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D Helminth Infections

General Statements

Most of the protozoan diseases mentioned before were, regarding their clinical symptoms, well known for many centuries; their causative agents, however, were only discovered after microscopic research and experimental work had greatly advanced during the 19th century.

It was different with helminth infections as the larger intestinal helminths of man and of a number of animals could not have been overlooked.

Among non-intestinal worms *Dracunculus medinensis* was noticed and recorded already in antiquity, and *Loa loa* migrating under the conjunctiva of the eye was long known to the local population in endemic areas of equatorial Africa. They told GUYOT, a French naval surgeon in the second half of the 18th century, when he visited Angola and saw for the first time a filaria moving under the conjunctiva that it was a 'Loa' and that the infection was not rare among them¹.

Ancient records of helminths occurring in Africa (Egypt) are found in the Papyrus Ebers (VON OEFELE, 1902; EBBELL, 1937). The worms mentioned in the Papyrus Ebers were probably *Ascaris lumbricoides*, *Taenia saginata*², as according to Herodotus pork was not generally eaten by the Egyptians, and *Dracunculus medinensis* (EBBELL, 1937; HOEPPLI, 1959). It should be kept in mind that the identification of these three worms can only be made with a certain reserve (EBBELL, 1938) as the wording of the Egyptian text can be interpreted in different ways. Another worm, Herxetef (RIAD, 1955), is regarded by some authors to be *Enterobius vermicularis*. Although the clinical symptoms of schistosomiasis due to *S. haematobium*, especially haematuria, were apparently known, it is highly improbable that the Egyptians knew the parasite (see GHALIOUNGUI, 1963; HOEPPLI, 1959). In the second quarter of the second century B. C. AGATHARCHIDES of Cnidus referred to *Dracunculus medinensis* as common among the population on the

¹ Loa is an African name used by the native people.

² VON OEFELE assumed the existence of *Diphyllbothrium latum* in ancient Egypt.

shores of the Red Sea. After Egypt had become a part of the Roman Empire, PLINY (Hist. nat.) mentioned the frequent occurrence of tapeworms among the Egyptians. PLINY also knew of *Dracunculus medinensis*.

After the conquest of North Africa by the Moslems in the seventh century, Arabic medicine was introduced. From the writings of the Arabic authors the following three conclusions can be drawn regarding intestinal worms: (a) They regarded *Cucurbitini* — single *Taenia* segments — as a distinct helminth species; (b) those who speak of the existence of three kinds of helminths, refer to *Ascaris*, *Enterobius* and *Cucurbitini*; (c) those who differentiate four kinds of helminths (e.g. Avicenna), distinguish *Ascaris*, *Enterobius*, *Taenia* and *Cucurbitini*.

Although some Persian-Arabic authors may have known *Ancylostoma duodenale*, there is in their works no clear reference to this form. The Arabic physicians knew the Guinea worm, but it was not regarded as an animal by all of them³.

In the Western Hemisphere intestinal helminths were known before Columbus. The *Historia General de las Cosas de Nueva España* by SAHAGÚN in the *Códice Matritense del Real Palacio* and in the *Florentine codex* contains the pictures of a man and a dog discharging large intestinal worms (plate XV)⁴. The early Spanish authors writing soon after the Conquest refer to round-worms, lumbrici, evidently *Ascaris lumbricoides* and mention various anthelmintics used by the indigenous population.

EGGS of *Trichocephalus* were found by PIZZI and SCHENONE, 1954, in the intestinal contents of the corpse of a boy of the late Inca period, buried on a mountain near Santiago de Chile.

We do not know at present whether *Hymenolepis nana* existed in the Western Hemisphere before Columbus. It is nowadays the most common human tapeworm in the Southern United States.

The existence of *T. saginata* and *T. solium* in Mexico, Central and South America before the Conquest is very doubtful, as cattle and pigs were only introduced by the Spaniards.

Nowadays *T. saginata* is widely distributed in Mexico and *T. solium* occurs from Mexico and Venezuela to Ecuador.

Some early Spanish writers mention the peccary as a kind of pig which 'had the navel on its back' (it is actually a large sebaceous gland). As the peccary has a strong odor, it was probably not

³ For a good review of the opinions of Graeco-Roman and Arabic-Persian authors on helminths, see F. ADAMS, 1846, vol. 2 (Book IV), pp. 139–153.

⁴ A detailed discussion of the SAHAGÚN codices is given by F. GUERRA: *Aztec Medicine*, 1966, pp. 317–318.

eaten often and it may not harbour *Cysticercus cellulosae* (ASHBURN, 1947).

Apart from helminths which were certainly autochthonous in the Western Hemisphere, such as *Ascaris* and *Trichocephalus*, a number of African species were introduced by the imported negro slaves as will be shown in the following chapters.

I

Intestinal Helminths

Ascaris, *Enterobius*, *Trichocephalus*, *Taenia*, *Hymenolepis*

Africa

Except for the publication of ALEIXO DE ABREU, 1623 (Angola and Brazil), who describes what may have been *Trichocephalus* infection, there are no records regarding intestinal helminths in equatorial Africa up to the 18th century when worm infections were occasionally mentioned by foreign physicians, traders, and explorers. In the following a few statements are given:

THOMAS M. WINTERBOTTOM, 1803. Sierra Leone.

"Worms of the intestines are well known among the Africans, and considered as a very frequent cause of diseases, particularly in children. The Timmanees and Bulloms do not distinguish the different species of worms by particular names but use the word *Abilloo*, worms, or *Abilloo Rokóor*, 'worm sickness', to denote the whole. Among the Foolas and Mandingos, the various kinds are very accurately distinguished; the *ascarides*, or maw worms, are called by the Soosoos, *Koolee*, by the Foolas, *Toomboo*; and by the Mandingos, *Nyaallee*. The *lumbrici* or long worms are called by the Foolas and Soosoos, *Tonnangho*, and by the Mandingos, *Shoóndes*. The Foolas name the *taenia* or tapeworm, *Neagoómee*; the Mandingos and Soosoos call it *Cálligbràý*.

The Foolas are particularly subject to the tapeworm. This they attributed to their living so much upon milk."

"The slaves who are brought down to the water-side by the Foolas for sale are always infested with the tapeworm; this probably arises from the very scanty and wretched diet with which they are fed in the *path*, as they term the journey, and which from the distance they are brought inland, often lasts for many weeks at the same time that their strength is further reduced by the heavy loads, they are obliged to carry."

F. PRUNER, 1847. Cairo.

He found intestinal helminths extremely frequent among Egyptians, *Ascaris*, *Enterobius* and *Trichocephalus* were as a rule present in large numbers already in children. *Taenia saginata* was known to be especially common in Abyssinia. He found *T. saginata* also frequent in regions inhabited by negroes.

WILLIAM F. DANIELL, 1849. Gulf of Guinea.

(Bight of Benin) "... of the species of intestinal worms, teniae and ascarides are the most common, particularly the former, and the populations of several inland countries not infrequently suffer severely from their continual existence."

Various French physicians stressed the frequency of intestinal worms in the indigenous population of different parts of Africa.

Taenia is common in the Sudan (QUINTIN, 1869). It is also very common in Algeria (REY, 1880) and Senegal (BORIUS, 1882). The same statement was made by DAZILLE, 1776, for Réunion. According to BORIUS (1882), in Senegal *Taenia solium* besides *T. saginata* has occasionally been observed. The present writer has found no other early reports of the occurrence of the pork-tapeworm in Africa as pork was generally not eaten, especially not by Moslems.

Hymenolepis nana, the dwarf-tapeworm, was discovered by BILHARZ in 1851 in the small intestine of a boy who had died of meningitis in Cairo. It is fairly cosmopolitan but apparently more frequent in warm climates and certainly more frequent in children than adults.

America

Negro slaves introduced their intestinal helminths into the New World, and infections with worms drew the attention of the slaveholders. JAMES THOMPSON in his *Diseases of Negroes*, 1820, says (of Jamaica) that "of all complaints this (worms) is the one the planter should make himself most completely master of, from its varied appearance, fatality and being so much under his power of judicious management."

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Hookworm: *Ancylostoma duodenale* and *Necator americanus*

Africa

Hookworm infection existed in Eurasia and Africa since ancient times. Anaemia, probably due to hookworm infection, is mentioned in the Papyrus Ebers. Hippocrates refers to people with yellowish colour who suffer from intestinal disturbances and indulge in geophagy, in Rome Lucretius (first half of first century B.C.) and Lucanus, A.D. 39-65, remark on the pale skin of those working in mines. In China hookworm disease was well known. Early authors refer to it as "able to eat but lazy to work yellow disease" (HOEPPLI, 1959, p. 29).

Whereas the clinical symptoms of hookworm infection were well known since antiquity, one will remember that the worms themselves were only fairly recently discovered: *Ancylostoma duo-*

denale in 1838 and *Necator americanus* in 1902 (noticed already before that year by several workers, but not described as a different species)¹.

