REVIEWS AND ABSTRACTS

Editor's Note: In addition to Mr. Harry H. Stage's invaluable Bibliography ("References to Literature of Interest to Mosquito Control Workers"), Mosquito News will try the experiment of adding a section for **Reviews and Abstracts**, of books, and of articles published elsewhere that may be of special interest to mosquito control workers. To be successful, this new section must have the cooperation of members and readers everywhere. Members should prepare for publication in Mosquito News and send to the Editor, a brief abstract of any article they may have had accepted for publication elsewhere; members should suggest to the Editor, books and articles which in their judgment should be reviewed or of which abstracts should be prepared; and last, but by no means least, it is hoped that members themselves, where possible, will prepare and submit for publication in Mosquito News, signed reviews and abstracts of significant books and articles that may come to their attention.

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Saboteur Mosquitoes. By Harry H. Stage, Senior Entomologist, U. S. Bureau of Entomology and Plant Quarantine, National Geographic Magazine, 85 (Feb. 1944): 165-179, 12 figures; and **Life Story of the Mosquito** by Graham Fairchild, formerly Medical Entomologist, Gorgas Memorial Laboratory, Panama; now First Lieutenant, Sanitary Corps, Army of the United States, working on new insect repellents and insecticides, National Geographic Magazine 85 (Feb. 1944): 180-195, 6 figures and 8 plates reproduced in color from paintings by the Japanese artist, H———— M————, and verified for accuracy by Dr. Alan Stone, Entomologist, U. S. Bureau of Entomology and Plant Quarantine.

No Fooling!

"An' the Gobble-uns 'll git you
Ef you
Don't
Watch
Out!"

In the February, 1944 number of the National Geographic Magazine are these two outstanding popular articles on mosquitoes and the part they have played, are playing now, and will continue to play in the affairs of men, unless prevented by intelligent and persistent application of our only recently acquired and still growing knowledge of these pernicious insects and of their importance in human ecology as critically active agents in a notable aggregate of profoundly important environmental hazards.

In **Saboteur Mosquitoes**, profusely illustrated with significant photographs reproduced in black and white, Mr. Stage tells how throughout recorded history military campaigns, the course of victory, and even the fate of nations have been decided by the intervention of mosquitoes.

Mosquito borne malaria shattered the health of Julius Caesar's whole army during the Roman civil wars; Napoleon's forces were ravaged by malaria; malaria was rampant during the Chino-Japanese war of 1894-95; this mosquito borne disease was responsible for more than 5,000 deaths during the Spanish-American war of 1898; and the British, French and German troops alike were immobilized for months by malaria in Macedonia during the first world war.

Neither Julius Caesar nor Napoleon knew that without mosquitoes there could be no malaria. In fact, no one knew that malaria is dependent on mosquitoes before 1898 (well within the memory of many men still living), when the work of Ross, Grassi, Bastianelli, Bignami, Celli, Manson and others proved that **Anopheles** mosquitoes are the carriers of this disease.

From time immemorial, malaria has been associated with swamps and marshes; and even after 1898 it was thought that swamp breeding mosquitoes were responsible. In general, marshy areas were malarious, and the upland relatively free from the disease. But in the Macedonian campaign of 1916 to 1918, and again when the Italians invaded Albania in 1939, as well as in the experience of our own troops in the Philippines, it has been learned at heavy cost that dangerous malaria carrying mosquitoes may inhabit

the hilly upland as well:—**Anopheles superpictus** in Europe, and **Anopheles minimus** in the Philippines.

Little was known about the life history and habits of mosquitoes prior to 1879 when Sir Patrick Manson showed that **Filaria bancrofti**, the blood inhabiting worm that is the cause of elephantiasis in man, passes through an intermediate development cycle in the body of a mosquito, after which the mosquito may transmit the worm parasite again to man.

Manson's discovery in 1879, supplemented by the discoveries at the turn of the century, that Anopheline mosquitoes are carriers of malaria, and that **Aedes aegypti** is a carrier of yellow fever, focused attention upon the importance of developing effective mosquito control procedures.

Beginning with the use of kerosene as suggested in 1892 by Dr. L. O. Howard, for many years Chief of the U. S. Bureau of Entomology, Mr. Stage traces the progressive suppression of mosquitoes and mosquito borne diseases up to the recent demand of the Surgeon General's Office for a larvacide which would kill malaria carrying mosquitoe larvae for several weeks after it has been applied to breeding places. "Such a larvacide must still be afloat after being subjected to torrential rains." Mr. Stage implies that this has already been accomplished, and that "This material, also, can be used effectively against adult mosquitoes."

