lingua*, a parasite of fish, was found by Zimmerman & Smith (1975) in the intestinal content of a mummy from St Lawrence Island in the Bering Sea. The mummy was dated to AD 405 ± 70. As pointed out by the authors, eggs of this parasite have been found in modern Eskimos but the adult helminth has not been identified in that group. This then may well be a case of false parasitism where eggs of parasites of an animal consumed as food are found in the human digestive tract.

Finally, Moore *et al.* (1974) report finding a fluke egg in a single human coprolite from Glen Canyon, Utah dated to about AD 1250–1300. A specific identification could not be made. Of the trematodes infecting man the egg most closely resembled those of *Opisthorchis*, *Clonorchis* or *Heterophyes* species. The authors note that they have documented yet another potential medical hazard to prehistoric man. Dunn & Watkins (1970) report a similar case where a fluke egg that could not be positively identified,
although apparently one of the fasciolid (liver) flukes, was recovered in coprolites (c. 500 BC to AD 1150) from Lovelock Cave, Nevada.

The Phylum Platyhelminthes contains another important Class Cestoidea—the parasitic tapeworms. Of those infecting man all but *Hymenolepis* requires at least one intermediate host. The tapeworms are flattened dorsoventrally with segmented bodies. The scolex (head)—the only point of attachment to the gut wall—may be arrayed with a series of hooks, suckers or grooves. Nourishment is absorbed through the body wall. Certain of these organisms can exceed 10 m in length.

Evidence for the existence of tapeworm in the precontact New World comes from a report of Callen & Cameron (1960) who tentatively identified eggs of *Diphyllobothrium* in coprolites dated to c. 2500 BC from the Peruvian coastal site of Huaca Prieta. Recently, Ferreira et al. (1984) reported finding *Diphyllobothrium pacificum* eggs in four of 26 human coprolites from the coastal site of Tiliviche, northern Chile. The coprolites date from 4110 to 1950 BC and are considered of human origin, based on the presence of charcoal and quartz particles and toasted food remains. Fifty-three eggs were measured and correspond in both size and shape to *D. pacificum*. Another recent report of *D. pacificum* comes from the site of Los Gavilanes, coastal Peru in coprolites dated by 14C to 2700–2850 BC (Patrucco et al., 1983). The definitive host of *D. pacificum* is the sea lion, while intermediate hosts are various marine fish (Baer, 1969). Man becomes infected by eating contaminated, raw or insufficiently cooked fish. *Diphyllobothrium* infections are often asymptomatic or cause poorly defined symptoms such as nausea, diarrhoea and weakness. In a small percentage of those infected a serious anaemia develops due to the absorption of vitamin B₁₂ by the parasite (Schmidt & Roberts, 1981).

A report of infection with the closely related species *D. latum* comes from a sample of 20 coprolites of the Late Middle Woodlands period at the Schultz site, Michigan (McClary, 1972). Eggs of *D. latum* were found in one sample. *Diphyllobothrium latum*, unlike *D. pacificum*, has a completely freshwater cycle involving a copepod, minnow-sized fish and larger predatory fish. Infection with this tapeworm is widespread today, especially in circumpolar regions including the Great Lakes area (Katz et al., 1982). The significance of this find is limited since the author could not be certain that the coprolites were of human origin. The coprolites may be canine in origin and *D. latum* infects dogs as readily as humans.

Fry (1977) reported taeniid eggs (superfamily Taeniodea) in nine of 146 ancient human coprolites from Danger Cave (one), Hogup Cave (five) and Glen Canyon (three), Utah. McClary (1972) also reported a taeniid egg in a single coprolite from the Schultz site and suggested that the egg was of the dog tapeworm *Echinococcus granulosus*. Hevly et al. (1979) report taeniid eggs and eggs of a hymenolepid tapeworm, probably *Hymenolepis* sp. at Elden Pueblo.

