Reprinted from the PROCEEDINGS OF THE FORTY-FOURTH ANNUAL MEETING
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A WORLD SURVEY OF MOSQUITO WORK IN 1956

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INTRODUCTION

For the first time in 30 years a new genus of mosquitoes has been reported in the United States. *Haemagogus,* a proved vector of yellow fever and found in association with the epizootic of the disease in Central America, was collected in Texas in September 1955. Harold Trapido and Pedro Galindo discovered *Haemagogus equinus* Theo. larvae and pupae in water in several tree holes 5 miles northeast of Brownsville. By September 8, adults were noted to have emerged. The species is generally found in the forest canopy where it attacks monkeys and also man.

I don't have much to report to you concerning the yellow fever wave in Central America. The disease was in the Lake Izabal area of Guatemala last July; however, it is rumored that monkeys are dying just across the border in British Honduras, presumably of yellow fever.

Owing to the spread of the disease, intensive research on vectors has been carried out in Panama by Galindo and Trapido. Rodaniche recovered the virus of yellow fever from *Haemagogus mesodentatus* Komp and Kumm, *H. equinus* and *Sabethes chloropterus* (Humboldt) captured by Boshell and Bevier. *H. mesodentatus* is probably the most important of the three species as high proportions readily transmit the virus by bite and frequent isolations have been made from naturally infected specimens during the epizootic in Guatemala.

At the Gorgas Memorial Laboratory in Panama, an interesting piece of research on the colonization of *Sabethes chloropterus,* a suspected vector of yellow fever, is being conducted by Pedro Galindo. In a personal communication, I learn that he has simulated the natural breeding place of the species. He placed the mosquitoes in cages, 2′x2′x2′, partly exposed to sunlight, in high temperatures and relative humidities, ranging respectively between 28-32° C. and 75-100 percent.

Although mating occurs readily under these conditions, he found that the females won't accept any puddle of water in a tree hole for oviposition. Instead, they like a dark, humid place in solitude. Galindo was clever enough to place an old (well rotted) bamboo section about 18 inches tall and 5 inches in diameter, upright inside the cage. He made a hole one inch in diameter on the side, near the top of the bamboo and filled the latter with water almost to the level of the aperture. The females hover outside the hole in the bamboo and eject their eggs through the opening, often with force enough to strike the far side of the container.

As larvae are cannibalistic, they are removed from the bamboo, placed in pans and reared on yeast and dog chow. As many as 400 to 500 larvae may be reared to adults in a pan 10 inches in diameter. The colony has been maintained for two years in an insectary and appears to be in a healthy condition.

More than 50 years ago a famous entomologist, Dr. L. O. Howard, the centennial of whose birth some of us are celebrating on June 11, 1957, had a keen interest in yellow fever and its vectors. One of his well-known books, "Mosquitoes," came off the press at precisely the right moment in history. For at that time (1901) yellow fever was still a scourge in Havana and Panama. The catastrophic mortality that the French had suffered in Panama, a decade earlier, was still fresh in their mind. The control measures presented in his book were put into immediate action and helped rid both places of the disease.

There is something else I want to mention about Dr. Howard. He was the first to present a review of mosquito work around the globe to your Association. Of his initial paper he said, "In 1920 . . . I prepared a paper entitled, 'Efforts at Mosquito Control in Different Parts of the World.' . . . This was the first attempt to summarize in a broad general

way what had been done since 1912. I found that this paper was received with very general interest by the members of this association and that since its publication it has been read by a lot of people and that I have had occasion to refer to it many times myself."

It must have been a great privilege to hear him for he had much of value to give and had such a delightful way of expressing himself. I deeply appreciate having such a famous predecessor.

It is of interest to note that 1957 marks the one hundredth anniversary of the birth of another world famous figure. Sir Ronald Ross, who discovered that malaria is carried by mosquitoes, was a friend and contemporary of Dr. Howard's. Ross was born May 13, 1857.

Although the literature on malaria control and eradication in 1956[1] is too voluminous to cite, you should know some of the progress which the two largest programs have made. In Mexico, the president of the country launched a large scale 3-month pilot project on September 7 to determine the effectiveness of the eradication system. The Mexican government has assigned the highest authorities in the country to direct the campaign and loaned transportation and supply experts of the Ministry of Defense to handle its logistics. An information service has been organized to encourage the fullest cooperation of the public. Starting January 1, 1957, about 3 million houses in the malarious areas of that country will be sprayed with DDT although some dieldrin will be used. The immense control program in India is progressing satisfactorily according to a personal communication from Lt. Col. Jaswant Singh, the director. The project is expected to protect about 200 million people in that country before the end of 1957 and already, he says, "we are thinking in terms of eradication."

Another large scale project in India is the Indian National Filaria Control Programme. I recently learned of this project's existence from Dr. A. K. Krisnaswami who has been visiting the United States. According to a personal communication from Don R. Johnson, Division of International Health, USPHS, pilot projects were initiated in 1952 and 1953. The program was formally launched in 1954, utilizing U. S. financial aid. During the first year the United States allocated approximately $700,000 to be used for antifilarial drugs, insecticides and equipment. In 1956 this amount reached $1,000,000. The program is conducted under the Malaria Institute of India and directed by N. G. S. Raghavan. Twenty-five million people are in need of protection in India from the disease. The goal for 1956 to reach was over 12 million persons. Dr. Henry K. Beye of the U. S. National Institutes of Health went to India as consultant to the filaria program.

Although the insect resistance problem does not appear to be advancing more rapidly than are the means to control the situation, yet the World Health Organization feels that a "greatly accelerated effort, organized on an international basis, is needed to cope with it." One of the first steps taken by WHO was a survey covering numerous laboratories on all

[1] All dates refer to 1956 unless otherwise stated.

continents. Of the 122 laboratories investigated, more than half were working on problems of resistance.

Following this preliminary survey, the WHO Expert Committee on Insecticides met in Geneva in July and suggested that WHO collect information on insect resistance and distribute it to research workers, promote needed research and assist in the procuring of funds as well as personnel. The Committee also recommended that a standard testing technique be adopted so that resistance may be detected as it appears.

WHO plans to sponsor a conference of directors of the major laboratories able to participate in the research program on resistance. There is much more in the Seventh Report which cannot be covered here but I recommend its inclusion on your reading list.

As a result of the meeting of the Expert Committee, WHO is promoting a number of research projects by grants and is issuing to research workers a bimonthly information circular on the resistance problem.

According to WHO Chronicle for December 1956, resistance now exists locally in 4 species of *Anopheles* : *A. sundaicus* (Roden.) to DDT in Java, *A. sacharovi* Favr. to DDT, BHC and chlordane in Greece, *A. stephensi* Liston to DDT in Saudi Arabia and *A. gambiae* Giles to dieldrin in Nigeria. In addition *A. quadrimaculatus* Say has shown resistance to dieldrin in Mississippi, *A. superpictus* Grassi and *A. maculipennis* Meig. both appear to be resistant to DDT in Greece.