Nowadays one assumes that the original distribution of *Ancylostoma* and *Necator* was only in the Eastern Hemisphere and that *Ancylostoma duodenale* occurred about north of 20° north latitude, while *Necator americanus* occurred south of 20° north latitude.

The migrations of people have changed considerably the original distribution of these two hookworm species, and as DARLING pointed out, the present distribution gives interesting indications of the early migrations.

Concerning Africa there is an exclusively *Ancylostoma duodenale* infection in the northern coastal region. In Equatorial and South Africa we find an overwhelming or pure *Necator* infection except in the Portuguese colonies, especially Angola, where *Ancylostoma duodenale* is also found, introduced by the foreign immigrants.

Necator infection occurs also in pygmies (LOOSS, 1905).

In 1847 PRUNER rediscovered *Ancylostoma duodenale* in Egypt in cases of Egyptian chlorosis, and in 1853 BILHARZ related hookworm infection and chlorosis as cause and effect, a relation which was strongly emphasized by GRIESINGER in 1854.

In the second half of the nineteenth century, hookworm disease was reported from different parts of Africa, especially from Senegambia, the Guinea coast, the Comoro group and the Zanzibar coast.

America

Introduction of the two hookworm species into America.

It may be mentioned that, as DARLING pointed out, "it is possible that either or both species have also been introduced into the American continent from Asia, Indonesia or Polynesia by voyagers or stormtossed fishermen. This is a subject for future research."

SOPER, 1927, following DARLING's theories examined Lengua Indians living isolated in the Paraguayan Chaco and found an *Ancylostoma* – *Necator* ratio of 13 to 1. This is by far the highest ratio for any group on the American continent. If one leaves open the question whether *Ancylostoma* had been introduced in prehistoric times by migrants from Asia, one has to consider the possibility or even greater probability that the infection had been transmitted by Spanish conquistadores.

¹ It is doubtful whether certain statements by Arabic authors, e.g. Avicenna (A.D. 980–1037) refer to hookworm.

Europeans, especially Spaniards and Portuguese from countries bordering the Mediterranean or close to it, have introduced *A. duodenale* into Brazil and other parts of South- and Central America. In more recent times, Japanese, Chinese and Indian workmen likewise contributed to the introduction.

Necator americanus has been introduced into America within historic times by negro slaves from Africa. Apart from them, workmen from India and Indonesia played a rôle in more recent times.

Even if we consider the possibility that in prehistoric times migrants had transmitted *N. americanus*, the infection cannot have been a widespread and heavy one, as the early Spanish historians never mention in their description of the conquered territories and their populations a disease with symptoms which might indicate hookworm infection.

On the other hand, following the importation of a large number of African slaves, not only physicians but also government officials, planters and traders mentioned a disease which practically was only found in negro slaves. The described symptoms leave no doubt that they were due to hookworm infection. Geophagy – dirt-eating – attracted special attention and was described by several authors such as LABAT, 1742, BAJON, 1777–78, WINTERBOTTOM, 1803, MOREAU DE JONNÈS, 1816 (note). The disease got various names: ‘mal d’estomac’, ‘mal de cœur’, ‘anaemia tropicalis’, ‘cachexia africana’, ‘cachexie aqueuse’, ‘oppilação’, and was for a long time regarded as peculiar to negro slaves.

In the first half of the 17th century, PISO in Brazil had already described a disease with intestinal disturbances, anaemia, weakness and dropsy.

Similar symptoms were reported by Père LABAT from negro slaves in Guadeloupe.

From the beginning of the 18th century, French and English physicians, based on their observations in the Antilles, divided the symptoms in those caused by intestinal disturbances and others connected with anaemia and circulatory disorders. In 1820 JAMES THOMPSON described the ravages of the disease among slaves in Jamaica.

Only a few of the numerous authors dealing with hookworm disease in the West Indies, Central- and South America may be mentioned: PISO, 1648, Brazil; BAJON, 1777–78, Cayenne; LABAT, 1742, MOREAU DE JONNÈS, 1816, Guadeloupe; RODSCHIED, 1796, Brazil; SAVARÉSY, 1809, Martinique; LEVACHER, 1840, Antilles; SIGAUD, 1844, WUCHERER, 1872, Brazil.

In concluding it may be repeated that *N. americanus* infection was introduced into the West Indies and the American continent

by negro slaves from Africa (not considering more recent introductions). Proofs are (1) that symptoms of the disease were not mentioned by early Spanish historians describing the Conquest. (2) Those who showed symptoms of hookworm disease in the Western Hemisphere were practically all African slaves. (3) The infection was widespread in those parts of Africa, wherefrom the slaves came.

Ancylostoma duodenale was introduced into the Western Hemisphere (not considering more recent introductions) by the conquistadores and other immigrants from mediterranean countries, chiefly Spaniards and Portuguese.

Note

“That strange propensity called ‘dirt eating’ in the West Indies, where it frequently occurs among the slaves and often proves fatal by inducing chronic complaints, is sometimes met among the children in Africa. When this pernicious practice has been followed for some time, it induces such a change in the countenance and complexion, as renders the disease obvious to every one at first sight. The colour of skin changes from a deep black to a dirty light brown, or even approaches a clay colour. The skin also feels rough, and is cold to the touch. The tunica conjunctiva, or white of the eye, becomes of a dusky yellowish white. The countenance appears dejected, the eye-lids are puffy, and the whole face is bloated. The gums lose their healthy red colour, becoming pale and flaccid, and the inside of the lips and tongue appear almost white; even the hair undergoes a change of colour, and becomes of a dirty white, like that of the white negro. There is a constant uneasy aching pain at the stomach, attended with a degree of nausea and loathing of food. The pulse at first is not much affected but gradually becomes quicker and very small; there is frequently a troublesome palpitation of the heart, and a constant throbbing of the large vessels in the lower part of the neck. The respiration is often oppressed, and is always hurried by the least degree of exercise. The abdominal viscera, particularly the mesenteric glands being enlarged and hardened cause the belly to swell; the lower extremities become anasarcaous; and frequently towards the conclusion of the disease effusion takes place into the cavities of the abdomen and thorax.

The unhappy people are fondest of a white kind of clay, resembling tobacco pipe clay, with which they fill their mouths and allow it to dissolve gradually.” THOMAS WINTERBOTTOM, 1803. An Account of the Native Africans, etc. Chapt. XIII. Dirt eating.

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II

*Filariae**Wuchereria bancrofti* – Elephantiasis*General Statements*

Elephantiasis understood as a pathological condition representing enlargement of various parts of the human body with fibrous thickening of the skin was known from ancient times in different parts of the world; it may have very different causes. *Elephantiasis graecorum*, for example, judging from the various descriptions, referred chiefly to leprosy. *Elephantiasis arabum* was elephantiasis due to filaria infection. *Sli pada* of Indian medical literature was mainly elephantiasis in cases of filariasis.

It is certain that some filaria species are able to produce elephantiasis, but this condition develops only in a certain percentage

of cases. Heavy infection and especially continuous reinfection over a long period are important, apart from individual factors which determine the strength and the kind of reaction against the parasite.

The causative organism is in Africa *Wuchereria bancrofti*.

In Africa *W. bancrofti* is endemic in Egypt, in tropical West-, Central- and East Africa, also in Madagascar, Mauritius and Réunion. In the New World it occurs in the West Indies, in some parts of Central America and in the northern part of South America, from Columbia to the north of Brazil. Small foci which existed in some of the southern States of North America, especially in South Carolina and Alabama, have apparently disappeared; Charleston, S.C., was formerly an endemic focus of infection (FAUST, 1949).

For a detailed historical review of the work of various investigators concerning the discovery of the microfilariae, of the adult male and female parasite, the periodicity of the microfilariae and their transmission by mosquitoes, the reader is referred to MANSON-BAHR, 1959.

Africa

Elephantiasis occurred probably in ancient Egypt. A statue in painted sandstone of Mentuhotep III, 1998–1991 B.C., a pharaoh of the XIth dynasty, about 2000 B.C., shows pronounced enlargement of both legs (Egyptian Museum, Cairo, no. 287). The enlargement, however, is completely symmetrical and therefore it is doubtful whether elephantiasis due to *W. bancrofti* infection is represented. Elephantiasis in this infection is usually not equally developed in both legs.

T. Lucretius Carus, ca. 98–55 B.C., regarded elephantiasis even as a characteristic disease of the Egyptians. He emphasized the importance of the country's climate for the prevalence of certain local diseases and stated that elephantiasis originated on the Nile in the climate of Egypt and nowhere else¹.

Ibn Battūta (1304–1377), the famous islamic traveller, reports in his *Rihla*, 1355, that he saw many cases of elephantiasis in Zafar (SARTON, 1947, vol. III).

The negroes of equatorial Africa must have noticed cases of elephantiasis from ancient times and during the last 2000 years reproduced it in works of art.

