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Distribution of Leishmaniasis in the Old World

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The area of distribution of leishmaniasis is determined by the distribution of its nosogeographical forms, these being determined by the composition of the parasitic system (parasite–vector–host) and by environmental conditions. There are three distinct nosogeographical forms of visceral leishmaniasis in the Old World (Mediterranean–Middle Asian, Indian, and East African forms). In the Mediterranean–Middle Asian subzone there are three types of focus : natural, semi-synanthropic, and synanthropic. This situation reflects the evolution of visceral leishmaniasis from a zoonosis to an anthroponosis. Indian kala azar is a true anthroponosis. There are two geographical forms of cutaneous leishmaniasis in the Old World: a zoonotic form and an anthroponotic form. Natural foci of zoonotic cutaneous leishmaniasis are located mainly in the deserts of Middle Asia. Foci of anthroponotic cutaneous leishmaniasis have developed mainly in those areas where zoonotic cutaneous leishmaniasis does not occur. All the known published data concerning autochthonous cases of leishmaniasis in the Old World are summarized in two maps, and a third map shows the distribution of cutaneous leishmaniasis in the USSR.

Two main forms of leishmaniasis are recognized in the Old World—visceral and cutaneous. The geographical distribution of these forms depends on the components of the parasitic system, itself determined by environmental conditions (see accompanying table).

DISTRIBUTION OF VISCERAL LEISHMANIASIS

The area of distribution of visceral leishmaniasis stretches from the Asian shores of the Pacific Ocean to the straits of Gibraltar (Fig. 1). The area is north of the equator and in the USSR and China it extends to a latitude of 45°N. Within this zone, there are areas where the disease has not occurred, notably in Indochina, South China, and Western Africa.

The area may be divided into three subzones: Mediterranean–Middle Asian, Indian, and East African (Kenya, the Sudan). The first of these, the Mediterranean–Middle Asian subzone, has a paraxenosis pattern, with man and various canids (dog, fox, and jackal) sharing the role of vertebrate host, as parallel phases of the life cycle. The agent is the so-called *Leishmania infantum* (or *L. donovani infantum*), and the vectors are the Mediterranean or palaearctic sandflies *Phlebotomus major*, *P. perniciosus*, *P. chinensis*, and *P. longicuspis*. The disease is scattered in isolated lowland or foothill foci, usually below 700 m. The maximum known height of the foci in the USSR is 1240 m in Georgia and 1500 m in Armenia.

In East China, widespread epidemic incidence is found, but cutaneous infection is absent; the principal vector is endophylic *P. chinensis*. The focus appears to be a derived one, originating from Middle Asia through the Gobi desert. The occurence in this area is now much reduced because of the control of sick dogs, the treatment of patients, and malaria eradication campaigns.

This nosogeographical form of the disease is transmitted as a zoonosis (dogs are the reservoirs of the infection in synanthropic foci, in the cities, and jackals and foxes are the reservoirs in the natural foci). Man is a biological terminal for the parasite, as the leishmania can very rarely be found in the blood. Children are mostly affected by the disease, and if not treated the infection is almost always fatal.

The largest foci were situated in Middle Asia (probably the home of leishmaniasis) and in China. Until recently independent synanthropic foci existed

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The basic nosogeographical forms of leishmaniasis in the Old World

Form of leishmaniasis	Noso-geographical forms	Parasitic system
Visceral	Indian (kala azar)	*L. donovani* → *P. argentipes* → *man*
	Mediterranean Middle-Asian	*L. infantum* → { *P. major*, *P. perniciosus*, *P. chinensis*, *P. longicuspis* } → Canidae, man
	East African (Sudan, Kenya)	*L. donovani* → { *P. orientalis*, *P. martini* } → man, rodents
Cutaneous	Wet (zoonotic)	*L. t. major* → { *P. caucasicus*, *P. papatasi* } → rodents, man
	Dry (anthroponotic)	*L. t. minor* → { *P. papatasi*, *P. sergenti* } → man, Canidae

in Middle Asia in the ancient cities, and before treatment measures were undertaken in this subzone, tens of thousands of visceral leishmaniasis cases occurred each year. The killing of infected dogs and the extermination of sandflies with the aid of DDT has greatly reduced or even eradicated visceral leishmaniasis in many cities (Tashkent, Samarkand, Andijan, Kokand, Tashaus, Osh, Kzyl-Orda, Tbilisi, Erevan, etc.). The incidence of the disease in small communities, situated in the region of natural foci, is of a sporadic nature. Every year a few new cases occur, and there is no visible connexion between the new cases and earlier cases.

