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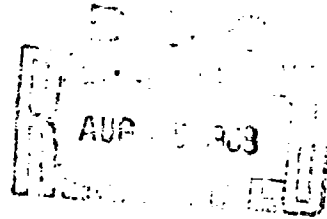
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UNITED STATES ARMY
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On the occurrence of variola among monkeys of the genera *Mycetes* and *Cebus* in the wake of a pox epidemic on the tributaries of the Alto Uruguay in the jungles of southern Brazil.

by J. C. Bleyer.

Translated from Muenchener Medizinische Wochenschrift 69:1009-1010 (1922) by the Technical Library, Technical Information Division.

The prophylactic measures against dissemination of smallpox, such as inoculation and other sanitary precautions, have not always succeeded in controlling the spread of variola in Brazil, and could not prevent penetration of this extraordinarily infectious disease into distant jungle areas. Such a dissemination of smallpox occurred in the last few years and extended into the jungles on the upper tributaries of the Alto Uruguay.

The disease initially afflicted the colonists, then spread to Indians living in so-called "aldeamentos" (very primitive Indian settlements) and to migratory Indians of the Caingaenge and Guarany tribes, whose last remnants are found on the tributaries of both banks of the upper Uruguay River. The mortality among colonists and even among Indians has been low; it can be expected that infective germs are attenuated in jungles (consisting in part of the pine *Araucaria brasiliensis* L.) rich in ozone and oxygen, and exposed to intense sunlight.

Infection of Indians in the jungles was followed by infection of simian species (*Mycetes seniculus* Kuhl and *Cebus capucinus* Erxl) found relatively often in these distant jungle areas. Cadavers of these monkeys were found under trees from which they had fallen. Diseased and dead animals were covered with numerous variola pustules which due to the furry coat were less visible than in man. *Cebus*-monkeys affected by the disease were seen wringing their hands... Mortality among these pox-infected animals was extraordinarily high in certain areas, as reported to me: In some isolated forest regions these two species even died out. The sick monkeys also suffered from mosquito bites and certain dangerous flies that deposit their eggs or larvae in body cavities or sores (*Musca*, *Sarcophaga*, *Compsoomyia*), from infection by blood-sucking species such as *Chrysops*, *Tabanes*, *Phlebotomus*, etc. Monkey cadavers were consumed by wild animals, especially by vultures (*Cathartes aura* et *foetus* Ill.), foxes (*Canis azarae*, *Nauricol*), and partly by ants, wasps and

fly larvae; starving or wild dogs also ate the carrion. It is clear that these carrion-eating animals can contribute to the spreading of variola under variegated conditions. -- I want to add to the discussion of variola dissemination by animals that the number of species capable of spreading pathogens is much greater in the tropical and subtropical regions than normally suspected. As an example, on hot and dry days I have seen pretty, multicolored butterflies of the Brazilian tropics and subtropics (belonging to the families Papilio, Pieris, Heliconia, Vanessa, Morpho, etc.) sitting on human and animal excrements, even bloody feces, and on putrefying animal cadavers, whose lymph-like secretions they sucked through their long proboscis, wings spread apart. A few beats of their wings carry the butterflies onto flowering weeds, plants and bushes in neighboring gardens and near inhabited dwellings: Infection with pathogens carried by butterflies that have rested on putrefying cadavers is therefore quite likely. A more prophylactic part is played in Brazil by the beetle family Scarabaeidae; the members of this family, frequently quite large, gold-green to black beetles equipped with a peculiarly keen sense of smell, undermine the cadavers or decomposing excreta (feces, sputa) and in this manner remove them from the surface and from the reach of numerous harmful species of flies so prevalent in the southern climates, which disseminate agents of disease. I have frequently watched the odd behavior of these eminently useful beetles, whose properties resemble those of the European family Sylphidae (sylpha, necrophorus), during the eruption of small epidemics, near huts on the jungle's edge. Schomburgk (1) has pointed to the rare properties of these Coleoptera in his "Travels in British Guiana in 1840-1844." This explorer reports that "the speed with which Phanaeus Minas and Jasiac assemble around a dead animal or a piece of meat is as unusual as the speed with which they bury them. The cadaver has barely been thrown down before they come flying from all directions like vultures, alight near the carrion, crawl under it and begin to tunnel until, within a short time, a pile of loose earth marks the spot where death becomes the fertile source of life.