In the Museum of Jos in Nigeria there is the torso of a terracotta statuette of the Nok period (ca. 500 B.C.–A.D. 200), which shows in a simplified way but definitely elephantiasis of the scrotum (plate IX).

¹ "Est elephas morbus qui propter flumina Nili gignitur Aegypto in media neque praeterea usquam."

Another terracotta statue of about the 12th–14th century, kept in the Museum of Ife, Nigeria, likewise represents elephantiasis of the scrotum in a naturalistic style (plate X).

The British Museum and the Wellcome Historical Medical Museum in London have each a Yoruba bronze figure of a sitting man with a very pronounced elephantiastic enlargement of the scrotum. Both figures are very similar and date probably from the middle of the 19th century (plate XI).

An Ashanti Goldweight in the Pitt Rivers Museum in Oxford shows a naked beggar with marked elephantiasis of the scrotum. He is sitting on the ground with outstretched legs, holding a bowl between his feet (plate XII).

Elephantiasis from Africa has been mentioned by numerous writers of the 18th and 19th centuries. Among them are: JOHN BARBOT, 1732, Sierra Leone (note 1); CLARKE, 1860, Gold Coast (note 2); ANTONIO PINTO ROQUETE, 1868, Mozambique (note 3).

America

As *W. bancrofti* infection is widespread in tropical Africa, it is certain that many slaves with microfilariae in their blood but without clinical symptoms were shipped to the Western Hemisphere and, in the presence of a suitable mosquito, contributed to the spread of the infection. It is somewhat surprising that elephantiasis has not been mentioned by the early Spanish historians in their descriptions of the newly conquered territories and their inhabitants.

Some modern authors, for example ASHBURN, 1947, therefore assume that *W. bancrofti* probably did not exist in the Western Hemisphere before the coming of the Spaniards. One may, however, point out that even in parts of the world heavily infected with *W. bancrofti*, elephantiasis is often rather rare due to local conditions. It is therefore possible that even if cases of elephantiasis existed in small numbers, the Spaniards may not have noticed them (see also C. W. DANIELS, 1898)².

² In the ruins of Dzibilchaltun, 75 miles away from Chichén Itzá, the well-known Maya center in Yucatán, a temple was found of about A.D. 500 which contained seven small clay figurines buried under the floor of a sanctuary. They are of unpainted clay crudely modeled and each exhibits some deformity. (E. WYLLYS ANDREWS, Dzibilchaltun: Lost City of the Maya. Nat. geogr. Mag., vol. 115, no. 1, 1959, 90–109.)

The present writer had no opportunity of seeing these figurines but a photo of them, reproduced on page 105 shows a figure which, as far as can be judged from the photograph, represents a case of elephantiasis scroti.

The writer is indebted to Miss R. Greter, Basle, who drew his attention to E. WYLLYS ANDREWS' article.

As mentioned before, *W. bancrofti* infection was brought by negro slaves from Africa to the New World where it may have existed already in some parts before the conquest. It is interesting to trace the ways how the infection spread in America. Only the migration of Jewish settlers with their slaves from Brazil may be mentioned as an example (note 4).

Notes

1. "From Sierra Leone to Rio Sestro – Inland. Here is another elsewhere unknown and foul distemper, the Blacks are subject to, throughout all the country about Sierra Leona, and in Quoya; i.e. a wonderful swelling of, or in the Scrotum; mostly occasioned by the excessive drinking of palm-wine, which causes violent pains, and hinders their cohabiting with women."

JOHN BARBOT, A description of the coasts of North- and South Guinea and of Ethiopia Inferior etc. in six books, London 1732. Book II, chapt. 5, A description of the Coasts of South Guinea, p. 118.

2. "Elephantiasis and lepra in all its hideous forms prevail, and sarcomatous enlargements of the scrotum frequently attain such dimensions as to reach to the knees, and even below them. The disease is said to prevail more on the windward than on the leeward part of the coast. The natives suppose it may be induced by drinking excessively of palm wine which has been mixed with the juice of the bamboo; but it may, with much greater reason, be accounted for by an excess of fish diet!" – R. CLARKE, Topography and Diseases of the Gold Coast. Trans. epidemiol. Soc. 1, p. 106, 1860.

3. "Enfin on observe aussi l'éléphantiasis des Arabes et quelques cas d'éléphantiasis des Grecs parmi les mulâtres, les Arabes et les Maures qui résident à la côte mozambique. L'éléphantiasis du scrotum est plus fréquent chez les indigènes." – ANTONIO PINTO ROQUETE. Note sur la topographie médicale de Mozambique. Arch. Méd. nav. 9, 1868, p. 167.

4. With the kind permission of Dr. I. Snapper, Director of Medical Education of the Brookdale Hospital Center, Brooklyn, New York, I give in the following a part of a letter which he wrote me on May 14, 1964³:

"Starting in 1623, the West India Company, incorporated in Amsterdam, repeatedly tried to invade Brazil which, at that time,

³ The author wishes to thank Dr. Snapper for his information.

was a Portuguese colony. In 1629, the Hollanders took Olina, Recife and Pernambuco and in 1636, one of the Princes of the House of Orange, Count Johan Maurits of Nassau, left for South America to become the Governor of the new Dutch possessions in the 'Brasyl'."

"His small army was accompanied by a Dutch physician, Jan Willem Piso, who carefully studied the diseases of Brazil and the remedies the natives used. The book Piso wrote about his experiences in this remote tropical country was probably the only advantage the Netherlands ever obtained from this invasion because the Portuguese after 1645 gradually succeeded in recapturing their original colony."

"During the time the Hollanders were in Brazil, a large number of the Spanish and Portuguese Jews suffering under the Inquisition in their home countries emigrated to Brazil. As soon as the Hollanders started to retreat from this territory, the Jews had to flee again. A large number of the displaced persons settled in the area which is now the Province of Antiochia of the Republic of Columbia. Even today, although practically all inhabitants of Antiochia are Catholics, their given names are often Sarah, Rebecca, Moses, David, and the citizens of Columbia outside Antiochia designate the inhabitants of the latter province as 'Judio'. A second wave of Jewish emigrants went to Surinam and Curaçao, a third wave went to Charleston, S.C. One ship with Jews from Brazil arrived in New Amsterdam in 1653."

"I have always surmized that the endemic filariasis of Charleston, could be connected with the arrival of the Jews. The Jews and their slaves have at all times lived as if they belonged to one family and this custom persisted after the slaves had been freed. When a Jewish child was born, a small Negro child was selected to be its special servant who stayed with his master or mistress from the cradle to the grave. During the night the small special servant slept before the bed of the child. In other words, at all times, a child heavily infected with filaria was sleeping before the beds of Jewish children. Since filaria only takes hold in the human organism after many infections have taken place, there were always more severe cases of filaria among the Jews than among the rest of the population."

"Even today this can be observed in Surinam. There, all women wear short skirts, except the women with elephantiasis due to filariasis who wear long skirts. Walking in the streets in Paramaribo, it is striking that far the greater part of the women with long skirts are Jewish women."

"I am not aware whether I ever *read* that the filariasis of S.C. depended upon the influx of the heavily infected Jews in the 1650ths. I may well have dreamt it up as a *possible* explanation of the course of the endemic."

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Dracunculus medinensis – the Guinea worm

The Guinea or Medina worm was known since antiquity. In Africa it is found in Mauretania, on the west coast and across equatorial Africa to northern Uganda. It occurs in the southern Sudan and in Egypt. It was very frequent on the Guinea Coast but rarely found in the Congo. On the east African coast it was not reported from Djibouti southward.

By the slave trade *Dracunculus* was transmitted to the West Indies; furthermore to the Guianas and the State of Bahia in Brazil.

Fedschenko (1869) discovered the life-cycle and indicated that species of *cyclops* are the necessary intermediate hosts of *Dracunculus medinensis*.

Africa

It is very likely that *Dracunculus medinensis* was known to the Egyptians, as it was mentioned by AGATHARCHIDES (see below).

The fiery serpents of the Bible (Numbers XXI. 6) were in the opinion of some writers Guinea worms (KÜCHENMEISTER and

ZÜRN, 1878–1881, pp. 419–425). Their opinion is not shared by some more recent authors (HAIM BEN HAMRAN, 1959).

Dracunculus medinensis was, according to PLUTARCH (c. A.D. 46–120) Symp. lib. VIII, cap. 9, mentioned by the geographer AGATHARCHIDES of Cnidus, who wrote in Alexandria in the second quarter of the second century B.C. and was the teacher of one of the sons of Ptolemy VII Alexander (Physcon) (note 1).

Besides AGATHARCHIDES the following Greek and Roman writers who knew *Dracunculus* may be mentioned: Pliny, 23–79; Soranus of Ephesus fl. in Rome under Trajan and Hadrian, i.e. A.D. 98–138 (in Caelius Aurelianus and Paulus Aegineta); Julius Pollux, fl. under Commodus, 180–192; Galen, 129–c. 200; Leonidas of Alexandria, 3rd century (in Aetius lib. XIV, cap. 86); Aetius of Amida, fl. under Justinian I, 527–565; Paulus Aegineta, fl. c. 640 in Alexandria; Joannes Actuarius fl. under Andronicus III, 1328–1341.