The Thorny-Headed Worms

This group (Acanthocephala) poses little threat to man today and is rarely encountered by physicians. The life cycle of acanthocephalans involves intermediate and transport hosts such as insects, centipedes, toads, lizards and small rodents. Although man today rarely eats such animals, this may not have been the case among the prehistoric hunter-gatherer (see Fry, 1977). However, five different species have caused disease in man in recent times, as reviewed by Schmidt (1971). The body of these organisms consists simply of an anterior proboscis, a neck and trunk. The proboscis may be spherical or cylindrical and has embedded in it a series of recurved hooks for attachment to the gut wall which can cause severe damage including perforation and death from peritonitis (Schmidt & Roberts, 1981).
Moore et al. (1969) reported eggs of Acanthocephala in four coprolites from Danger Cave, Utah dating from 1869 BC ± 160 to AD 20 ± 240. Species differentiation is not possible among the acanthocephalans by studying the eggs due to their similarity. It is suggested, however, that the eggs in question are those of *Moniliformis clarki* which is relatively common in the vicinity of Danger Cave today. Hall (1972) reported eggs tentatively identified as those of Acanthocephala in two coprolites from the San Rafael Fremont occupation (AD 400–1200) from Clyde's Cavern, Utah. Similar eggs have also been reported in large numbers in five coprolites from Dirty Shame Rockshelter, Oregon dating from 4850 BC to AD 1550 (Hall, 1977). Fry & Hall (1969) and Fry (1970), in a study of a large series of coprolites, report the finding of Acanthocephala eggs in coprolites from Danger and Hogup Caves and various sites in the Glen Canyon.

**Summary and Conclusions**

A review of the evidence of human endoparasitism in the precontact New World shows that early man of that region was infected with representatives of all three phyla of helminths which cause disease in man. Of the nematodes, pinworm (*E. vermicularis*) has been reported from Arizona, Colorado, Utah, Chile, Peru and Argentina. The whipworm (*T. trichiura*) has been reported from Brazil, Chile and Peru with a single report from Arizona. Of the two hookworms which infect man *A. duodenale* has been reported once from Peru and *N. americanus* once from Brazil. *Ascaris lumbricoides* has been tentatively identified at one site in Kentucky and once each in Arizona and Peru. Fluke eggs which could not be specifically identified were reported from Nevada and Utah with a single case each of *P. westermani* (Chile) and *C. lingua* (Alaska). Tapeworms of the genus *Diphyllobothrium* have been reported from Chile and Peru with a possible find in Michigan. Various reports of taeniid eggs came from Utah, Michigan and Arizona. Eggs of the thorny-headed worm have been reported from four sites in Utah and one in Oregon.

Of the numerous problems which plague the coprolite analyst (Heizer, 1967; Fry, 1968; Watson, 1974; Wilke & Hall, 1975), a major one for those interested in the palaeoepidemiology of endoparasitism is the fact that, for the most part, coprolites are restricted to arid regions such as the American Southwest and the Atacama Desert of Peru and Chile. Hence, of the helminths with an indirect life cycle only those adapted to the same arid conditions which preserved the coprolites will be found and this tells us little of the parasites of man from more temperate regions. On a more local scale, coprolites are often found in dry caves which may represent only seasonal occupations (Heizer & Napton, 1969: 565; Fry, 1970) or migrants from larger populations (Callen, 1967) so that the true picture of parasitism in the population as a whole may be difficult to appreciate. One should also consider if host populations are sufficiently large to maintain the infection (Manter, 1967; St. Hoyme, 1969).

The question of plant and animal diversity should also be considered as pointed out by Dunn (1968: 228): "The complexity and diversity of the ecosystem must influence—perhaps profoundly—the patterning of infection and disease in hunter-gatherer populations." This latter idea may be extended to domesticated as opposed to natural fauna. As pointed out by MacNeish (1964) there was a paucity of domestics animals in the New World with a rich diversity of plant domesticates. In the Old World the opposite was true. Newman (1976) felt that infectious disease in the New World would have been somewhat restricted due to the lack of domestic animal reservoir for the horizontal transmission of zoonotic disease. St. Hoyme (1969) had earlier expatiated on the same point. If this is a valid hypothesis then *Ascaris*, a parasite of pigs, the pork tapeworm (*Taenia solium*) and the beef tapeworm (*T. saginata*) would not be expected
among the parasites of man in the precontact New World. Nelson (1972) has discussed the lack of *Taenia* in present day hunter-gatherers.

There are technical problems as well. There is no test available to differentiate animal from human coprolites with certainty, although colour and odour of the rehydration solution and composition of the coprolite have long been used as indicators. Identification of the origin of the coprolite is essential since the same helminth may infect non-humans as readily as humans. As well, it is often difficult to identify helminth eggs with complete certainty. To avoid misidentifications it is urged that those studying coprolites seek expert advice, where any doubt is concerned, from at least two experienced parasitologists. To make data on the precontact evidence of parasitism meaningful the palaeofaecal material must be dated with a fair degree of accuracy (see Cockburn, 1980).

Despite the problems encountered, the only direct information we have concerning parasitic disease in ancient man, except for mummified remains, is to be gleaned from the study of coprolites. It is hoped that more specialists interested in ancient man and the diseases from which he suffered will appreciate these least-attractive of man's relics for the true treasures they are.

References