Mr. Stage describes vividly how an African mosquito, **Anopheles gambiae** "known to be one of the most efficient and dangerous malaria vectors in the world" invaded northeastern Brazil, where it was first discovered in Natal in 1930; how this mosquito was responsible for 14,000 deaths in 1938 and 1939; and how the Brazilian Government aided by the Rockefeller Foundation had exterminated it by September 1940:—"A classic demonstration of species sanitation in mosquito control."

Mr. Stage describes the search for an efficient mosquito repellent, which produced the Formula 612, the dimethyl phthalate, and the indalone repellents which singly and in combination have been employed by the army in war areas. He also describes the aerosol "bomb" or "fine fog spray", which "may save more American lives than any other single invention of the war."

This article also tells of the relation of mosquitoes to the group of virus diseases which are called encephalitis or sleeping sickness in man, encephalomyelitis or brain fever in horses, and which may attack birds and many other animals.

In his beautifully illustrated companion article, Dr. Fairchild begins by describing his own personal experience with larvae of the human bot fly, that attaches its own eggs to the body of a mosquito, which then may bring the eggs and the larvae hatching from them into contact with an involuntary human "donor" from which the mosquito carrier may take a meal of blood.

As indicated by the title of his paper, Dr. Fairchild then describes the feeding habits, the egg laying habits, and the habits of the larvae and pupae of tropical mosquitoes, the life histories of which are illustrated by eight beautiful plates reproduced in color from paintings made exclusively for the National Geographic Magazine by the Japanese artist Hashime Murayama, and checked for accuracy by Dr. Alan Stone of the U. S. Department of Agriculture Bureau of Entomology and Plant Quarantine.

Dr. Fairchild then discusses the relation of mosquitoes to yellow fever, a subject to which he has himself made notable contributions, as well as the relation of these insects to other mosquito borne diseases.

He also tells how the eggs of northern mosquitoes may have to be refrigerated, as by a winter's cold, before they will hatch; and how the eggs of desert mosquitoes do not all hatch with the first fall of rain, which might be disastrous for the species if all hatched at once when too little water had fallen to complete their development. Indeed, the eggs of some of these "dry-land" mosquitoes may remain alive for at least five years, if conditions are not right for hatching.

Mosquito control workers might well bring these two articles to the attention of their public. If copies of this issue of the National Geographic Magazine are not available for purchase, the articles may be read in public libraries everywhere.

Mosquito Control, by William Broadbeck Herms and Harold Farnsworth Gray. 1944, Second Edition, Revised and Enlarged. XIV + 419 pages, with 9 tables, 11 plates, and 86 figures. Published by the Commonwealth Fund, New York, and Humphrey Milford, Oxford University Press, London.

The editor has just seen a copy of this indispensable book; which, unfortunately, came to hand too late for review in this issue of Mosquito News. The book will be reviewed in the December issue; but it is imperative that it be mentioned here, because it will be a "must" for mosquito control workers everywhere.

Mosquito Vectors and Inapparent Animal Reservoirs of St. Louis and Western Equine Encephalitis Viruses, by Hammon, W. McD., W. C. Reeves, and M. Gray. (Univ. of Cal., San Francisco) Amer. Journ. Publ. Health, 33 (3): 201-207, 1943.

In this report read before the Health Officers Section of the American Public Health Association at the Seventy-first Annual Meeting at St. Louis, Mo., October 28, 1942, the authors review and discuss some recent findings in their own work and that of others on the epidemiology of the St. Louis type of encephalitis. The St. Louis epidemic of 1933 was characterized as up to that time the largest localized encephalitis epidemic ever recognized to have occurred in North America. And only one other epidemic has surpassed it in numbers of cases and deaths—that of the western type in and about North Dakota in 1941. Since the virus of western equine encephalomyelitis is responsible for an epidemic infection of man epidemiologically closely parallel to that produced by the St. Louis virus, the two were discussed together with emphasis on the St. Louis type.