Leonidas stated that *Dracunculus* occurred in Ethiopia (teste MOULÉ, 1911). Galen had never seen *Dracunculus*, he regarded it as of a nervous nature, resembling varices. Soranus of Ephesus and Pollux likewise denied that *Dracunculus* was an animal. Pollux called it a piece of corrupted nerve.

The Arabic physicians knew the Guinea worm but it was not universally regarded as a worm. It was described as 'corrupted matter' or as a kind of filament, a nerve, a vein or even the root of a plant. It should also be kept in mind that the Arabic word ark or erk, which has been used to describe *Dracunculus*, merely means something long, thin or filiform.

Among outstanding Persian-Arabic authors dealing with the Guinea worm are Rhazes (Abū Bakr Muhammad ibn Zakarīya al-Rāzī, born in the middle of the ninth century, died 923–24), who regarded *Dracunculus* as a worm, AVICENNA (Abū 'Alī al-Husayn ibn 'Abdallāh ibn Sīnā, 980–1037, a Persian), who denied the animal nature of *Dracunculus* (note 2), ABU'L QĀSIM, 936–c. 1013, and Avenzoar, Abū Marvān ibn Zuhr, ca. 1091–1162.

During many centuries, physicians and scientists speculated about the nature of *Dracunculus*. The important question was always, whether it was a worm or something else. AMBROISE PARÉ (1510–90) was of the opinion that it was not a worm but a corrupted nerve (DELAUNAY, 1926). Even after most investigators at about the beginning of the 18th century had come to the conclusion that it was a worm, hardly anything was known about its structure.

Regarding early illustrations of the Guinea worm, see note 3.

In the following a few brief excerpts from reports on the occurrence of *Dracunculus* in Africa from 1600 to the middle of the

19th century are given. Although the list is very small, the publications reflect the various opinions held during about 250 years.

1. HAKLUYTUS POSTHUMUS or Purchas His Pilgrimes (1625), Glasgow 1905, vol. VI, p. 350: "The negroes themselves are much troubled with them (Guinea worms), especially those that dwell about the castle of Mina, and it is a thing to be wondered at for the negroes that dwell but 25 miles lower East-ward are not troubled with worms as their neighbors are."

The negroes suspected that the infection is due to water. During extraction the worm should not be broken.

2. ALEIXO DE ABREU, Tratado de las siete enfermedades, 1623. All over the Mina coast another worm is generated as well, in the legs of men mainly, which being born very small, grows to the size and width of a thick fiddle-string. This is cured (by) extracting it little by little, turning it around a little stick in order (that) it will not break for this will result in great damage. (Transl. from the Spanish by F. GUERRA, 1968.)

3. O. DAPPER, 1686. Dapper describes the clinical picture of *Dracunculus* infection. Suspects that bad air or water are responsible. Mentions that while the infection is very common in some regions, it is absent in others. Negroes are chiefly infected, but foreigners may also get the infection. Some show the symptoms of dracontiasis while they are still on the African coast, others many months and even a year after their return to Europe. Advises to extract the worm very slowly.

OLFERT DAPPER (ca. 1636–37 to 1689) wrote a very detailed and in many respects correct and interesting work on Africa, although he spent the greater part of his life in Amsterdam and probably never visited Africa. His work was translated from the original Dutch into several languages.

4. W. BOSMAN, 1705. *Filaria medinensis*. Describes the method of slowly extracting the worm. "This Worm-Disease is frequent all the Coast over, but our Men are most tormented with it at Cor-mantyn and Apam; which perhaps may be occasioned by the foul Water which they are obliged to drink there." Copied from: Ann. trop. Med. Parasit. vol. 29, 1925.

WILLIAM BOSMAN was Chief Factor for the Dutch at the Castle of St. George d'Elmina.

5. F. MOORE, 1734. He describes the symptoms of dracontiasis and the dangerous consequences, when the worm is broken during extraction. Regarding the cause of the infection he states: "The Natives tell me that these Worms are bred with drinking 'thick' water."

MOORE was sent out by the Royal African Company of England as Factor to James Fort at the mouth of the Gambia.

6. JOHN (JEAN) BARBOT, 1732. Book I, chapt. 2. Describes the infection. It occurs in Whites and Negroes, especially the latter "which may be attributed to their usual bad diet and debauchery of all sorts."

BARBOT (French) was Agent-General of the Royal Company of Africa and Islands of America in Paris.

7. JOHN ATKINS, 1742. He mixes up *Dracunculus medinensis* and *Tunga penetrans*. ATKINS is of the opinion that it is erroneous to assume that drinking bad water is the cause of the infection.

ATKINS was a naval surgeon.

8. JAMES BRUCE, 1805 (second edition), vol. IV, p. 234: "The next complaint I shall mention as common in these countries is called *Farenteit*, a corruption of an Arabic word which signifies the worm of Pharaos; all bad things being by the Arabs attributed to these poor kings, who seem to be looked upon by posterity as the evil genii of the country which they once governed."

Then follows the description of *Dracunculus* infection and the method of slow removal by turning the worm around a thin piece of silk or a small bird's feather. The natives know the danger connected with the breaking of the worm.

Bruce, a famous explorer, himself experienced the infection.

9. T. M. WINTERBOTTOM, 1803, vol. II. chapt. V: *Dracunculus medinensis*. "The inhabitants of the river Gambia, and they who live between that river and the Senegal, are said to be affected with the Guinea-worm, but at no other time than the dry season when the water is bad." . . .

"A slave trader in the Rio Nunez informed me that the inhabitants of the kingdom of Bouree, a country from which much gold is brought, and situated about four days journey from Teembo, towards Tombuctoo, are greatly troubled with the Guinea-worm, which he has often seen in the slaves brought from that country. It does not appear that the disease could have been there caused by drinking bad water, as he says that the natives of Bouree take only the water of springs." . . .

"That this disease originates upon the Gold Coast from the badness of water seems probable from the worms being seldom found in those parts, where to guard against it, they take the precaution of boiling the water they drink. — (Mr. Park says the Guinea-worm is very common in certain places, especially at the commencement of the rainy season and is attributed by the negroes to the badness of the water. They allege, he observes that the people who drink

from wells, are more subject to it than those who drink from streams.)" . . .

"Out of two hundred and twenty slaves which were bought at Cape Mount, Cape Mazurado, and Cape La Hou, only one was affected with Guinea worm which occurred in the great toe. On the contrary, among sixty slaves which were bought at St. George del Mina, a third part laboured under this disease; and among six hundred bought at Angola, not a single of it occurred."

10. H. BARTH, 1857, vol. II, chapt. XXXVII (Plains of Bo'runu proper), p. 546. "... However, I have already had occasion to observe that the water from these stagnant pools is anything but wholesome, particularly after the rainy season, when they receive no further supply; and I have no doubt that the drinking water is the principal, if not the only cause of that dreadful and widespread disease (the *fantit* or *arug - ugi-duvi* in Kanuri - the misery) which disables the working man and makes him a poor wretched being - the Guinea-worm which is sure to be met with in at least one out of three persons who travel a great deal through the whole of Central Africa¹." BARTH was an outstanding explorer in Africa.

11. R. CLARKE, 1960. "Regarding Guinea worm, I am satisfied that it is not caused by drinking impure water. . . . To remove the worm the natives use a thread to which they attach a small weight at the free end, for example a piece of lead."

America

As mentioned at the beginning, *Dracunculus medinensis* was introduced by the slave trade from Africa into some of the Antilles, the Guianas and the state of Bahia in Brazil. In some regions the Guinea-worm found *cyclops* which could serve as intermediate host, and the infection continued there for many years after the slave trade had ceased. The infection gradually decreased in frequency in the endemic areas and has by now completely disappeared from Brazil.

A very early reference to the Guinea worm, observed in South America, was made in 1599 by the Spanish governor of Rio de la Plata (note 4).

In the following, only a somewhat unusual report from the Western Hemisphere is given:

PERÉ, 1774, studied the infection on the coast of Guinea and at St. Domingo; PERÉ comes to the conclusion that *Dracunculus* is a real living worm, not something else.

¹ It may be added that the Nubas in Kordofan (Sudan) believed that the Guinea worm entered through cuts and abrasions or even through the normal skin of the feet when people were standing in water (see HOEPPLI, 1959, p. 242).

He describes the case of a 10–12-year-old negro boy who arrived in March 1771 at St. Domingo from Africa on a French ship carrying negro slaves. The boy had lost so much weight during the voyage that he could not walk. The physician of the slave vessel told PERÉ that the boy had something under the skin of his abdomen and chest which looked like very long veins. The captain, who regarded the case as hopeless, gave the negro boy as a present to PERÉ, who made the correct diagnosis that the supposed veins were the coils of a Guinea worm. He successfully operated and removed the worm. Within a very short time after extraction, the boy gained much weight and was restored to complete health, so that when after three months PERÉ had to leave, he could sell the boy for twelve hundred livres!