R. Elliott, who visited many laboratories in the United States in 1956, has presented an excellent discussion, in a highly readable fashion, of the programs on research on resistance he saw here. One interesting point he made was a case of seasonal variation in resistance concerning saltmarsh mosquitoes at Savannah. He stated that these mosquitoes started the season with a rather low level of resistance to DDT but became rapidly more resistant as the season wore on. Elliott (WHO Mal/Inform/18, 25 pp.) feels that the "cause of the increased resistance might well be the cumulative effect of selection by the year's insecticidal treatments, but the cause of the drop back to a lower level after the winter is hard to understand."

In a notable paper, "Malaria Vector Resistance to Insecticides," Prof. G. Lividas says that the end point of malaria transmission in Greece was probably reached at least 2 years before the spraying schedule ceased. It was felt that the "revival of *Plasmodium*, once it is broken to a great depth and extent, is not as rapid and easy as is usually believed." Lividas was unable to find any definite relationship between the appearance of insect resistance and distribution of malaria. It is his opinion that the great lesson to be learned from the Greek experience is the discontinuance of spray programs at the proper time.

Unfortunately the world has lost several outstanding mosquito workers and malariologists during 1956. Perhaps the best known to you here was Col. J. A. A. LePrince who worked with General Gorgas in the drive against yellow fever that terminated with great success. From 1904 to

1914 LePrince was health officer in the Panama Canal Zone and during this period he became an acknowledged authority throughout the world on methods of malaria and mosquito control. During World War I, it is estimated that his mosquito control methods cut the U. S. Army's malaria rate to one percent of what it had been in the Spanish-American War. In 1938 he assisted the Puerto Rican government during a serious outbreak of malaria there. He organized the Howard-Krauss Society which used student talent for original posters, exhibits, skits, stories, radio programs, songs and other means — long before commercial artists and writers had entered the field of insect-borne disease control. Dr. LePrince was born at Leeds, England, and came to the United States as a youth. He died at the age of 83 on February 10, 1956. Among his many honors was the Ross Medallion awarded him for his exceptional service in the cause of health of mankind.

Professor Jerome Rodhain, known to us for his excellent studies of the plasmodia in anthropoid apes and his establishment of their relationship to the agents of human malaria, died September 26, 1956, at the age of 80. He was a great pioneer in tropical medicine and the recipient of many honors. He was born in Herselt, Belgium, January 25, 1876.

Brigadier John A. Sinton, a brilliant malariologist and the first Director of the Malaria Survey of India (now the Malaria Institute of India) died at the age of 71 on March 25, 1956. His demonstration that pamaquin combined with quinine brought about a striking reduction in the relapse rate of vivax malaria was a noteworthy finding. Sinton wrote numerous papers on host-parasite relationships of human and simian malaria. His "Bibliography of Malaria in India" contains references to 2,000 publications and his well-known book entitled "What Malaria Costs India" is unusually comprehensive in scope and documentation. He was born December 2, 1884, in British Columbia.

Col. Henry Beeuwkes, Director of the West African Yellow Fever Commission of the Rockefeller Foundation 1925-1934, died January 31, 1956. The key finding of the Commission was the isolation of yellow fever virus in rhesus monkeys in 1928 by Stokes, Bauer, and Hudson. Beeuwkes retired from the U. S. Army after being on General Pershing's staff in World War I but returned to active duty during World War II. He was born August 29, 1881.

The most notable entomological meeting of the year was the Tenth International Congress of Entomology, held in Montreal, Canada, August 17-25, 1956. It is believed that this was the largest gathering of entomologists ever held as over 1400 members attended. Dr. Karl Jordan (now ninety-five), the founder and honorary life president of these congresses, though unable to attend the meetings, sent a recorded address. Fifteen sections were run under the presidency of Dr. W. R. Thompson and about 720 papers covering numerous fields of entomology were presented.

"Specifications for Pesticides," has been published by the World

Health Organization as a guide for users and manufacturers of insecticides and related products as well as equipment. The first and largest part of the 400-page book has been devoted to insecticides while the last part discussed specifications for sprayers and dusters. These specifications were established by the WHO Expert Committee on Insecticides at its second through sixth sessions. This is a particularly valuable manual.

A new repellent, developed by the United States Department of Agriculture, is superior to former ones in use against mosquitoes. Diethyl toluamide, an organic chemical, is a multi-purpose repellent as it protects an individual also against chiggers, fleas, ticks and biting flies. At the Orlando, Fla., Laboratory, where its outstanding qualities as an insect repellent were revealed, tests show diethyl toluamide to remain effective at least twice as long as the next best repellent on some species of mosquitoes. The composition of the repellent makes it pleasant to use on the skin.

April 7 has been selected as World Health Day throughout the globe. Last year the eighth birthday of the World Health Organization was celebrated on that date and the theme was "Destroy disease-carrying insects!" The World Health Organization, since its formal establishment on April 7, 1948, is now composed of 88 member countries and territories.

TAXONOMY

New mosquitoes which have been brought to my attention for the year 1956 by Dr. Alan Stone are as follows: *Aedes ishigakiensis* Bohart, *A. kennethi* Muspratt, *A. stenei* Thompson; *Culex afridii* Qutubuddin, *C. belemensis* Duret and Damasceno, *C. douglasi* Dobrotworsky, *C. latus* Dobrotworsky, *C. mojuensis* Duret and Damasceno; *Haemagogus garciai* Levi Castillo, *H. mesodentatus alticola* Galindo, Trapido and Boshell, *H. mesodentatus gorgasi* Galindo and Trapido, *H. soperi* Levi Castillo; *Phoniomyia esmeraldasi* Levi Castillo, *P. galvaoi* Correa and Ramalho, *P. lopesi* Correa and Ramalho; *Psorophora stonei* Vargas; *Toxorhynchites yaeyamae* Bohart; *Anopheles cavernicolus* Abonnenc, *A. colledgei* Marks, *A. gomezdelatorrei* Levi Castillo, and *A. riparis macarthuri* Colless.

Although the date of an important taxonomic paper entitled, "Insects of Micronesia: Diptera, Culicidae" 12(1): 85 pp., by R. M. Bohart is 1956, the actual date of publication is 1957. The species described by Bohart in the paper are as follows: *Aedes agrihanensis, A. dybasi, A. gressitti, A. hui, A. maehleri, A. neopandani, A. palauensis, A. pipkini, A. savoryi, Culex boninensis, C. gossi* and *C. kusaiensis.*

I have learned recently of the following mosquitoes described in 1955: *Aedes kiangsiensis* Tung; *Culex cambournaci* Hamon and Gandara, *C. manaensis* Floch and Fauran, *C. patientiae* Floch and Fauran, *C. reginae* Floch and Fauran, *C. yaoi* Tung; *Heizmannia kanhsiensis* Tung; *Neoculex horridus* v. *rageaui* Hamon and Rickenbach, *N. laplantei* Hamon, Adam and Mouchet, and *N. adami* Hamon, Adam and Mouchet.

