

of technical literature services. As another step toward making these services available a revised schedule of corporation and institutional membership fees is announced. The minimum fee for permanent membership, which has been \$100 for any corporation or institution, remains at this level for laboratories having ten or more research workers. For smaller laboratories it is based on the size of the research staff. Full information about the library as a non-profit service institution may be obtained from the Hooker Scientific Library, Central College, Fayette, Mo.

THE annual California Audubon Convention was held at Santa Barbara from January 23 to 25. The exhibits included paintings by and objects connected with Audubon, and these were discussed by Donald Culross Peattie, who also spoke on the life of Audubon. There were shown many colored motion picture films and Kodachromes, such as those of Mrs. Laurel Reynolds of California birds, Mr. Hoff's life history of the brown-tailed humming-bird, Mr. Harwell's picture of the Audubon Nature Camp in Maine, Mrs. Hood on the young of the California woodpecker and F. F. Gander on Lower California.

THE Council on Dental Education of the American Dental Association has issued a series of recommendations to the dental schools of the United States with reference to an acceleration of their work for the period of war emergency. These recommendations are essentially: That such acceleration be undertaken where it is possible without loss in teaching effectiveness; that there be no reduction in the number of hours devoted to the dental course; that so far as practicable the accelerated program should begin June, 1942. The council plans to gather data from the various schools concerned regarding the additional financial burden on the school and student. This information will be used to make known to university officials and Federal agencies the financial needs of dental education.

PROVISIONAL commissions as ensigns will be granted by the Navy, on application by students, to young men taking pre-medical college work who have been accepted for the next entering classes in Class A medical schools. After completing medical courses and serving internships of one year each, they will be commissioned as lieutenants, junior grade, and called to active duty. The granting of provisional commissions will serve to prevent the drafting of such students.

DISCUSSION

INSECTS AS CARRIERS OF POLIOMYELITIS VIRUS

IN SCIENCE for December 19, 1941, A. B. Sabin and Robert Ward report the recovery of the virus of poliomyelitis from the bodies of certain flies. Their account leaves no doubt as to the presence of active virus as shown by its infectivity for *Cynomolgus* monkeys when the latter received simultaneous doses of the insect material through several portals (intraperitoneally, intranasally and by mouth). As they cite several other similar recoveries besides those recently reported by Paul *et al.*¹ it is clear that the virus of poliomyelitis may be acquired under natural conditions by certain flies and may temporarily retain its virulence on or within their bodies. Where the flies may have obtained it must remain conjectural, but it is reasonable to suppose that it may have come directly from human alimentary dejecta or secondarily from sewage, since the active virus is well known to be recoverable from these media. It has, of course, long been known that houseflies (*Musca domestica*) fed on suspensions of spinal cord may retain the virus on the body or within the alimentary tract in an active condition for a limited time.

If, as seems highly probable, poliomyelitis is spread

¹ J. R. Paul, F. D. Trask, M. B. Bishop, J. L. Melnik and A. E. Casey, SCIENCE, 94: 395, 1941.

in some way through the agency of insects, it is very important to know what species are involved in all experimental studies. Sabin and Ward refer in one case to "flies—mostly large green ones and many house flies" and at another place describe a sample used to infect a monkey as containing small houseflies, green flies, large black flies, a moth, a caterpillar and a four-winged insect. Considering the great diversity of insects and the high specificity that exists between certain insect-borne diseases and particular insect vectors, such identifications are naïvely vague for an otherwise carefully executed experiment. One may guess that the large green flies were probably a species of *Lucilia* which commonly visits feces or garbage but does not ordinarily contaminate human foods. The houseflies were probably correctly identified, as this is our commonest domiciliary species. The "small houseflies" may have been the same, or possibly the more diminutive *Fannia canicularis*, often numerous in houses, but having very different habits. The large black flies are still more indefinite. They were hardly the large blood-sucking *Tabanus atratus* and most likely refer to some species of *Cynomyia* or a related genus. The materials with which traps are baited determines to a great extent what species may be caught, and blood-sucking flies are attracted almost

exclusively only to living animals. The caterpillar was no doubt innocuous; some species are a favored delicacy not only for monkeys but for human aborigines in many parts of the world. Altogether, in these studies, it is clear that the suspected culprit (if specific) has escaped identification by mingling with a motley crowd of other insects.