The reports on *Dracunculus medinensis* may be concluded by a note of R. T. LEIPER, 1911, on the native tradition that the Guinea-worm can attain maturity outside the body:

In West Africa natives widely held the belief that the Guinea-worm can attain its full maturity outside the human body. Even some European settlers shared this belief. LEIPER got a specimen which was sent to him as a supposed Guinea-worm such as was occasionally found in earth by the natives and regarded by them as a mature Guinea-worm.

On examination, the specimen was found to be a species of the genus *Mermis*.

The various listed reports and statements on the Guinea worm were given by physicians, scientists, traders and explorers. The following may be stated as a summary: *Dracunculus medinensis* was known since antiquity but there was no consensus of opinion up to the 17th century whether it was a real worm or something else. Based on experience, the writers during many centuries strongly advised not to break the worm during extraction as otherwise very often a dangerous inflammation developed.

It is interesting that the natives in various infected regions believed that dracunculosis was due to drinking 'thick' (impure) water. Running water from streams was generally regarded as less dangerous than stagnant water from pools or wells. This correct opinion of the natives based evidently on observation and experience is in contrast with the opinion of some foreign physicians (e.g. ATKINS, 1742, and CLARKE, 1860) who believed that the drinking of impure water had nothing to do with the infection.

Dracontiasis was introduced into the Western Hemisphere by infected negro slaves.

Notes

1. AGATHARCHIDES. "That the people taken ill on the Red Sea suffered from many strange and unheard of attacks, amongst others worms upon them which gnawed away their legs and arms and, when touched, retracted themselves up in the muscles and there gave rise to the most unsupportable pains; but their evil was only been found then, neither before nor since amongst any other people." In: PLUTARCH, *Symp. lib. VIII, cap. 9*.

2. *Avicenna* on the Medina worm. "The Medina 'erg' consists in the occurrence on some parts of the body of a pustule that swells, gets spotted and perforated; then something comes out of it red-dish-black in colour that goes on lengthening and lengthening, that may have a vermiform movement under the skin, as if it were an animal in motion, indeed as if it were in reality a worm, so that some have thought that it is a reproductive animal; and some have thought it a fasciculus of a nerve fibre that degenerated and thickened. It occurs most frequently in the legs, and I have seen it in the hands and on the side. It is frequent on the side in youngsters. If it stretches and ruptures, the calamity increases and so does the pain, although it may be painful even if it does not rupture. Galen said that he could not make of it anything clear and reliable because he never saw it; and he says that its cause is red, dirty, bad atrabilious blood, or burnt phlegm that becomes sharper with the increase in dryness of the humours. It may be generated by some waters or pulses owing to some property in them. Foods most likely to cause it are dry ones. The sharper the matter from which it originated in the body, the stronger the pain. It may arise in the same body in forty or fifty places although one may get rid of it by treatment. And heaviness in humid bodies and the ones used in baths and refreshing foods and used in drinking. It is most frequently generated in Medina, and for this reason it has been called after it; it may also occur in the country of Khuristan and in other countries, and it may also be frequent in Egypt and in other countries." – AVICENNA, the Canon III Cairo Ed. 1294 H., p. 138, 139².

3. A very early illustration of the extraction of the Guinea-worm by slowly winding it around a thin stick is found in a manuscript by Sharaf al-Din 1405 (Charaf Ed-Din); the illustration is rather primitive. Sharaf al-Din in his work follows closely Abulcasis (HUARD et GRMEK, 1960).

² The writer is greatly indebted to Prof. G. Ghalioungui, Cairo (now Kuwait) for the translation.

LINSCHOTEN's description of his voyage to the East Indies has a plate which has also been inserted by the editors, the brothers de Bry in the publication on the Congo by F. Pigafetta. This plate shows extraction of a Guinea worm in the typical way by the patient himself (see chapter on *Loa loa*).

VELSCH, 1674, in his curious book on *Dracunculus* has pictures of the Guinea worm protruding from various parts of the human body (p. 311) and also the extraction of the worm. He gives, however, no details of the parasite.

MEIGE, 1901, refers to a copperprint by Jan Luyken of about the end of the 17th century. The print represents two patients with dracontiasis. The extraction by winding the worm around a small stick has been completed in one patient and the operator holds up a worm of greatly exaggerated size.

4. Don Diego Rodriguez de Valdés y de la Vanda, governor of Rio de la Plata, who in 1599 had taken a Dutch ship which arrived at Buenos Aires from Amsterdam via the Guinea coast and who held the captain and the crew as prisoners, stated that on the Guinea coast in the Mina region there occurred worms which developed in the legs and other parts of the body and grew to a length of 2–3 varas. He had seen the removal of such worms from two of his prisoners. — Relación de lo que a pasado con un navio que llegó a este Puerto de Buenos-Ayres a los veinte y nueve de Julio de 1599 años. (See: HENDRIK OTTSEN, 1918, p. 165.)

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Loa loa

Loa occurs in West Africa from southern Nigeria to Angola and from the Congo through central tropical Africa; it is especially frequent on the West Coast. Numerous infected negro slaves were carried to the West Indies and to parts of South America.

The first report of an infection with *Loa* did not come from Africa but from St. Domingo (MONGIN, 1770). MONGIN recorded the extraction of a worm from between the conjunctiva and albuginea of a negress.

BAJON at Cayenne had already in 1768 removed a filaria from

below the conjunctiva of an eight-year-old negro girl. This case was published in 1777 together with another one in which BAJON had observed a worm in an older negress, moving between conjunctiva and cornea; he was, however, not allowed to operate.

MERCIER at St. Domingo in 1771 extracted a worm from beneath the cornea of a negress. In 1774 he removed a worm from the eye of a negro. His two cases were published by ARRACHART in 1805.

Africa

In Africa cases of *Loa* infection were for the first time recorded by GUYOT, a French naval surgeon, who made seven voyages to Angola and in 1777 observed cases of filariae under the conjunctiva in indigenous people who told him that the worm was a 'Loa'. He attempted the extraction of the filaria after an incision of the conjunctiva in five cases, but only succeeded twice. GUYOT differentiated *Loa* from the Guinea worm.

ARRACHART, 1805, recorded the cases in St. Domingo, known to him; he also reproduced BAJON, 1777, and GUYOT.

Increasing numbers of cases were gradually reported from the West Coast of Africa: Sierra Leone, Gold Coast, Nigeria, Old Calabar, Cameroon, Gabon, Congo, Angola (see BLANCHARD, 1899, and WARD, 1906).

The peculiarity of *Loa* to appear during its wandering in the human body under the conjunctiva was well known to the natives in endemic areas and attracted the attention of foreign physicians who gradually also became familiar with the so-called 'Calabar swellings' caused by this filaria. The African name 'Loa' was used by the native population in Angola.

Early publications on Calabar swellings (Kamerungeschwülste of the German authors) were those by PLEHN (1898) and by THOMPSTONE (1899), a district medical officer in Old Calabar. WARD (1906, p. 41) pointed out that Calabar swellings were recognised as a distinct disease earlier and were referred to under this name already by ROBERTSON (1895).

Concerning treatment, it seems that in general the native population did nothing to remove the worm from the eye. They were of the opinion that it would reappear in longer intervals under the conjunctiva and would ultimately not be seen any more.

Occasionally attempts were made to remove the *Loa* from the eye by means of a thorn or a very thin sharp piece of bone (MORTON, 1877). An English trader, living on the Ogooué, had a *Loa* removed from his eye by a native using a thin thorn (WARD, 1906, p. 14).

America

Following MONGIN's first observation in 1770, there were a few more case reports from the Western Hemisphere before GUYOT's first observation of *Loa* in Africa. We have mentioned already BAJON, 1768, 1771 (published 1777) from Cayenne; MERCIER, 1771 and 1774 from St. Domingo (published 1805 by ARRACHART). Subsequently, many more cases were reported from the Western Hemisphere; all concerned slaves who had recently arrived from Africa.

After 1845 *Loa loa* has no longer been recorded from the West Indies or South America. Apparently the cessation of the slave trade was the reason that its occurrence stopped, as all cases recorded up to that date concerned negroes imported from Africa.

Subsequently cases with *Loa* infection which came to America, especially the United States and occasionally also to Europe, were missionaries, government officials and traders who returned from infected parts of Africa (see WARD, 1906).

Several authors, GUYON, 1864, MONIEZ, 1896, and R. BLANCHARD, 1899, have erroneously stated that the first record of *Loa* is found in a plate of FILIPPO PIGAFETTA's 'Description of the Congo', published together with travel records of other authors including J. H. LINSCHOTEN by the brothers Joh. Theod. and Joh. Israel de Bry under the title *India Orientalis* at Frankfort in 1598¹.