Attention is called to an intersting paper by J. N. Belkin and W. A.

McDonald (Ent. Soc. Amer. Ann. 49(2): 105-132) on the description of the stages of one of the rarer North American mosquitoes, *Uranotaenia anhydor* Dyar. An isolated population of the species was discovered at the south end of Death Valley, California, in 1954. A discussion of the *anhydor* complex was included.

"The *Stegomyia* Mosquitoes of South Africa and some Neighboring Territories," is the title of an important piece of research by J. Muspratt (Ent. Soc. South. Afr. Mem. No. 4, 138 pp.). Larval and adult keys have been included along with taxonomy, distribution, bionomics and relation to disease of 17 species of *Aedes* of the region. In addition, distribution maps and records (by tables) of forest habitats were presented in detail. An alphabetical list of localities with key numbers to the maps was also included. Muspratt has covered the epidemiology of yellow fever in Africa, its vectors, endemic areas, surveys and immunization, Rift Valley fever, dengue and other viruses. An excellent list of references and index are valuable additions to the booklet.

In part IV of the research of South African culicines, the same author (Ent. Soc. South. Afr. Jour. 19(1): 37-46) has listed 38 species from Tongaland, Natal. He included notes on the taxonomy of four of these and ecological factors relating to the larvae of pool-breeding mosquitoes with special reference to predators. Species of the following genera were collected: *Toxorhynchites, Ficalbia, Taeniorhynchus, Aedes, Eretmapodites* and *Culex*.

One of the few books on mosquitoes published during the year was "Les *Anopheles* de l 'Afrique du Nord et du Bassin Mediterraneen," by G. Senevet and L. Andarelli. This taxonomic work, containing 280 pages, has been divided into three parts as follows: one, general anatomy of all stages; two, the species of the region; and three, distribution and keys. The authors discussed each of the 17 species in detail, including notes on biology, description, variation and relation to malaria. In addition numerous illustrations are presented throughout the text. Both the distribution records and keys to various stages are distinctly helpful.

V. M. Vargas (Rev. Biol. Trop. 4 (1): 27-34) has presented numerical keys for identification of fourth-stage larvae of anophelines in Costa Rica.

A highly creditable study of the *Anopheles leucosphyrus* Dönitz group has been made by Donald H. Colless (Roy. Ent. Soc. London Trans. 108 (3): 37-116). The first part of the paper, devoted to systematics, listed 13 forms of the *A. leucopshyrus* group together with keys for larvae and females. "A tentative scheme of internal relationships and evolutionary history is described, with geographic isolation as the major factor producing differentiation of new forms." In the second part, on biology, the breeding place of *A. l. balabacensis* Baisas was described in detail. The effects of clearing on breeding areas, flight and feeding habits, host preferences and seasonal variation were also discussed. The three known vectors of human malaria in this group are *A. l. balabacensis, A. l. leucosphyrus* and the "Celebes form" of *A. l. leucosphyrus*.

Part II of a valuable series of papers on type specimens of mosquitoes in the United States National Museum by A. Stone and K. L. Knight (Wash. Acad. Sci. Jour. 46(7): 213-228) dealt with the genus *Aedes*. Information on specimens including type localities was included under each species. Following this, a list was presented of those in the collection based on unique specimens for which holotypes were clearly designated. Part III by the same authors (ibid. 46(9): 276-280) covered the genera *Anopheles* and *Chagasia*.

P. F. Mattingly (Roy. Ent. Soc. London, Ser. A., Gen. Ent. Proc. 31 (4/6): 37-44) has presented a second paper designed to validate lectotypes of mosquitoes in the British Museum. The genera *Toxorhynchites* and *Theobaldia* were discussed, along with a number of species of *Aedes* and *Culex*. Most of the species were Ethiopian and were described by Edwards but the types had not been designated by him at the time of his death.

W. R. Horsfall has continued his studies of eggs of floodwater mosquitoes. Part III (Ent. Soc. Amer. Ann. 49(1): 66-71) concerned the conditioning and hatching of *Aedes vexans* (Meig.). Part IV with G. B. Craig, Jr. (ibid. 49(4): 368-374) covered the species of *Aedes* common in Illinois.

L. Vargas and A. Martinez Palacios have written a worth-while book (of 181 pages) in Spanish entitled, "Anofelinos Mexicanos Taxonomia y Distribucion." Description of external anatomy and keys were included for all stages of anophelines of that country and 26 species were discussed in detail. In addition, the distribution maps, tabular arrangement of localities and a spiral form of cover (enabling the book to lie flat when in use) are of particular help.

DISTRIBUTION

J. Hamon, J. P. Adam and A. Grjebine (World Health Organ. Bul. 15 (3/5): 549-591) have reported on the *Anopheles* of West Africa, the Cameroons and French Equatorial Africa. Both biology and behavior of each species were included. The most formidable carrier of human malaria in Equatorial and West Africa is *Anopheles gambiae* Giles which is by far the dominant species in urban malaria. Many other items concerning anophelines were discussed in this worth-while paper.

The anophelines of Madagascar have been presented by A. Grjebine (World Health Organ. Bul. 15 (3/5) : 593-611). By 1955, 32 species and varieties of *Anopheles* were reported from the area.

A careful and detailed study of "The Mosquitoes of Arabia. I," has been made by P. F. Mattingly and K. L. Knight (Brit. Mus. Nat. Hist. Ent. 4(3): 6-141). A total of 46 species, subspecies and varieties (17 *Anopheles*, 1 *Culiseta*, 8 *Aedes*, and 20 *Culex*) were recorded. *Anopheles demeilloni* Evans, *Aedes caballus* Theo., *Culex arbieeni* Salem., *C. duttoni* Theo., and *C. pipiens molestus* Forsk. were reported for the first time from the area. Keys to adults and fourth-stage larvae of all species have

been included and the taxonomic position of a few have been reassessed. The available distribution records were included with a list of localities and their approximate altitudes, latitudes and longitudes.

Three papers by D. J. Lewis are valuable contributions to our knowledge of mosquitoes of the Sudan. The first, on anophelines (Bul. Ent. Res. 47(3) : 475-494) included 29 species and 3 varieties. Distribution was plotted on maps and notes were included on each. He discussed the former spread of *Anopheles gambiae* Giles into Egypt, from which it was eradicated in 1945, and additional records of its occurrence in the Wadi Halfa area before it was exterminated there also. Occasional records of *A. gambiae* since 1945 were included. General distribution of the anophelines of Sudan was reported upon as well as the relation of some species to malaria and filariasis. The second paper on the *Culex* mosquitoes of the area (ibid. 47(4) : 703-721) comprised a list of 28 species, two subspecies and two varieties. Taxonomic notes on a few species, relation to disease and several aspects of distribution were included. The third paper entitled, "Some Mosquitoes of the Sudan" (ibid. 47(4) : 723-735) dealt with species of the genera *Harpagomyia, Hodgesia, Uranotaenia, Aedomyia, Theobaldia, Ficalbia, Taeniorhynchus, Eretmapodites* and *Toxorhynchites.*

M. Ovazza, J. Hamon and P. Neri (Soc. de Path. Exot. Bul. 49(1) : 151-182) have published a list of species, locality records, ecological information and taxonomic details of about 60 species of Culicidae occurring in Ethiopia.