There are numerous facts relating to the epidemiology of poliomyelitis that are readily compatible with the belief that insects are at least a major factor in its spread. Many of these are utterly at variance with the assumption so long current that it is spread by healthy human carriers, although they have commonly been disregarded by the proponents of this view.

During the early epidemics of poliomyelitis in Massachusetts and later at the time of the great outbreak in New York City in midsummer, 1916, the writer attempted to correlate the epidemiology of this disease with reference to some possible insect vector.^{2,3,4} There are wide differences among the several insects known to be vectors of disease, with reference to distribution, seasonal prevalence and association with the artifacts and ecological changes introduced by civilized life in varied types of human communities. On account of the immutable instinctive behavior of insects in general and our extensive knowledge relating to special groups like mosquitoes, biting flies, fleas, lice, *et al.*, it is by no means idle speculation to apply the deductive method in considering their possible relationship to the epidemiology of a disease like poliomyelitis. Experimental research in several other directions has so far developed no clear picture either of the manner in which poliomyelitis is spread during epidemics, or of how sporadic cases arise. Exact geographical, ecological and seasonal prevalence, relation to lanes of human and animal movement, barriers to insect and animal migration, breeding places, food preferences and the like are differential characteristics of particular insects and as such they are highly significant in this connection.

Preliminary studies, conducted in Massachusetts during 1911 and 1912, indicated a possibility that the biting stable-fly (*Stomoxys calcitrans*) might serve as an insect vector. Corroboratory work by Rosenau and Brues⁵ in transmitting the disease in rhesus monkeys by the bites of this fly were promptly confirmed by Anderson and Frost.⁶ However, these results could not be repeated by the same workers, nor by others who later made the attempt, and it was obvious that

some factor had been overlooked in the first trials; perhaps epizootic parasites like fleas may have escaped attention.

In 1916 a considerable amount of circumstantial evidence was brought to light indicating that poliomyelitis might depend upon dissemination by some insect incapable of free and rapid migration. On this basis it appeared from considerations of seasonal prevalence, distribution in human communities, lines of migration and apparent scattered endemicity, that poliomyelitis is strikingly similar to bubonic plague in its epidemiology. Thus, the pattern of epidemics in relation to population density, their spread with little reference to human travel or activities and the paucity of multiple cases in families, are all prominent features of both poliomyelitis and bubonic plague. The latter is, of course, in recent times restricted almost entirely to tropical regions. It was not recognized then that any rodent was susceptible or capable of acting as a reservoir of poliomyelitis, and desultory attempts at that time to demonstrate the virus in trapped rats were unsuccessful. At about the same time, Richardson⁷ had pointed out certain peculiarities of the epidemiology of poliomyelitis that led him to suspect some association with rats. The virus can now readily be propagated in certain rodents, following the discovery by Armstrong in 1939 that the cotton rat (*Sigmodon hispidus hispidus*) is susceptible to the experimentally implanted virus.

As it grows increasingly evident that the spread of poliomyelitis can not be traced to direct human contact nor to indirect contact through healthy human carriers, medical investigators have naturally turned their attention to other likely channels of infection, and certain flies are now under suspicion in connection with the belief that the alimentary canal is a common portal of entry for the virus in the several clinical types of poliomyelitis.

Inasmuch as the whole epidemiological picture dovetails very closely with the well-known habits, distribution, channels of migration and other ecological peculiarities of rats and their attendant fleas, a strong suspicion rests upon these animals. Whether it is a reality must await direct experimental evidence.

Since the precautionary measures most generally advocated to restrict the spread of poliomyelitis are based on the assumption of infection through personal contact, it is particularly urgent that the possibility of insect vectors receive discriminating attention and experimentation.

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² C. T. Brues and P. A. E. Sheppard, *Jour. Econ. Entom.*, 5: 305-324, 1912.

³ C. T. Brues, Monograph on Epidemic Poliomyelitis in New York City in 1916, pp. 136-177, 1917.

⁴ C. T. Brues, *Scientific Monthly*, 16: 471-478, 1923.

⁵ Bull. State Bd. Health, Massachusetts, Vol. 7, p. 1733, 1912.

⁶ Public Health Repts., 27: 1733, 1912.

⁷ *Boston Med. Surg. Journ.*, 175: 397-400, 1916.