WARD, 1906, has carefully examined this question and came to the following conclusion: PIGAFETTA's 'Description of the Congo' does not contain any reference to *Loa*, a statement which the present writer can confirm, and in its original edition does not have a plate. The plate in question belongs to a publication by JAN HUYGHEN VAN LINSCHOTEN, dealing with his voyage to the East Indies. Even in LINSCHOTEN's publication, the plate is not found in the first edition (1596 in Dutch) but was apparently inserted by the editors in later editions.

The plate shows on the left removal of Guinea-worms from the legs by an infected person, and on the right an operation on the eye of another person, interpreted by GUYON, MONIEZ and R. BLANCHARD as a removal of a *Loa*. From the text of LINSCHOTEN's publication it becomes, however, evident that this operation does not represent the removal of a *Loa*, but the blinding of a relative of the king. On the island of Ormuz, at the entrance of the Persian Gulf, where the scene is supposed to take place, all male relatives of a new king were blinded at his accession, as according to an old law, no blind man could become king. It should be added that *Loa* does not exist at Ormuz.

¹ The plate is reproduced in BLANCHARD, 1899.

In order to avoid possible confusion, it may be mentioned that there are two different authors by the name of PIGAFETTA with whom we have to deal in the present study, neither of them mentions worms in the eyes:

1. FRANCISCO ANTONIO PIGAFETTA, an Italian traveller and historian. He accompanied Magellan on his circumnavigation of the globe (1519–1522) and is the principal authority on this voyage. He died about 1534.

2. FILIPPO PIGAFETTA, who published a description of the Congo based on records of the Portuguese Edoardo (Duarte) Lopez. It is found together with descriptions of voyages by other authors in de Bry's 'India Orientalis', Frankfurt 1598. A more recent edition is by Hutchinson, London 1881. FILIPPO PIGAFETTA's publication in its original edition does not contain the mentioned plate.

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Carefully prepared lists of records of *Loa* with bibliographic references were published by R. BLANCHARD (1899) — twenty-six cases, and by WARD (1906) — ninety-four cases. The two authors used different methods of listing the published records.

Onchocerca sp. — Enfermedad de Robles — Onchocerciasis

The discovery of *Onchocerca volvulus* and the first reference to the parasite in the literature are connected with the names of LEUCKART and MANSON.

Africa

In 1892 a German medical missionary removed two subcutaneous nodules from two negroes on the Gold Coast (now the Republic of Ghana). As the nodules were found to contain coiled-up worms, they were sent to LEUCKART for examination. LEUCKART recognized that the worms were a new kind of filaria which he named *Filaria volvulus*. He forwarded some of his material to MANSON, who in 1892 was the first to mention this filaria in the literature.

PROUT in 1901 found two cases of onchocerciasis in Sierra Leone and gave a detailed description of the parasite.

In 1910 RAILLET and HENRY showed that *Filaria volvulus* had the characteristics of the genus *Onchocerca*, created by Diesing in 1841 and should therefore be named *Onchocerca volvulus* (note 1).

The adults, males and females, live in subcutaneous nodules, surrounded by numerous microfilariae which migrate into the subcutaneous tissue all over the body and can be found by skin biopsies (MAZZOTTI, 1951).

The skin in very early stages of onchocerciasis may show rash and pruritus (WANSON, 1950). In later stages, the changes represent essentially different degrees of scleroderma followed by atrophy (JAMISON et al., 1955; HOEPPLI and GUNDERS, 1962; REBER and HOEPPLI, 1964). Heavy chronic infections frequently damage the eyes.

Human onchocerciasis is widespread in Africa; it occurs on the African west coast, in the Sudan and in central Africa extending to the great lakes.

Already in 1875 JOHN O'NEILL, a British naval surgeon, published a case of 'craw-craw' in a negro from the Guinea coast (Cape Coast Castle) in which he found microscopically small nematodes in material obtained by a skin biopsy of a papule. The nematode larvae, which he observed actively moving in water on a slide, were in all probability microfilariae of *O. volvulus*.

In consequence of the First World War, 1914–18, not much work on onchocerciasis was carried out for some time in Africa.

America

An entirely new phase in the study of onchocerciasis began in 1915 with the discovery by RODOLFO ROBLES of the existence of *Onchocerca* infection in Guatemala. The zone of infection is situated at a height of about 600–1300 m above sea-level on the pacific slopes of the chain of volcanos which extend along the southern coast of the country. ROBLES also discovered a causative relation between *Onchocerca* infection and eye lesions, which in some cases improved or even disappeared after excision of the *Onchocerca* nodules. ROBLES furthermore suspected *Simulium* species as transmitters of the infection.

The literature of onchocerciasis is already very large (see SPOTO, 1950), and only a few publications connected with historical aspects are considered in the present study.

Bibliographies and reviews are found in STRONG et al., 1934, 1938; BENITEZ SOTO, 1946; RUIZ REYES, 1952; MARTÍNEZ BÁEZ, 1962; FIGUEROA MARROQUIN, 1963; Editorial Universitaria, Universidad de San Carlos de Guatemala, vol. No. 43, 1963.

As ROBLES made his great discovery during the First World War, the first announcements appeared in two journals 1916 and 1917 (Editorial in 'La Republica' 1916 and CALDERON in 'La Juventud medica' 1917) which were not widely known outside Guatemala (note 2). In 1919 ROBLES published his discovery in the *Bulletin de la Société de Pathologie Exotique* with the result that investigators in increasing number studied onchocerciasis, which nowadays in Latin America, especially in Guatemala, is generally known as 'Enfermedad de Robles' – Robles Disease.

In 1923 FÜLLEBORN expressed the opinion that human onchocerciasis existed also in Mexico. His opinion was soon confirmed and many Mexican workers contributed valuable studies on the various problems of onchocerciasis.

BRUMPT, 1919, regarded for biological reasons the American

Onchocerca, which he named *Onchocherca caecutiens*, as different from the African *O. volvulus*. BRUMPT's opinion was not generally accepted – see, however, the recent work by WOODRUFF et al., 1966, and ROMEO DE LEON and DUKE, 1966.

The eye lesions in onchocerciasis aroused special interest. The pioneer in these ophthalmological studies in the Western Hemisphere was RAFAEL PACHECO LUNA, 1918 (Guatemala). Early Mexican investigators in this field were ISAAC OCHOTERENA, 1930; LARUMBE, 1930, and JUAN LUIS TORROELLA, 1930.

Stimulated by ROBLES' discovery, work on onchocerciasis was intensified in Africa (STRONG et al., 1938), and it was found that here, similarly as in the Western Hemisphere, the infection damages the eyes. The early studies in the Congo of the eye lesions due to onchocerca by HISSETTE, 1931, were especially valuable.

The hypothesis of ROBLES that *Simulium* species were the transmitters of *Onchocerca* was confirmed by numerous investigators, among them BLACKLOCK, 1926, and BEQUAERT, 1938, in Africa, and C. C. HOFFMANN, 1930, DAMPF, 1931, and VARGAS, 1945 (numerous publications, see M. MARTÍNEZ BÁEZ, 1962) in Mexico and DALMAT, 1954, 1955, 1956, in Guatemala.

In 1947 a very small focus of onchocerciasis was discovered in Venezuela and in 1965 a case of ocular onchocerciasis was found in Colombia in a patient who had never left the country (GEORGES ASSIS-MASRI and M. D. LITTLE, 1965). Subsequently investigators from the Universidad del Valle in Cali, Colombia, and the Tulane University in New Orleans found 43 cases of onchocerciasis in 312 persons living in the village of San Antonio (personal information by Dr. B. B. Waddy, London).

The foregoing very brief review shows that the documentation of human onchocerciasis in Africa goes back to 1875 (O'NEILL) and 1892 (LEUCKART and MANSON). In Guatemala ROBLES made his great discovery in 1915. A focus of *Onchocerca* infection was discovered in Venezuela in 1947 and in Colombia as recently as 1965. There remains the possibility that foci of onchocerciasis will be found in the course of time in other parts of South America.

Among the millions of negro slaves carried from Africa to America during the centuries of the slave trade, there must have been many with *Onchocerca volvulus* infection, especially as a large percentage of the slaves came from the African west coast and other regions where the infection is widespread. Onchocerciasis might have established itself in Mexico, Central- and South America, provided climatic, geographical and botanical conditions for a transmitter were favorable.

We are confronted with the main question whether human

onchocerciasis was introduced into the Western Hemisphere by negro slaves from Africa or whether it was autochthonous in America and existed there long before the coming of the Spaniards, so that negro slaves with onchocerciasis to some extent merely have added to the infection.

Hypothesis A

Onchocerciasis was introduced by negro slaves from Africa during the time of the slave trade; it did not exist in the Western Hemisphere before.