In the 1933 epidemic, transmission by mosquitoes was suggested, but not proved. Mosquito transmission in the laboratory was attempted at that time, but failed. In the years following the St. Louis epidemic, it has been shown that, following inoculation, the St. Louis virus may be found readily in the blood of chickens, ducks, doves, horses, mice, monkeys, guinea pigs and rabbits.

Substances (antibodies) that neutralize the St. Louis virus have been found in the blood serum of normal persons as well as of those convalescent from encephalitis in many parts of the United States. Antibodies have been found in the serum of horses and of numerous other vertebrates, both domestic and wild.

In a closely correlated series of field and laboratory studies sponsored by the George Williams Hooper Foundation for Medical Research, University of California, San Francisco, California, and the Washington State and Yakima City-County Health Department, aided by a grant from the National Foundation for Infantile Paralysis, Inc., the authors report that the St. Louis and the western equine virus were isolated repeatedly from one species of mosquito, **Culex tarsalis** Coquillett, and that antibodies to both viruses were found in as high as 50 per cent of apparently healthy domestic fowl in that area. These findings suggested both mosquito transmission, and a large "inapparent" vertebrate reservoir as a source of infection.

The authors cite the claim of Mitamura and associates in Japan of successful transmission of the St. Louis virus by **Culex pipiens variety pallens, Coq.**, subsequently disputed, but recently confirmed by the authors with transmission by **Culex pipiens** Linn. to doves, mice and pigeons. The authors cite also, the extensive successful transmission of the western and eastern equine viruses by Aedine mosquitoes, by the wood tick, by a cone nose bug, all of which have been shown to be potential vectors. Epidemologically, however, the Aedine mosquitoes are considered the most likely vectors.

From the Yakima Valley studies, the finding of antibodies in many animals in the epidemic area and the isolation of virus from wild mosquitoes which feed upon these animals, appear to justify the hypothesis for both viruses of a mosquito-vertebrate-mosquito cycle. "It seems likely that mosquitoes become infected principally from animals which fulfill the following criteria: (1) they should be abundant; (2) they should show no apparent signs of infection, because no epizootic had ever been observed, except in horses and horses are relatively few in number; (3) they should have as a result of a small peripheral inoculation a reasonably large amount of virus circulating in the blood for more than a fleeting period of time; (4) it should theoretically be a bird because in an area where epidemics occur annually, the reservoir animal should be one which does not bestow a first season's protection to its offspring by maternal transmission of antibodies, as frequently occurs in mammals. --- For the Yakima area, young domestic fowl best fit all the above criteria of this hypothetical reservoir.

"Since all known vertebrate infections have been of short duration and laboratory mosquito infections have been occasionally lifelong, a mosquito which winters in the adult stage, such as **Culex tarsalis** in some areas, might be advanced as a hypothetical vector for the Yakima area. It is found frequently in domestic habitats, feeds readily on domestic fowl, and was found infected in nature."

Rigorously critical field collections, laboratory tests, and experimental studies are reviewed and discussed, leading to the following conclusions:

"Thus for both the St. Louis virus and the western equine virus the cycle suspected in nature has been reproduced. Since both the fowls and the mosquitoes used are present in large numbers in the epidemic area investigated, and have been demonstrated to be naturally infected, it seems reasonable to conclude that this cycle is a normal and an important one. Man, in contrast to the enormous number of other animals suffering from inapparent infection, appears to be an accidental host.

"Caution in generalization is advised."

Editor's note: Control of potential mosquito vectors is indicated, and possibly also of the tick reservoir suggested by the work of Blattner and Hays if confirmed.

Blood-Sucking Vectors of Encephalitis: Experimental Transmission to White Swiss Mice by the American Dog Tick, Dermacentor variabilis Say., by Blattner, Russell J. (Washington U. Sch. Med.) and Florence M. Hays (Children's Hospital, St. Louis, Mo.) Journ. Exp. Med., 79 (4): 439-454, 1 fig. 1944.

The common dog tick, **D. variabilis**, is shown experimentally to be capable of becoming infected by the virus of the St. Louis encephalitis, Hubbard strain, through feeding on inoculated laboratory animals, and of transmitting the virus to normal susceptible animals by its "bite". A female tick can transmit the virus to her young, through all stages of the second generation and on to the third generation without reinfection. Ticks infected under laboratory conditions and kept inactive at a temperature of 12.5° C. remained infective for at least 10 months. Eggs deposited by an infected female retained infective virus after storage in a refrigerator at 12.5° C. for 10 months, and larvae hatched from such eggs after 10 months dormancy were also infective.