The mild course of the disease among natives, the contrasting affection of the aforesaid simian species in the jungle, the absence of permanent scars in most cases seen among colonists, the unusually rapid dissemination of variola epidemics with unusual progressions over extended regions of central and southern Brazil suggested to some physicians that a new, special form of variola was involved which had been introduced from other continents and which permitted an analogy with "Sanaga pox" mentioned in southwest Africa by Plehn (2) and Schroeder (3), with "pockie" of the Bergdamara negroes and "amas" or "Kaffir milkpox." It is not easy to agree with this opinion off-hand for practical and scientific reasons. I have frequently seen very mild forms of this pox disease in southern Brazil among whites, mixed breeds and, less often, among negroes, both adults and children, with the clinical appearance of so-called European "windpox" (varicellae); in other instances the same family harbored such mild cases side by side

with individuals who had very severe, characteristic symptoms of smallpox, such as suppurating pustules with depressions, confluent pustules, ecchymoses 10-11 cm long and about 4-5 cm wide, usually on the extremities, less frequently on the trunk. Such seriously ill persons often had intercurrent nephritis accompanied by edema of the lower and upper extremities; some patients had bloody diarrhea. Isolation and careful hygienic-dietetic and therapeutic treatment of such patients seemed urgently indicated if they were to be saved. Persons previously vaccinated with fresh calf's lymph were almost never affected by the pox disease. The pathogens of variolar diseases presumably do not only adjust to specific circumstances, but ought to be subject to the universal laws of evolution in the course of time, as all large and small organisms: the possibility of change or mutation of such small microorganisms into new forms cannot be discounted for this reason.

An item of medico-historical interest involves a report of devastating variola epidemics in the 17th century A.D. among Indians of the wilderness near the Alto Uruguay. A satisfactory explanation therefor is offered by the introduction of poxvirus by ill persons who sailed from Europe to Paraguay and thus disseminated smallpox among Indians in missions established by Jesuit fathers. Thus the missionaries Dias Tauho and Montoya report a frightful smallpox epidemic in 1687 among Indians of the Guanana tribe on the Alto Uruguay. Led by converted Indians, the zealous padres penetrated into the nearly endless wilderness (4) on the upper Uruguay and encountered suffering, dying and dead natives of all ages, victims of the epidemic. As reported by the pious Jesuits, they not only comforted the suffering and dying, but also helped bury the dead in order to prevent consumption by wild animals. Neither the padres nor the hapless natives possessed spades; one can imagine the difficult labors with which the missionaries discharged their responsibilities. I have witnessed the burial of an Indian from the Caingaenge tribe in the jungle near the Chapeco, a tributary on the right bank of the Uruguay River. I saw on this occasion that the Indians loosened the hard earth at the grave site with the aid of pointed stakes and then tried to scoop out a pit with their hands. The corpse and his pitiful belongings were then placed in it, supported by branches. I recalled this difficult mode of burial among jungle Indians when I read excerpts of the travelogue written by (5) Dias Tauho and Montoya when they visited the upper region of the Uruguay. I had occasion in recent years to see the existing jungles on the Uruguay's upper tributaries and the remaining Indian population, most of which is in the process of dying out.

Summary

Pathogens of variola, introduced into the jungles on the upper tributaries of the Uruguay under various circumstances, not only caused smallpox infections among colonists and Indians, usually in a mild form, but also spread to monkeys of the genera *Mycetes* and *Cebus*, in which they took a severe form that brought great devastation.

Dissemination of variola in jungle regions is promoted under favorable conditions by numerous members of the animal kingdom, such as mosquitos, harassing or blood-sucking flies of the genera *Musca*, *Sarcophaga*, *Comptosia*; *Tabanus*, *Chrysops*, *Stomoxys*, *Phlebotomus* and others; ants, wasps, even butterflies (*Papilionidae*, genera *Papilio*, *Pierus*, *Heliconia*, *Vanessa*, *Morpho*, etc.), which on hot, dry days are attracted by pathological excretions, even sanguineous human and animal wastes; also by such carrion-eating animals as foxes (*Canis azarae*, Neuwied), wild dogs, vultures (*Cathartes aura et foetus*). A more useful part is played in Brazil by the family *Scarabaeidae* of *Coleoptera* (genera *Phanaeus*, *Copris* and others). Its numerous species, equipped with an unusually keen sense of smell, remove fresh, pathological excreta (feces, sputa) from the surface by undermining and thus prevent contact with the enormous number of flies that disseminate pathogens in the southern climates.

Prophylactic measures against variola (with the exception of vaccination) require much more care in the southern zones than elsewhere due to the large number of animal species that may act as vectors under certain conditions. The natural transmission of human smallpox to monkeys of the genera *Mycetes* and *Cebus* in the jungles of Brazil indicates that preventive measures directed against variola should not be subjected to undue limitations.

Notes

(1) Rich. Schomburgk: Travels in British Guiana in 1840-1844. Leipzig.

(2) see Scheube: Tropical diseases. German edition, G. Fischer, Jena 1910, pp. 1030. -- It would be interesting, from the scientific viewpoint, to learn whether pox diseases have been observed among the African species of monkeys, especially the anthropoids, and the form which variola takes in these animals.

(3) Pustular secretions of diverse origin, when transferred with a sterile knife to sterile gelatine in sterile glass tubes closed with sterile or burnt cotton, usually developed into grayish-white cultures. Only a few plates showed several yellowish or greenish stripes amidst the grayish-white cover. These cultures persisted for about 8 months when stored indoors without exclusion of light, after which they began to dry out. Unfortunately I was unable to send these cultures to scientific institutes in Europe for special studies.

(4) and (5) not available.