W. Peters (Bul. Ent. Res. 47(3) : 525-551) has presented a third of a series of papers on the mosquitoes of Liberia. On the basis of a survey in the hinterland and the findings of previous workers he has listed 85 species and varieties of mosquitoes occurring in that country. Notes on distribution, bionomics, morphological variations in some species and relation of *A. gambiae, A. melas* Theo., *A. funestus* Giles, *A. nili* (Theo.) and *A. hancocki* Edw. to malaria were given.

According to W. Peters and S. C. Dewar (Indian Jour. Malariol. 10(1) : 37-51) no previous records of megarhine and culicine mosquitoes of Nepal have been published. These authors reported 29 species most of which belonged to the genus, *Culex*. Among the taxonomic notes were included a few new larval and pupal descriptions.

M. O. T. Iyengar and M. A. U. Menon, with appendix by P. F. Mattingly, (Bul. Ent. Res. 47(4) : 785-795) have corrected a previous list of mosquitoes of South Thailand by Iyengar and have added *Anopheles barbumbrosus* Strickl. and Chowd. and *Anopheles letifer* Sandosham. The larva of *Uranotaenia bimaculiala* Leic. was described for the first time and taxonomic notes were included on eight species of mosquitoes. P. F. Mattingly has selected and marked lectotypes as recorded in the appendix.

Studies, made by D. H. Colless (Bul. Ent. Res. 47(1) : 115-123) at a typical Sarawak village on the banks of the Akah River, have shown that 14 species of anophelines existed there and that the malaria vector was *Anopheles leucosphyrus leucosphyrus* Dön. This was the only species

common in houses and biological observations on its feeding and resting habits were made as it was the only species in sufficient abundance.

E. C. Loomis, R. M. Bohart and J. N. Belkin (Calif. Vector Views 3 (8): 37-45) have added materially to knowledge of the distribution of the 42 species of mosquitoes known to occur in that State. Information was included on types of breeding places of some species together with stages and dates of collection.

H. D. Pratt (Mosquito News 16(1):4-10) has presented a check list of the mosquitoes of North America. This valuable summary included 138 species, in 11 genera as follows: *Anopheles* 14, *Toxorhynchites* 1 with 2 subspecies, *Wyeomyia* 4, *Uranotaenia* 1 with 2 subspecies, *Aedes* 61 with 2 subspecies, *Culex* 27 with 3 subspecies, *Culiseta* 7, *Deinocerites* 2, *Mansonia* 3, *Orthopodomyia* 13 and *Psorophora* 13. Of the 138 species listed, adult males and females and fourth stage larvae are known for 136.

Distribution records of mosquitoes have also been recorded from the Great Basin and the drainage of the lower Colorado River by C. S. Richards, L. T. Nielsen and D. M. Rees (Mosquito News 16(1) : 10-17).

F. S. Blanton and E. L. Peyton (Mosquito News 16(1): 22-26) have presented the first of a series of papers on distribution of Panama mosquitoes based on light trap studies. The genera *Anopheles* and *Chagasia* were discussed in the present article.

TECHNIQUES

A chemical medium for rearing *Aedes aegypti* (L.) aseptically, starting with surface-sterilized eggs, has been devised by A. O. Lea, J. B. Dimond and D. M. DeLong (Jour. Econ. Ent. 49(3): 313-315). The preparation (fully described in this useful paper) contained amino acids, salts, glucose, cholesterol, ribonucleic acid and a vitamin mixture dissolved or suspended in water. Agar was added to the medium prior to sterilization. Hatching to pupation took 11 to 13 days and adults emerged successfully from pupae transferred aseptically to sterile water. Adults fed on blood, mated and deposited viable eggs.

The maintenance of a colony of *Anopheles gambiae* Giles under laboratory conditions was described by G. T. Shute (Ann. Trop. Med. and Parasitol. 50(1): 92-94). Egg production per night was prolific when 300-400 adults of both sexes in equal numbers were kept in one cage in total darkness. Life history under these conditions was as follows: hatching occurred in 36 hours, the larval stage lasted 7-8 days and pupal stage 36 hours.

A method for rearing individually, isolated larvae was described by J. D. Long and O. P. Breland (Mosquito News 16(3): 232-233). The "float" was made by boring holes through a piece of Plexiglas. An end of each of the holes, in which the larvae were reared, was closed by attaching a piece of nylon hose to one side of the plastic. Glass tubing was used for legs.

M. T. Gillies (World Health Organ. Bul. 15(3/5): 451-459) has described a new character to recognize nulliparous *Anopheles gambiae* females. The "mating plug," observed in recently fertilized females, was normally absorbed in 36 hours following fertilization. The presence of the plug in wild-caught mosquitoes indicated that mating took place the previous night. As far as the author knows, such plugs have not been found previously in mosquitoes. Dissection techniques and a method of tabulating results were included.

"A Modified Precipitin Technique for Determining the Source of Mosquito Blood-meals" was presented by J. H. Schubert and L. V. Holdeman (Amer. Jour. Trop. Med. and Hyg. 5(2): 272-273). The method was reported to be more reliable than the "capillary holder" precipitin technique. Because of the smaller diameter of the capillary tubes, less antiserum was needed and saving in time resulted from the tubes which could be discarded after use.

C. A. Lang and R. C. Wallis (Amer. Jour. Trop. Med. and Hyg. 5(5): 915-920) found that adult *Aedes aegypti* not only engorged on a sucrose solution, the preferred sugar, but "fed to repletion on unattractive test preparations when supplemented with this disaccharide." This simple feeding procedure for *A. aegypti* was believed to provide sizeable numbers of engorged mosquitoes.

A dependable method of making surveys of floodwater mosquitoes based on sampling soil surfaces for eggs has been described by W. R. Horsfall (Mosquito News 16(2): 66-71). The apparatus was described in detail and figured. The eggs were separated from the soil and identified microscopically.

J. C. Jones (Mosquito News 16(3): 230-231) reported on a small portable Knierim feeding device for use in small cages of mosquitoes. The device was illustrated and a description was given for its simple and cheap construction.