In examining the publications supporting this theory one finds that the authors are not in agreement about the time of introduction. Apart from those who regard onchocerciasis as having been introduced already in the first period of the slave trade, there are others who assume that the introduction took place at a much later time. Some believe that the disease became known only in the first half or the middle of the 19th century (RUIZ REYES, 1952). JAVIER TORROELLA, 1964, is of the opinion that onchocerciasis was first introduced into Mexico by a bataillon of Sudanese sent from Egypt (Alexandria) in January 1862 to assist the French invasion troops of Napoleon III. These Sudanese came from a region where onchocerciasis is very prevalent. They established themselves in Oaxaca at Villa Alta, wherefrom they spread to the neighbouring regions. This happened at a time when, according to different writers who had lived in that area, onchocerciasis was noticed for the first time among the local population.

If one assumes that these comparatively few Sudanese soldiers introduced onchocerciasis into Mexico, one has to admit that among the millions of negro slaves imported during the 300 years of the slave trade, many were infected and must have brought the infection to the New World. The question arises why onchocerciasis has nowadays been found in America only in a few areas in Mexico, Guatemala, Venezuela and Colombia.

In answer it may be stated that the infection apparently depends on certain conditions which in many places did not exist. Geographical, climatic and botanical factors are of great importance for the transmitting *Simulium* species. A certain number of heavily infected persons are apparently required before the parasite can become self-perpetuating in a new area (ROMEO DE LEON and DUKE, 1966). Several other circumstances may also have played a rôle, for example the way how and where slaves were housed and where they worked. It is also possible that small foci of the infection disappeared and that others so far have not yet

been discovered. Many negroes were in the course of time absorbed by the Amerind population so that nowadays onchocerciasis is nearly exclusively found among Indians.

Hypothesis B

Onchocerciasis is autochthonous in America.

This hypothesis was already expressed soon after ROBLES' discovery in 1915. Among the early representatives of the theory that onchocerciasis is indigenous in America is F. DIAZ, who found a small number of pre-Columbian skulls with erosions and perforations which he attributed to *Onchocerca* nodules. He also found by X-ray examination of an *Onchocerca* patient alterations in the skull under a nodule which corresponded to those observed in a skull of the Maya period.

ROBLES, 1919, observed among 500 operated cases of onchocerciasis with nodules on the head, four with a perforation of the external and internal layer of the skull.

A pre-Columbian skull of a male adult found at Santa Maria Astahuacan D.F. is kept in the Instituto Nacional de Antropología e Historia in Mexico D.F. This skull shows on the left os frontale a digital impression which possibly may have been caused by an *Onchocerca* nodule¹.

One has to add that the total number of pre-Columbian skulls with erosions and perforations (not due to operations) which might be attributed to onchocerciasis is extremely small, compared with the total number of examined skulls and that there is no specific character of the bone lesions in onchocerciasis.

Among other representatives of the hypothesis that onchocerciasis is indigenous in America is H. FIGUEROA MARROQUIN, 1963.

FIGUEROA refers to three interesting statements in the early Spanish literature which indicate to some extent the existence of onchocerciasis at the time of the conquest.

The first report is by Pánfilo de Narváez, the antagonist of Cortéz (COUTTS, 1936). Narváez reported that during his expeditions of discovery in Central America, he found, while passing through a colder region, a population in which everybody was blind.

The second report is by FRANCISCO LOPEZ DE GÓMARA, who was chaplain of Cortéz. In his *Historia General de las Indias* (completed about 1540), speaking of 'Costumbres de Cumaná' (in Venezuela)

¹ The writer wishes to thank Prof. A. Romano for the information and for permission to see the skull.

he writes that the water of the river causes the formation of clouds in the eyes. GÓMARA refers to the river which flows through Cumaná, and it is interesting that there, in the Estado de Sucre, in the neighbourhood of Monagas, onchocerciasis was for the first time discovered in Venezuela.

The third report was given about 150 years later by FRANCISCO ANTONIO DE FUENTES Y GUZMÁN in his *Recordación Florida* (written between 1675 and 1699). He states that in a certain town Malacatepeque, all, or nearly all, inhabitants were blind. The town does not exist any more, but from FUENTES Y GUZMÁN's map one can see that it must have been situated in the area of the volcanos Fuego and Acatenango where onchocerciasis is nowadays prevalent (see FIGUEROA, 1963).

The first two reports date from the first half and the middle of the 16th century, the third report was written in the last quarter of the 17th century.

One has to keep in mind that modern investigations have shown, as is obvious, that even in areas with heavy *Onchocerca* infection not all people are blind. There is, however, the possibility that the old Spanish chroniclers were so impressed by a comparatively large number of blind people that they exaggerated the number of cases (note 3).

Regarding a document supposedly sent to Spain at the time of Philip II (1556–98) describing the existence of onchocerciasis, see note 4.

As mentioned before, BRUMPT, 1919, expressed the opinion that the African and the American *Onchocerca* are two different species. Although he could not find morphological differences, he judged their biological differences as sufficient to regard the American form, which he named *Onchocerca caecutiens*, as a new species. As already stated, BRUMPT's view was not generally accepted. Recent research by WOODRUFF et al., 1966, and by ROMEO DE LEON and DUKE, 1966, however, gave results which support the view that the African and the American strain may have been evolving separately since the Continental Drift (KERSHAW, 1964). They show considerable differences regarding clinical features (WOODRUFF et al., 1966) and transmissibility by African and American *Simulium* species (ROMEO DE LEON and DUKE, 1966), so that ROMEO DE LEON and DUKE regard central American onchocerciasis as an indigenous infection, differing in many respects from onchocerciasis in Africa. These authors are of the opinion that the American disease may be referred to as 'Enfermedad de Robles', different from African onchocerciasis. One has, however, also to consider the possibility that people in Guatemala and in

onchocerciasis regions in Africa may differ in their reaction to similar parasites.

Whether or not one regards onchocerciasis as autochthonous in America, one has to admit that infected African negroes during the centuries of the slave trade must have introduced onchocerciasis into regions with suitable transmitters of the Western Hemisphere, where in certain areas the infection may have already existed.

Notes

1. Several authors stated in their publications that the first description of *Onchocerca volvulus* was given by LEUCKART in 1893. In that year LEUCKART published the second edition of his book 'Die Parasiten des Menschen und die von ihnen herrührenden Krankheiten'. This work contains no reference to *Filaria (Onchocerca) volvulus*. DALMAT, 1956, discusses in detail the early descriptions by different authors. MANSON was the first who mentioned the parasite in the literature.

2. The first two publications dealing with onchocerciasis (Robles disease) in the Western Hemisphere are:

a) Editorial: *Una enfermedad en el continente ha sido diagnosticada en Guatemala*. Diario "La República" 26 (8437); 1 y 4, 29 dic. 1916.

b) CALDERON, V. M.: *Enfermedad nueva en Guatemala*. "La Juventud médica" 17 (8): 97-115, agosto 1917.

3. The early Spanish chroniclers may have exaggerated the number of blind people whom they met in some places. It is, however, of interest that even in the first quarter of the 20th century, there were in Mexico localities with many blind inhabitants. An example was Tiltepec in the Sierra de Ixtlán, Oaxaca.

JOSÉ E. LARUMBE, 1930, who during several years visited Tiltepec and described the local conditions in various publications, found onchocerciasis as the cause of the blindness.

4. A report supposedly sent from Mexico to Sevilla in 1571 describing the clinical symptoms of onchocerciasis as we know them to-day "bolas que se forman en la cabeza, ojos que se arrugan y van perdiendo la noción de ver y piel que se torna en pergamino" is apparently spurious and the product of the fertile imagination of a modern writer. The document could not be found by several investigators in the Archivo de Indias in Sevilla, in the archives of Simancas and in the Archivo General de la Nación in Mexico D.F. For details see: H. FIGUEROA M., 1963, p. 18.

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III

Blood Flukes

Schistosoma haematobium and *S. mansoni* – Schistosomiasis

Africa

RUFFER found calcified eggs of *S. haematobium* in the kidneys of two mummies of the twentieth Dynasty, ca. 1200–1075 B.C. and in this way proved the existence of the infection in ancient Egypt (RUFFER, 1910, 1921).

Some authors, e.g. EBBELL, 1937, and JONCKHEERE, 1944, expressed the opinion that haematuria, due to *S. haematobium* infection, is mentioned in ancient Egyptian medical texts under the name *âââ* as 'Hématurie parasitaire'¹.

GHALIOUNGUI, 1962, does not share the opinion that *âââ* represents schistosomiasis. He regards *âââ* as a condition existing in polyinfestation with a number of different helminths, including *Schistosoma*, *Ancylostoma*, *Ascaris* and *Taenia*. As the ancient Egyptian physicians evidently did not see *Schistosoma* and probably also not hookworm, but only larger worms such as *Ascaris*, *Enterobius* and *Taenia*, they probably regarded the latter as caused by *âââ* and responsible for the disease and haematuria.