As a rule, foci of this form of visceral leishmaniasis appear in places where cutaneous leishmaniasis does not occur. Comparing the two Middle Asian Soviet Republics of Uzbekistan and Turkmenia, visceral leishmaniasis prevalence is higher in Uzbekistan, where cutaneous leishmaniasis occurs only locally. The territorial incompatibility of visceral and cutaneous leishmaniasis foci is well illustrated by the distribution pattern of these types of infection in Georgia. This phenomenon is usually explained by the difference in the sandfly fauna in the various regions where leishmaniasis occurs.

The Indian subzone is represented by foci of Indian kala azar, an anthroponosis caused by *L. donovani* and maintained only between man and *Phlebotomus argentipes*. No natural reservoir has been found and this form of infection represents an extreme of the evolutionary sequence from zoonosis to anthroponosis. The causative agent can frequently be isolated from the blood and at the later stage of the disease it can also be demonstrated in the so-called post-kala-azar leishmaniasis (dermal leishmanoid).

Kala azar is endemic in the States of Assam, West Bengal, Bihar, Uttar Pradesh, and Madras and in the Union Territory of Tripura in India, as well as in East Pakistan and some regions of Nepal. It is characteristic that this form of visceral leishmaniasis has periodic outbreaks once every 15–20 years, connected with fluctuations in the proportion of immune persons in the population and the density of the sandflies. During the epidemics morbidity reaches hundreds of thousands of cases each year. Only recently (1955–56) the number of treated cases in India reached 60 000 per year, and in Pakistan it was 15 000–17 000 per year (1959–63). With the extensive use of DDT in malaria control, the sandfly density was also reduced and correspondingly the incidence of kala azar dropped. From 1947 to 1948 morbidity dropped in West Bengal by a factor of more than 40, and in Calcutta and its suburbs by a factor of 100.

Kala azar foci occur at altitudes of 200–700 m, where there is alluvial soil and much rain. A focus has also been discovered in Pakistan at an altitude

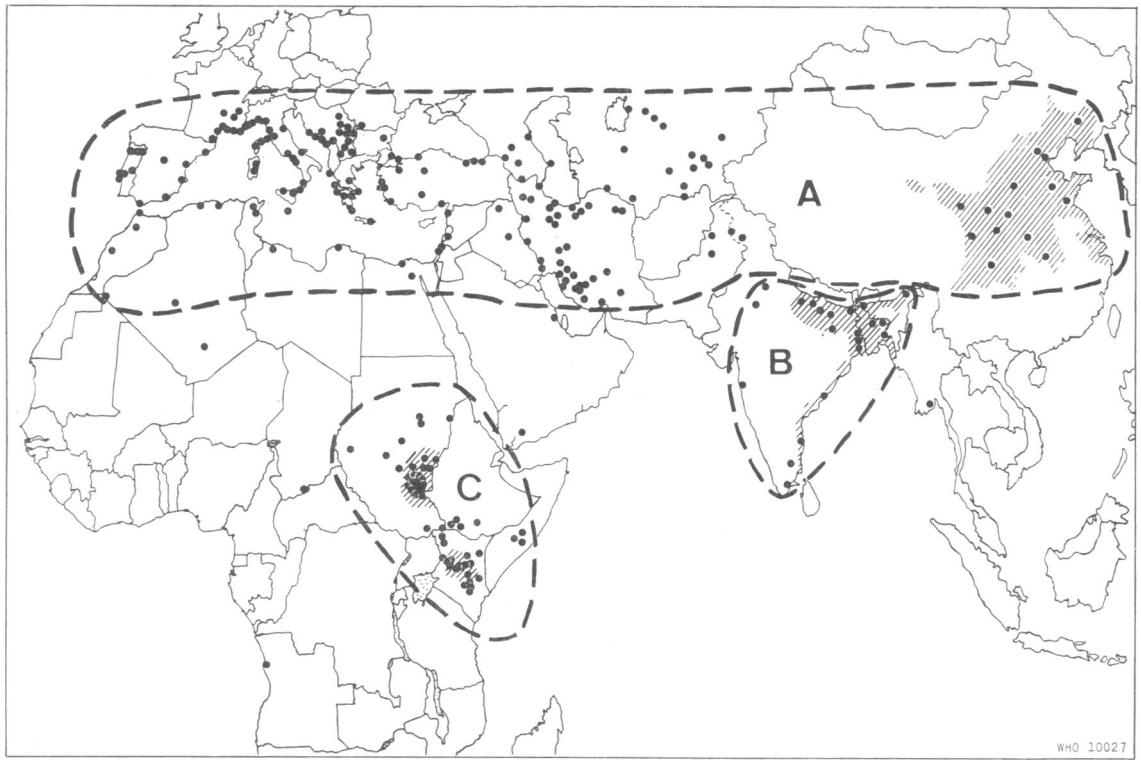

Fig. 1. The distribution of visceral leishmaniasis in the Old World.