BIOLOGY, ECOLOGY, AND BEHAVIOR

"The Biology of Northern Mosquitoes," a noteworthy and well-written paper, has been presented by W. C. Frohne (U. S. Pub. Health Serv. Rpts. 71(6): 616-621). He has brought together diverse data, ". . . some of it quite new," as Dr. Justin M. Andrews says, "about the insect fauna of the far north," and "more information than has been assembled in one place before." In Alaska there exist some 20 *Aedes*, 5 or 6 *Culiseta*, 1 *Anopheles* and 1 *Culex*. The Arctic Health Research Center laboratory recognized as new, the *Culiseta impatiens* type of life cycle in which there is a single brood and obligatory hibernation of the female. Such a cycle is not known among mosquitoes of the tropical or temperate zones. *Culiseta alaskaensis* (Ludlow) and the local *Anopheles* and *Culex* all share this new type of cycle in which the habits of the female are widely divergent in the two summers in which they live. Courtship and mating occur the first summer, oviposition the second. After mating

the females spend about 10 months in estivation and hibernation. "Normally, the blood lust appears concomitantly with increasing light in early spring, and hibernators will bite at near freezing temperatures," in order to ovipost about two weeks later. The role of northern mosquitoes as disease carriers has been almost completely unexplored.

The bionomics of the common mosquitoes of the Nile Delta were observed by H. S. Hurlbut and B. Weitz (Amer. Jour. Trop., Med. and Hyg. 5(5): 901-908) during a study of the epidemiology of West Nile virus. The 5 most comon species in the cultivated areas are *Culex antennatus* Becker, *C. univittatus* (Theo.), *C. pipiens* L., *Aedes caspius* (Pallas), and *Anopheles pharoensis* Theo. All readily fed on man. *C. univittatus* is probably the most diverse of the 3 species of *Culex* and is most strongly attracted to birds. This species was easily colonized and a colony kept for over two years.

Because of the possibility that yellow fever might be introduced into Malaya, investigations on the distribution and biology of *Aedes aegypti* (L.) were undertaken in that area. According to W. W. Macdonald (Ann. Trop. Med. and Parasitol. 50(4): 385-398) the species has spread into the rural parts of Malaya and eradication measures have been made more difficult. In his second paper (ibid. 50(4): 399-414) the biology was discussed and compared with that in Africa. Although *A. aegypti* on some occasions may breed in tree holes and plant axils in Malaya, it is chiefly domestic in its breeding sites.

Observations on the adult bionomics of the more common anophelines in an inland valley in Malaya where malaria is thought to be transmitted by *Anopheles maculatus* Theo. were made by G. Davidson and A. Ganapathipillai (Ann. Trop. Med. and Parasitol. 50(2): 137-146). This species and *A. philippinensis* Ludlow were the commonest ones taken in calf or dog-baited devices. Five other baiting devices were used and the main species taken in the area included *A. aconitus* Dönitz, *A. barbirostris* V.d.W., *A. crawfordi* Reid, *A. indiensis* Theo., *A. karwari* (James) and *A. kochi* Dönitz in addition to the two first mentioned species. All preferred to feed out-of-doors including *A. maculatus* which readily entered houses and fed chiefly on man. However, the authors are not certain whether *A. maculatus* prefers human blood or is merely attracted to man in the absence of other blood sources.

"Studies of Mosquitoes and Freshwater Ecology in the South Pacific," by Marshall Laird (Roy. Soc. New Zealand Bul. 6, 213 pp.) is a valuable publication. The area in which the field work was based included Queensland, the Solomons, the New Hebrides, New Caledonia, the Loyalties, Fiji, Tonga, Western Samoa and representative islands of the Cook, Gilbert, Ellice and Tokelau Groups. Anopheline larval habitats in the malarious zone were compared with those of the anopheline-free zone east and south of Aneityum, New Hebrides. In addition, consideration of the ecological barriers to introduction of anophelines to certain areas was given. In connection with observations on mosquito biology, the author devoted one-fourth of the book to distribution of aquatic flora and

fauna. He has proposed a new classification of larval habitats which will lend itself to the study of trends in mosquito biology. Of interest from the biological control standpoint was the description of two new parasitic fungi: *Coelomomyces solomonis* collected from *Anopheles punctulatus* (Dönitz) and *C. cairnsensis* from *A. farauti* Laveran. The possibilities of biological control in the area were discussed.

E. L. Peyton (Mosquito News 16(3): 220-224) has reported on the distribution and biology the Pacific Coast tree hole mosquito, *Aedes varipalpus* (Coq.). The importance of mosquito breeding in tree holes in another area: namely, Tahiti, also has been discussed by D. D. Bonnet and H. Chapman (Mosquito News 16(4): 301-305). The mosquito concerned in this case was *Aedes polynesiensis* Marks, the vector of filariasis there.

Observations on the biting habits of *Eretmapodites* in Uganda have been made by A. J. Haddow (Bul. Ent. Res. 46(4): 761-772, January 1956[2]). At Entebbe a well-marked wave of activity occurred before sunset but in Bwamba such a wave did not take place. The first hour of biting activity in Bwamba was more intense no matter when it occurred. *E. chrysogaster* Grah. is present in both localities. The author concluded that some environmental influence must be involved to account for the differences in behavior.

Despite the success of the malaria eradication campaign in Mauritius, J. G. Halcrow (Nature (London) 177(4520): 1103-1105) reports that *Anopheles gambiae* Giles has actually increased in number. Apparently the species is not the serious vector of malaria on the island that it is in Africa. *A gambiae* fed mainly on bovine blood and, when it attacked humans, fed early in the evening and out-of-doors. It was thought that the short life cycle of the species may have contributed to its survival and spread on Mauritius. Mosquitoes including *A. gambiae* reached their peak of activity earlier in the night than in Africa. Some biological and morphological data are included.

Studies on the bionomics of *Anopheles fluviatilis* James over a three-year period in the Mysore State, India, ahve been conducted by S. R. Bhombore, N. L. Sitaraman and C. Achuthan (Indian Jour. Malariol. 10(1):23-32). Larval habitats and adult habits as well as seasonal prevalence were discussed. Although no constant morphological variation has been found yet in adults or larvae, the authors believe that the existence of biological races may account for the variety of behavior of the species in different regions.

An interesting paper by N. Stahler and L. A. Terzian (Ent. Soc. Amer. Ann. 49(5): 429-435) on the influence of light on the mating activity of *Anopheles quadrimaculatus* Say, has been published. During a 24-hour period of day and night, under natural conditions of light and dark, most of the mating occurred at sunset. Although some took place at sunrise, none was recorded between the two periods. Previous light adaptations influenced mating activity at sunset and insemination rates

[2]All numbers of volume 47 of Bul. Ent. Res. were published in 1956 as well.

were greatest among individuals conditioned to natural light. "Finally, it has been shown that, over a 5-day period of continuous cohabitation, the maximal rates of insemination occurred in those groups kept in the natural cycle of day and night under the influence of changes in light intensity associated with sunrise and sunset."

W. O. Haufe and L. Burgess (Ecology 37(3):500-519) have discussed in detail the development of *Aedes* at Fort Churchill, Manitoba. Formulae for predicting mosquito emergence were given as a result of 3 years' field observations of the genus. For the pest species at Fort Churchill, curves of development were made on the basis of emergence of each species in at least three pools having different thermal characteristics. Tundra species were noted to have lower thresholds of development (about 34° F.) than the forest species which had a range of 38-45° F.