The work reported is especially significant, since it is said to represent the first successful transmission of St. Louis encephalitis to experimental animals by a blood sucking vector. It is not claimed that the dog tick is the vector responsible for the transmission of St. Louis encephalitis virus to man, since no history of tick bite appears to have been recorded for any human case of St. Louis encephalitis. It is suggested, however, that tick populations may play an important role in the natural epidemiology of the disease by their ability to carry the virus from generation to generation. Possibly ticks feeding on birds and on other mammals may create foci from which the virus may be carried to human beings by some other blood sucking vector such as the mosquito.

Editor's note: This very interesting and significant investigation illustrates how previously unsuspected ecological interactions may complicate our present ideas concerning the control of mosquito borne diseases. The study here reviewed may indicate that in some areas tick eradication (to contribute toward control of encephalitis as well as of spotted fever) could become as much of an objective as mosquito control; and the local mosquito control agencies (if any) should logically head up such work.

Studies on the Transmission of the Western Srtain of Equine Encephalomyelitis by the American Dog Tick, Dermacentor Variabilis Say., and by Triatonea Sanguisuga Le Conte, by Grundman, A. W., Kitselman, C. M. Roderick, L. M., and Smith, R. C. (Kas. Agr. Exp. Sta. Manhattan) Journ. Infect. Dis. 72(2): 163-171. 1943.

The results of further work by these authors on the possible relationship between certain bloodsucking arthropods of the Great Plains region of the United States to the epidemiology of equine encephalomyelitis, indicate that the American wood tick, **Dermacentor variabilis** did not become infected with the western strain of equine encephalomyelitis through feeding on an infected animal. In no case was the virus demonstrable in recently molted ticks of the several stages which had engorged on infected animals prior to the molt. Also, the virus was not found to pass through the egg to the succeeding generation of larval ticks. The virus of the western strain of equine encephalomyelitis was successfully transmitted from guinea pig to guinea pig through the feeding of the "big bedbug", **Triatoma (Conorhinus) sanguisuga**, although the mechanism of transmission is not clear. Several strains of virus were isolated from collected triatomas of which one was identified as the western strain.

(The Dog Heartworm) Experimental Studies on the Larval Development of Dirofilaria Immitis in Certain Insects, by Summers, Wm. A. (Tulane Univ., New Orleans.) Amer. Journ. Hygiene. 37 (2): 173-178. 1943.

The author reports comparative tests on the susceptibility to infection with D. immitis of 10 species of mosquitoes and 3 species of fleas. In these tests, both laboratory reared, and wild caught mosquitoes were used. Of the 10 mosquito species tested, only 4 appear to be potential transmitters of the dog heartworm, and are grouped as follows according to the success with which the larvae of D. immitis were able to establish themselves: (1) Species which usually refused to take a blood meal when offered are **Culex apicalis** and **C. fatigans**; (2) Species which fed on the infected dog, but in which larvae failed to develop, **C. fatigans, C. salinarius, Aedes aegypti, A. vexans,** and **Psorophora postica**; (3) Species in which larvae developed, but with notable retardation, **C. territans;** (4) Species in which larvae developed without retardation, and with some damage to the mosquito host, **Aedes infirmatus, A. sollicitans,** and **Anopheles crucians.** The 3 flea species studied are **Ctenocephalides canis, C. felis,** and **Pulex irritans.** These appear to acquire infection in nature as well as under experimental conditions. The fleas, therefore, may be more responsible for maintaining a high rate of heartworm infection in dogs than has been generally supposed.

The Indian Rat Flea in Indiana, by Cable, R. M. (Purdue Univ.) Proc. Indiana Acad. Sci., 52: 201-202, 1943.

Reports that this oriental rat flea, chief carrier of plague in its homeland, has frequently been found on wild rats in the Lafayette area, and that in 1941 it even invaded colonies of white rats at Purdue University.

Editor's note: The inland spread of the plague bacillus in rodent populations, and of this carrier flea redirects attention to the fact that in the event of an outbreak of plague, mosquito control commissions and engineers, where established, would be logical agencies to head up the necessary rodent control and rat proofing operations; and that public interest might be best served by anticipating the possibility of such an outbreak through education of the public to demand and pay for suppression of the destructive potential reservoir of the plague bacillus through practical rodent sanitation.