- Sporadic cases
- Area of epidemic outbreaks
- Subzones of the different nosogeographical forms
  - A Mediterranean–Middle Asian subzone
  - B Indian subzone
  - C East African subzone

of 2400 m. In most regions (except in Kashmir and Uttar Pradesh) cutaneous leishmaniasis is absent from areas where kala azar is found. At present kala azar is not a problem from the public health point of view, but is remains to be seen what will happen after mass DDT spraying has stopped.

The East African subzone is represented by foci of visceral leishmaniasis in Kenya and the Sudan. The degree of independence of this nosogeographical form is not so clear as that of the first two. The causal agent is *L. donovani archibaldi*, the vectors are *P. orientalis*, *P. martini*, and *P. celiae*, and the main reservoir of the infection is the sick man. The clinical picture of the infection is very similar to that found with Indian kala azar. In particular leishmania can be demonstrated in the blood and in the healthy skin of the patient and even dermal leishmanoid occurs, although rarely. However, there are essential differences, in particular the discovery of leishmania in some species of wild animals (*Xerus*, *Acomys*, *Genetta*, *Felis*, and *Tatera*): the parasites were not found in the blood but only in biopsy samples (from hamsters). Moreover, when volunteers were infected with the isolated leishmania strains these turned out to be dermatropic and did not induce a generalized infection. Dogs are not involved in the East African subzone. Some investigators are inclined to regard East African visceral

leishmaniasis as a special form of the disease with a natural reservoir of infection, while others regard it as an anthroponosis that is practically identical to the Indian kala azar. It is possible that the wild animals were reinfected with *L. donovani* from man.

The East African visceral leishmaniasis occurs as sporadic cases and also as epidemic outbreaks with a periodicity of 4–5 years. It is a disease of the rural and nomadic populations and morbidity may reach hundreds of cases per year, or sometimes more than a thousand cases in one year.

The foci of visceral leishmaniasis may be divided into four types:

(1) *Enzootic natural foci* with jackals as the wild reservoir of infection (Middle Asia). Man is involved only accidentally (a few dozen cases each year).

(2) *Rural endemic foci* (semi-synanthropic foci). A domestic animal, the dog, has become involved in the circulation of the parasite. Human cases are therefore more common (hundreds per year). This situation offers the conditions necessary for an evolutionary transition to an anthroponosis.

Examples of this type of focus are:

Middle Asia: jackal–sandfly–dog–sandfly–man.

Transcaucasia, Europe: fox–sandfly–dog–sandfly–man.

(3) *Urban endemic foci* (synanthropic foci). The dog is the main reservoir of infection, and man is frequently involved. There is thus consolidation of the pattern into a paraxenosis (a stage in the evolution of an anthroponosis). Foci exist in ancient settlements of Middle Asia, Transcaucasia, the Mediterranean region (hundreds–thousands of cases per year), and east China (tens of thousands of cases by the end of the 1950s).

(4) *Endemic foci of Indian kala azar.* These constitute the final stage of the evolution of a zoonosis to an anthroponosis. Only man is involved. Epidemics involve up to hundreds of thousands of cases.