Light trap collections by W. E. Snow and E. Pickard (Mosquito News 16(2):143-148) showed wide variation from year to year in the distribution pattern and density of *Culex tarsalis* Coq. in the Tennessee Valley region. Larval collections substantiate the fact that the species occurs in the fall with a peak in September. It was believed that the degree and regularity of late summer and fall precipitation might be an important factor in determining the extent of the annual appearance of *C. tarsalis.*

D. S. Bertram and I. A. McGregor (Bul. Ent. Res. 47(4):669-681) have described the use of entrance traps in a baited portable wood hut in Gambia, West Africa, to study the biology and behavior of *Anopheles gambiae* and *A. melas* Theo. Special reference was made to the effect of wind direction.

The relation of mosquitoes of the subgenus *Kerteszia* to the distribution of bromeliads in forest communities in Brusque, Santa Catarina, Brazil, was discussed in careful detail by H. P. Veloso, P. Fontana, Jr., R. M. Klein and R. J. de Siqueira-Jaccord (Inst. Oswaldo Cruz. Mem. 54(1):1-86). *Anopheles cruzi* D. and K., *A. homunculus* Komp and *A. bellator* D. and K. were the vector species involved.

By means of irradiation of two- to three-day old males with X-rays at a dosage of 4,000 röntgens, four mutant strains of *Culex pipiens* L. have been produced, according to H. Laven (Roy. Ent. Soc. London Proc. Ser. A 31 (1/3:17-19). The chief reason for the study was to obtain mutants which would permit the marking of the chromosomes of mosquitoes. This in turn would facilitate the study of such problems as inheritance of susceptibility to infection with malaria parasites, or resistance to insecticides and reproductive incompatability between different populations. The mutations were described in detail and appear to mark all the existing chromosomes in *Culex.*

MORPHOLOGY AND PHYSIOLOGY

An investigation of the amino acids required for *Aedes aegypti* (L.) egg production was made by J. B. Dimond, A. O. Lea, W. F. Hahnert,

Jr. and D. M. DeLong (Canad. Ent. 88(2):57-61). They found that 11 amino acids (arginine, isoleucine, leucine, lysine, phenylalanine, threonine, tryptophane, valine, histidine, cystine, and methionine) were necessary for a high level of egg production and if the first 8 were omitted from the diet, no eggs were produced. Glumatic acid also was found to be a stimulus to egg production. It has been found that amino acids needed for larval growth of *A. aegypti* were essentially the same as for egg production.

The number of eggs developed in *Aedes aegypti* in relation to the quantities of human blood ingested has been reported upon by P. A. Woke, M. S. Ally and C. R. Rosenberger, Jr. (Ent. Soc. Amer. Ann. 49(5):435-441). "No significant differences in numbers of eggs developed were found that could be attributed to differences in the blood of a single host between times of mosquito feeding, to individual differences between two female hosts, or to sex differences between the hosts. The actual mean numbers of developed eggs increased as the mosquito body weight increased."

A study on the *Culex pipiens* L. group of Japan has been made by Hisao Bekku (Nagasaki Igakkai Zassi 31(11):956-966). Part one is concerned with comparative studies on the morphology of specimens obtained from various localities in the Far East. The author believes the Japanese house mosquito or so-called *Culex pipiens pallens* Coq. to be a hybrid population of *fatigans* and *pipiens* and that it is distributed all over Japan from Kyushu to Hokkaido.

Aging of *Aedes aegypti* (L.) has been observed by L. A. Terzian, N. Stahler and F. Irreverre (Jour. Immunol. 76(4):308-313) to have an effect on its immunity to *Plasmodium gallinaceum*. However, aging mosquitoes, when given a normal blood meal at least 9 days prior to the infective feed, were found to become again as susceptible to infection as the newly emerged, young adults. Also, mosquitoes kept on raisin infusions for 4 weeks were as susceptible to infection as young mosquitoes.

A study was conducted by J. C. Jones (Jour. Expt. Zool. 131(2): 223-233, Mar.) on normal heart rates in intact *Anopheles quadrimaculatus* Say. He found the heart rates of fasting fourth-stage *A. quadrimaculatus* larvae to decline by about 20 beats during one hour while those of actively feeding larvae remained constant (loss of less than 10 beats during one hour). It was suggested, "but not proved, that fasting rates decline because the metabolic rate of the larva falls to levels lower than those needed to maintain constancy, and that the feeding rates stay constant because of a relative homeostasis resulting from continuous food intake."

FILARIASIS

A fine paper, written in an interesting style, is one by J. Bonne-Wepster (Doc. Med. Geog. et. Trop. 8(4):375-379) on *Culex bitaeniorhynchus* Giles as a vector of *Wuchereria bancrofti* in New Guinea. In

the search for the vector of *W. bancrofti* in that area, the three species collected in largest numbers were *C. bitaeniorhynchus* (or closely related species), *C. annulirostris* Skuse and *Mansonia uniformis* Theo. The first mentioned one not only was the most numerous in dwellings in Negeri Besar but it also attacked man. Such behavior was contrary to that of the author's experience in Indonesia. As only 3 cases of *C. bitaeniorhynchus* atatcking men have been recorded, she feels that this *bitaeniorhynchus*-like mosquito may be a different species. However, she is of the opinion that, for the present, the name should be retained.

M. Oshima (Japan. Jour. Sanit. Zool. 7(1):9-18) studied the natural infection of *Wuchereria bancrofti* in mosquitoes in Western Kyushu, Japan, during 1951-1954. In the 15 villages, where the mosquito collections were made, *Culex pipiens pallens* Coq. was thought to be the most important vector of filariasis. This was believed to be due to its preference for humans, natural infection rate which was the highest of the 15 species collected and its habit of breeding in close proximity to houses.

Attention is called to two papers on filariasis in the Indian Journal of Malariology: the first, "Filariasis in Patna (Bihar)" by L. Kant, S. K. Sen and B. S. Puri (ibid. 10(3):199-217) and the other entitled, "Filariasis in Travancore-Cochin State," by Jaswant Singh, N. G. S. Raghavan and A. K. Krishnaswami (ibid. 10(3):219-238). In Patna, *Wuchereria bancrofti* was the only species of microfilaria recorded and was observed in nature only in *C. fatigans*. On the other hand, in two towns in Travancore-Cochin State both *W. bancrofti* and *W. malayi* infections were recorded but the incidence of *W. bancrofti* was found higher. Also, filarial larvae were found in *C. fatigans, Mansonioides uniformis* (Theo.) and *M. annulifera* (Theo.)

See "Introduction" for information on the Indian National Filaria Programme.