In an interesting paper GHALIOUNGUI, 1962, has illustrated and discussed reliefs from two tombs of the Ancient Empire in Sakkarah (the tomb of Ptah-Hetep I and the tomb of Mehou, a notable of the VIth Dynasty). In the first mentioned tomb several men are shown with umbilical hernia.

In Mehou's tomb some figures show abdominal distension, scrotal swelling, phallic hypertrophy and complications with inguinal and abdominal hernia. These changes may have been due to chronic schistosomiasis with cirrhosis of the liver, especially as the people represented are peasants, fishermen and bargemen. In one

¹ *âââ*: *ꜥꜥꜥ* (Ajin, Aleph, Ajin).

of the reliefs there is a figure with gynaecomastia, a feminine enlargement of the breasts. Gynaecomastia is known to be occasionally associated with cirrhosis of the liver.

The mentioned changes shown in the reliefs of Sakkarah reproduced by GHALIOUNGUI make it likely that they represent symptoms of chronic schistosomiasis.

Already in 1902 VON OEFELE drew attention to the loss of the male habitus in some persons with chronic *S. haematobium* infection. They become somewhat obese with a rounded contour of the body, protruding belly and gynaecomastia. They acquire to some degree a feminine appearance.

VON OEFELE pointed out that the Nile-god represented in Egyptian statues and reliefs shows a similar, somewhat feminine habitus. VON OEFELE assumed a correlation between the representation of the Nile and the appearance of persons with chronic schistosomiasis, especially as the red colour of the Nile during its rise might have been regarded as an annual menstruation, just as the Fellaheen regarded the haematuria of their boys infected with *S. haematobium*, usually showing itself at puberty, as a kind of male menstruation.

GHALIOUNGUI and DAWAKHLY, 1965, illustrated a relief showing a procession of deities bearing offerings². Among them is *Hapi*, the Nile-god, *Wadj-Wr*, the Ocean-god and *Npri*, the god of wheat. These three gods are shown as obese men with beards but with pendulous breasts and bellies and a general feminine appearance as sign of their nutritive nature.

There are also other male gods with a similiar feminine habitus, so that the Nile is only one of them and VON OEFELE's theory of a correlation between the representation of the Nile and people suffering from chronic schistosomiasis and cirrhosis of the liver with haematuria is difficult to maintain.

Schistosomiasis is widespread in Africa. *S. haematobium* occurs in North Africa from Morocco to the Nile, the infection is especially frequent in Lower Egypt. It occurs in West Africa from Senegal to Angola, in the Sudan and in South and East Africa (BATHO, 1870), furthermore in Madagascar.

S. mansoni exists in Lower Egypt, in the Sudan, in East-, South- and West-Africa and in Madagascar.

In the Western Hemisphere it has been found in Brazil, Surinam, Venezuela, Puerto Rico and in some other islands of the Antilles.

² The relief is kept in the Egyptian Museum in Cairo and belonged originally to the temple of Sahu-Rē, Abusir.

THEODOR BILHARZ (1825–1862) discovered in 1851 *Schistosoma haematobium* (*Bilharzia haematobia*) at an autopsy in Cairo. From 1851–1853 he wrote nine letters to his former teacher C. Th. von Siebold, Professor of Zoology at Breslau (Wrocław), and informed him in detail about his discovery and about the pathological changes in the wall of the urinary bladder, which he regarded as due to the infection as they contained worms and eggs. The eggs in the bladder wall had a terminal spine. He found also eggs with a lateral spine but no worms in the intestinal wall and in the liver in cases with the clinical symptoms of dysentery. Von Siebold published the letters of BILHARZ in the *Zeitschrift für Wissenschaftliche Zoologie* 4 (1853) 53 ff. and 454 f., and his drawings in the Tafelband of the *Zeitschrift* (1853), plate V and XVII. (For additional details, see SCHADEWALDT, 1953).

Drawings in black and white and also with colour-pencils of the pathological changes in the mucosa of the urinary bladder due to *S. haematobium* infection were made by the brother (Alfons) of Theodor Bilharz in 1859–60, while he visited Cairo. They represent the earliest illustrations of schistosomiasis of the bladder. One drawing has been published, although greatly reduced, by AHMED ABDALLAH in his paper *The Fight against Schistosomiasis in Egypt*, Ciba Symposium vol. 9, no. 3, 1961, pp. 102–108³.

Due to the work of SAMBON and of LEIPER, 1918, the existence of two different species was definitely proved: *S. haematobium* with terminal spine eggs and *S. mansoni* with eggs provided with a lateral spine.

The clinical symptoms of *S. mansoni* infection were not well known until the second half of the 19th century and were often attributed to dysentery.

Haematuria, a characteristic symptom of *S. haematobium* infection, and occasional changes of the outer male genitalia were observed and mentioned already from Egypt by PROSPER ALPIN (PROSPERO ALPINI, 1553–1616), likewise the comparatively frequent occurrence of bladder stones in the population of Lower Egypt.

These symptoms, especially haematuria, drew the attention of French physicians during Napoleon's invasion of Egypt (RENOULT, 1808, and LARREY, 1812–1817) who, however, without knowledge of the nature of the disease attributed the symptoms to very dif-

³ The reduced reproduction was made from one of three original drawings belonging to Prof. H. Vogel, Hamburg. The writer wishes to thank Prof. Vogel for having given him details regarding the history of the drawings and for having sent him reproductions in the size of the originals.

ferent causes, e.g. to the climate of Egypt and to a faulty transpiration.

According to R. BLANCHARD, 1904, the Zulus of Rhodesia believed that haematuria was caused by some animal which entered through the urethra while the person took a bath. Therefore, before entering the water, they applied a ligature around the penis or used a kind of protective cover made of fine grass fibres, resembling somewhat the finger of a glove (illustration in BLANCHARD's publication).

Protective covers of the penis, especially of the glans, were widely used in different parts of Africa and are even shown on prehistoric wall paintings (note).

In the central part of Sierra Leone, in the Kpa Mende area, old people call haematuria due to schistosomiasis *red gonorrhoea*. They believe that it is transmitted to males and females by evil spirits whenever people take a bath outside their house at night or bathe in streams and rivers during day-time. These evil spirits supposedly hate to see naked people and punish them by giving them 'red gonorrhoea'.

In the eastern part of Sierra Leone, in the Kono area, people likewise call haematuria, due to schistosomiasis, 'red gonorrhoea'. They believe that they get it from their streams and rivers, the water having been poisoned by witch doctors.

In the northern part of the country in the Temne area, people hold the opinion that they get 'red gonorrhoea' from their streams when the water enters the male and female organs. To prevent the disease they apply a 'T' shaped country cloth as a bandage. They believe that people suffering from red gonorrhea contaminate the water.

For treatment they use infusions prepared from pounded leaves of various plants and from the bark of the Mbeli tree *Harungana madagascariensis*⁴ cut into small pieces with addition of palm wine (personal information by Mr. N. Williams of the Liberian Institute of the American Foundation for Tropical Medicine).

America

Negro slaves infected with *S. haematobium* or *S. mansoni* carried their parasites to the New World, but in the absence of snails, which could serve as intermediate host for *S. haematobium*, this parasite could not establish itself in the Western Hemisphere.

⁴ The writer is obliged to Dr. G. Verhaar of the Firestone Plantation Co., Harbel, Liberia, for identification of the tree.

It was different with *S. mansoni* which found suitable intermediate hosts in parts of Brazil, Venezuela, Puerto Rico and on some other islands of the West Indies.

It is the opinion of the great majority of investigators that *S. mansoni* infection was not autochthonous in the Western Hemisphere but was introduced by negro slaves from Africa. It could be demonstrated that the infection was primarily established in those places where slaves had been imported as in the North East of Brazil, Surinam, Venezuela, Puerto Rico and some other islands of the Antilles. The slaves came from parts of Africa where the infection exists.

In Brazil, MARTINS, 1958, found natural infection of wild and domestic rodents with *S. mansoni* rather common in all areas of schistosomiasis which have been investigated. He concluded that in Brazil schistosomiasis was imported by negro slaves from Africa and therefore man was the primitive host of *S. mansoni* which afterwards adapted itself to rodents.

Among the few investigators who believe that the infection with *S. mansoni* is autochthonous in Brazil are BERNARDO FIGUEIREDO MAGALHÃES and CAIO BENJAMIN DIAS (1944). They base their opinion on reports of a disease along rivers which existed before the arrival of the Portuguese and which showed symptoms similar to those found in *S. mansoni* infection.

Note

STÉPHEN-CHAUVET, 1936, gives illustrations of protective covers of the glans penis in different forms from Togo, from the Zulus and from the Bassari of former French Guinea. He also reproduces prehistoric wall paintings from Southern Rhodesia and from Tassali des Ajers (Sahara), showing protective covers of the glans in different shapes. These covers were evidently used not only for prevention of diseases but also to protect the glans against injury. The fact that they are shown on prehistoric wall paintings in such distant parts of Africa as the Sahara and Southern Rhodesia indicates their widespread use.

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