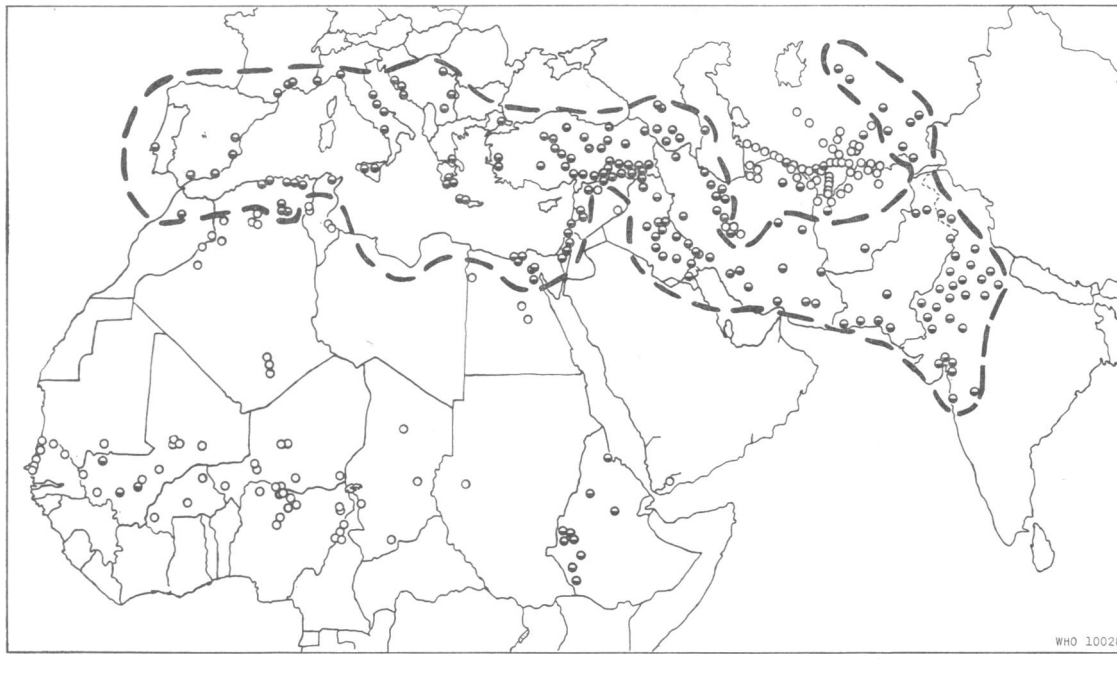

Fig. 2. The distribution of cutaneous leishmaniasis in the Old World.

- Rural (wet) form
- Urban (dry) form
- Proved area of distribution of dry form only

DISTRIBUTION OF CUTANEOUS LEISHMANIASIS

Cutaneous leishmaniasis in Asia does not occur further east than longitude 80°E (compared with longitude 120°E for visceral leishmaniasis). Territories with epidemic kala azar tend to be free of cutaneous leishmaniasis—for example, Kenya, the Sudan, and India. Cutaneous leishmaniasis foci are found in places where visceral infection is rare—for example, in West Africa, latitude 9°N–18°N (see Fig. 2). Except for West Africa all the foci of cutaneous infection lie within the area of distribution of palaearctic sandflies.

In countries other than the USSR a distinction has not been made between types of cutaneous leishmaniasis. Therefore the classification into " wet " and " dry " clinico-epidemiological forms applies chiefly to the Soviet Union.

The wet, or rural, zoonotic form (agent, *L. tropica major*) is chiefly found in various rodents on the edge of deserts. Main foci are around the Sahara Desert oases, the Syrian desert, and the Kara-Kum and Kyzyl-Kum deserts. The best known foci are in Middle Asia in the Turkmenian and Uzbek Soviet Socialist Republics, extending south to Afghanistan and Iran (see Fig. 3). The chief reservoirs of infection are *Rhombomys opimus and Meriones erythrourus*, though the range of these animals is far greater than the limits of the disease, particularly to the north.

The dry, or urban, anthroponotic form (agent,

Fig. 3. The distribution of leishmaniasis in Middle Asia and Transcaucasia, USSR.

■ Visceral leishmaniasis
□ Cutaneous leishmaniasis (dry form)
▨ Cutaneous leishmaniasis (wet form)
▧ Distribution of vertebrate animals that are reservoirs of *L. tropica major*

L. tropica minor = *L. tropica-tropica*) is chiefly found in ancient human settlements, partly within areas of zoonotic infection and partly outside them. Synanthropic sandflies in these ancient cities maintain the infection both in man and, to some degree, in dogs. Ashkhabad, Mary, and Samarkand were once such foci of infection but are now controlled. Isfahan is still an infected area.

Foci outside the natural zone of *L. t. major* include large cities, such as Algiers, Aleppo, and Kirovobad (now free of disease), and many smaller rural communities.

It is probable that the ecological conditions for the spread and survival of the rural wet zoonotic form are more stringent (hence the infection is more limited) than is the case for the urban, dry form of infection. Evidence for this is the fact that the urban form extends to the limit of its vector range, whereas the rural form does not, especially to the north. At least two passages of the agent per transmission season (i.e., the agent requires two generations of sandflies per summer) are necessary for successful establishment of the rural type. This imposes a northern limit to the distribution of the disease.

RÉSUMÉ

DISTRIBUTION DE LA LEISHMANIOSE DANS L'ANCIEN MONDE

La zone de distribution de la leishmaniose viscérale dans l'Ancien Monde est située au nord de l'Equateur et s'étend jusqu'au 45e degré de latitude nord. Correspondant aux trois formes géographiques de cette leishmaniose, il existe trois sous-zones: l'une méditerranéo-centrasiatique, la deuxième africano-orientale et la dernière indienne. La leishmaniose viscérale méditerranéo-centrasiatique donne des foyers de trois types: naturels, « semi-synanthropes » ou « synanthropes », ce qui indique un processus d'évolution d'une maladie animale vers une maladie humaine. Le kala-azar indien est une « anthroponose » pure.

L'aire de distribution de la leishmaniose cutanée en Asie ne va que jusqu'au 80e degré de longitude est. Cette forme n'existe pas en Chine orientale, au Kenya ni en République soudanaise, c'est-à-dire dans les trois zones où la leishmaniose viscérale évolue vers une maladie strictement humaine. Les foyers naturels de la leishmaniose cutanée zoonotique sont en général situés dans les déserts de l'Asie moyenne, tandis que ceux de la leishmaniose cutanée humaine se sont formés hors de l'aire de distribution de la forme zoonotique.