MALARIA

Paul Russell (Amer. Jour. Trop. Med. and Hyg. 5(6):937-965) reminds us that, despite the tremendous acceleration in the attack on malaria during the past few years, the sun has not set on malaria and malariologists. "One might more truly say that the morning's work has been well started but it is not yet high noon for malariology. There still remains an exceedingly large task involving both reesarch and control on a higher rather than a lower scale." In his usual excellent style, Dr. Russell discussed the distribution and prevalence of the disease from global and regional viewpoints. Regionally, he reviewed the malaria situation by countries including estimates (of population in malarious areas and numbers routinely protected) for the U. S. S. R. and other Iron Curtain areas. In most areas he pointed out the malaria vectors and results of control. At the close of this outstanding review, he indicated some of the principal requirements in a global campaign against malaria.

An interesting paper on the eradication time in relation to malaria has been presented by A. Gabaldon (Amer. Jour. Trop. Med. and Hyg.

5(6):966-976). He pointed out that, in Venezuela, malaria has been responsive in some areas and in others partially refractory to DDT indoor residual spraying. Although the time required for eradication of the disease depended partly upon the degree of endemicity and epidemicity peculiar to a given region, it was chiefly dependent on the bionomics of the vector. In areas where *A. darlingi* Root was the vector, five years were required for the disappearance of malaria while in *A. albimanus* Wied. areas, only 3 years were needed. In sections where both species occurred in low densities only 3 years were required for malaria eradication.

According to D. R. Johnson (Mosquito News 16(3):208-211) the estimated number of people living in areas in need of malaria protection outside of communist countries is about 600 million. Of these more than 260 million have been receiving such protection. The United States through ICA has given direct support to 20 countries of the free world for malaria programs. Such problems as anopheline resistance to insecticides, the need and availability of trained personnel, human behavior characteristics which in some areas precluded effective use of residual insecticides, area inaccessibility, apathy of some governments toward malaria programs and availability of funds were discussed in this useful paper. The author felt that, despite the obstacles, help should be continued until malaria is no longer a world-wide threat.

One should not miss the Bulletin of the World Health Organization (15(3/5):361-382) entitled, "Malaria" which is a fine review of modern-day problems by many authors.

The majority of articles were prepared for the Second African Malaria Conference (Lagos 1955) and for the Eastern Mediterranean and European Regions (Athens 1956). The first paper by G. Macdonald (ibid. pp. 369-387) concerned the theory of malaria eradication. He analyzed the process of elimination of malaria, the detection of residual foci and events following the reintroduction of the disease. Surveillance in Ceylon was discussed by L. F. Gunaratna (pp. 791-199), in Thailand by L. Ayurakitkosol and M. E. Griffith (pp. 799-805) and in Taiwan by C. T. Ch'en and K. C. Liang (pp. 805-810).

Several authors contributed to the problem of resistance of anophelines to insecticides. J. R. Busvine (ibid. pp. 389-401, 787-791) dealt with the meaning of insecticide resistance and with measurements of the susceptibility of different mosquitoes to insecticides. In Greece, G. A. Lividas and K. Thymakis (pp. 403-413) showed that, on the whole, the tendency for anophelines to acquire resistance to DDT there, appeared to be continuing. G. Belios and G. Fameliaris (pp. 415-423) found *Anopheles sacharovi* Favr. larvae resistant to chlordane and dieldrin in parts of Greece but no appreciable resistance to DDT was noted although the latter was more generally used. *A. sundaicus* (Roden.) resistance to DDT in Java was reported on by C. Y. Chow and H. T. Soeparmo (pp. 785-786).

Several articles covered the subject of research on entomological problems relating to malaria. G. Frizzi and M. Holstein (ibid. pp. 425-

435) related the finding of an extremely pronounced polymorphism of chromosomes in the salivary glands for fourth-stage *A. gambiae* Giles larvae. This was the first report of a study on the cytogenetics of the species and the first time the mapping of its chromosomes is available. Additional work on the species by M. T. Gillies (pp. 437-449; 451-459) concerned its exophily and the presence of a "mating plug."—See section on "Techniques." G. Giglioli (pp. 461-471) compared the biological variations of *A. gambiae* with those of *A. darlingi*. G. Graniccia (pp. 816-821) contributed a note on *A. claviger* (Meig.) in the Middle East and M. Farid (pp. 821-828, 828-833) on the implications of *A. sergenti* (Theo.) in malaria eradication programs east of the Mediterranean.

Some of the more general articles included papers by B. Weitz (ibid. pp. 473-490) on identification of arthropod blood meals, L. J. Bruce-Chwatt (pp. 491-511) on radioisotopes and one (pp. 513-548) on an original biometric study to determine the weights of liver and spleens of Africans and Europeans, with particular reference to endemic malaria, G. M. Edington and H. Lehmann (pp. 837-842) on sickle-cell and malaria in Africa. B. de Meillon (pp. 847-851) discussed malaria vectors in Africa; J. Hamon, J. P. Adam and A. Grjebine (pp. 549-591) also Grjebine (pp. 593-611), distribution of anophelines in Africa and Madagascar — see section on "Distribution;" H. M. Archibald (pp. 842-845), influence of malaria infection of the placenta on the incidence of prematurity; and P. C. C. Garnham (pp. 845-847) "Microsporidia in Laboratory Colonies of Anophelines."

The next series of papers was on the epidemiology and control of the disease in different areas. G. Macdonald (ibid. pp. 613-626) discussed malaria in equatorial Africa, P. M. Bernard (pp. 627-634) in tropical Africa, D. Metselaar (pp. 635-649) in New Guinea, J. de Zulueta (pp. 651-671) in Sarawak, Brunei and Borneo (second paper in collaboration with F. Lachance (pp. 673-693)), H. M. Archibald (pp. 695-709) in northern Nigeria, G. Joncour (pp. 711-723) control in Madagascar, M. Ciuca (pp. 725-751) in Romania and C. Simic (pp. 753-766) in Yugoslavia.

Malaria control by drugs was presented by G. Houel (ibid. pp. 767-774) who described the use of different drugs for mass treatment in Morocco; and by H. M. Archibald and L. J. Bruce-Chwatt (pp. 775-784) on the suppression of malaria in Nigerian school children.

The first country in the Eastern Mediterranean region to embark upon malaria eradication is Syria, who has signed an agreement with WHO and UNICEF for assistance in a five-year program according to World Health Organ. (Chron. 10(8):263.) An estimated 1,150,000 people live in malarious areas there and operations are expected to cover the affected areas simultaneously to stop transmission of the disease. The plan is to continue operations until no transmission has been observed for three consecutive years. Following this, affected areas are to be kept under constant surveillance. Particular attention to protecting nomadic tribes will be given. Dr. M. Postiglione has been appointed WHO team leader

and technical adviser. In southern areas of Damascus and Hauran, work will be coordinated with UNRWA.

Numerous breeding places for *Anopheles sacharovi* Favr. and *A. superpictus* Grassi, the vectors of malaria in Turkey, were found on the Asiatic and European coastlands of that country. Similar conditions also existed in south-east Anatolia. Residual spraying with DDT has been extended to protect 9 million persons in 12,600 villages. According to F. W. Kratz and C. B. Bridges (U. S. Pub. Health Serv. Rpts. 71(4): 409-416) much progress has been shown in terms of spleen rates and percentage of malaria admissions to hospitals. No resistance to anophelines has been reported.

According to P. D. Leshchenko (Roy. Soc. Promot. Health Jour. 76(9):645-646) there were more than 650,000 cases of malaria annually in the Ukraine, (USSR) before the Revolution. Following this period, widespread epidemics occurred throughout the area and malaria control became an urgent national problem. After the establishment of the "Hydro-technical anti-malarial works" the incidence of malaria cases dropped to 63 per 10,000 in 1940. In 1924 the rate was 329. A sharp rise occurred during World War II but by 1955 only 118 cases of malaria were registered in the whole of the Ukraine. The chief means of attack was through the use of antimalarials administered to 6 million people annually. Larvicidal spraying was also applied. The problem now is to eliminate malaria completely and antimalaria measures are now a part of the national economic plan.

According ot A. A. Kolesova (Med. Parazit. i Parazit. Bolezni 25(3):263-266) complete elimination of *vivax* malaria was accomplished in the rice regions of Uzbekistan, Samarkand Oblast, USSR, following the use of antimalarials and continuous treatment of dwelling places with DDT for two seasons. There was a sharp reduction in the vector, *Anopheles sacharovi*.

E. P. Hodgkin's valuable contribution, "The Transmission of Malaria in Malaya" (Studies from Inst. Med. Res., Fed. of Malaya, No. 27, 98 pp.) is the result of a series of investigations made in Malaya during 1931-1941. *Anopheles maculatus* Theo. was the principal, if not the only vector of the hill plantations and rice-growing valleys. *A. barbirostris* V. d. W., *A. letifer* Sandosham and *A. umbrosus* (Theo.) were found to transmit malaria on the coastal plain in the fresh water zone, while *A. sundaicus* (Roden.) was the vector in the brackish water area. The latter species appeared to be an efficient transmittor only where its density was much greater — perhaps 10 times — that of other vector species. On wide areas of the flat land, occasional outbreaks of malaria have been associated with *A. barbirostris* and *A. 'hyrcanus'* Pallas.

The objective of the six-year malaria control program in the Philippines has been changed to eradication and the planned spraying program has been enlarged to cover all houses on the island. Some of the usual problems involved in eradication, plus others peculiar to the country,

have to be met and the program is being reorganized in this light according to A. Ejercito (Philippine Med. Assoc. Jour. 32(7):396-411).

Nearly a century has passed but the question of whether human malaria parasites are intracellular or extracellular has never been solved. P. G. Shute and M. Maryon (Roy. Soc. Trop. Med. and Hyg. Trans. 50(2):139-149) suggested that "the parasite is extracellular and that it obtains its nourishment by puncturing or otherwise damaging the envelope of the erythrocyte with tentacle-like processes. The punctures of the cells form the basis of the stippling, and it is suggested that if this is the correct explanation of the stippling, the indications are that the parasite is on, and not in the red cell."

"The Microscopic Diagnosis of Human Malaria. II. A Morphological Study of the Erythrocytic Parasites," by J. W. Field and P. G. Shute (Studies from Inst. Med. Res. Fed. of Malaya, No. 24, 251 pp.) is a worthwhile publication. Chapters have been included on *Plasmodium falciparum, P. vivax, P. malariae, P. ovale* as well as the parasite, the host red cell and methods of examination. More than half the book has been devoted to 50 plates showing the appearance in thin blood films of the four species of *Plasmodium* infecting man. This study was issued as a companion volume to the one in 1949 concerning the morphology of Malayan parasites in thick blood films.

A new species of *Plasmodium—P. inopinatum*—has been described by R. Resseler (Soc. Belge Med. Trop. Ann. 36(3):259-263). The blood of a rat, caught near Lierre, Belgium, in May 1956, was found to contain a malaria parasite in low density. The two other known malaria parasites of rodents (*P. vinckei* and *P. berghei*) are confined to West Africa. P. C. C. Garnham has made the following comment: "This discovery may prove of great importance, because the problems of mosquito transmission (hitherto so difficult in the African species) may be simple with our European *Anopheles*."

Part five of a monumental study of *Plasmodium berghei* in relation to malaria in rats by E. Sergent and Alice Poncet, was devoted to the morphology of the asexual stages of the parasite. The study was based on examination of about 2,000 adult mice and 1,000 rats infected with the Keyberg 173 strain (through 618 blood passages). The work, begun by the authors in 1955, covered three parts during that year (Inst. Pasteur d'Algerie Ann. 33(2):71-77; 33(3):195-222 and 33(4):287-306). Part four on acquired resistance (ibid. 34(1):1-51) and part five on morphology of the parasite (34(2):139-180.) were published in 1956.

The use of hydroxychloroquine against *Plasmodium vivax* was found to control both parasitemia and temperature on an average of less than two days by M. Nieto-Caicedo (Amer. Jour. Trop. Med. and Hyg. 5(4): 681-685). This study in Venezuela confirmed observations of others that the drug's antimalarial activity against *P. vivax* was comparable to that of the other 4-aminoquinolines but appeared to be better tolerated.

The Malaria Institute, Ministry of Health, Republic of Indonesia has issued a "Manual of Operations" for use in their malaria control

program. In the 66 pages are included information on organization, evaluation teams and training of personnel for spraying operations. Several plates showing details of equipment will be found helpful to the operator.

"Plan de Erradicacion de la Malaria" has been published by the Ministerio de Salud Publica y Bienestar Social, Rep. de Paraguay. The organization of the program was outlined and such subjects as importance of malaria in the country, geography, epidemiology of malaria and other factors concerning the program were discussed in the 112 pages of the study.

The Ministry of Health (of Iran), Department of Public Health, Malaria Eradication Operation Division has published an "Activities Report 1949-1956." The malaria program is outlined in the many numbered and unnumbered pages; included are maps, pictures and tabular material. It was felt that malaria control was the most important factor in the increase of wheat, barley and cotton in certain areas during 1949-1953. In one locality the area under wheat cultivation increased 758,000 hectares and in another by 300,000 hectares under barley cultivation. Although foreign aid was at first necessary to implement malaria control operations, the entire expense during 1956 was paid by the Iranian Government alone.

Cambodia, Laos, Thailand and Vietnam participated in a conference sponsored by WHO in Cambodia in mid-January and planned to merge their malaria control programs in an effort to rid the Indochinese peninsula of its most expensive debilitating disease. Harry H. Stage, who attended the conference, reports that he suggested the establishment of an Anti-Malaria Coordination Board which was recommended by the Conference. A request was made to the World Health Organization to provide technical advice and secretariat services to the Coordination Board.

Three voluntary contributions to the special account for combating malaria, established by the Eighth World Health Assembly to promote malaria eradication have been accepted by the Board. (World Health Organ. Chron. 10(3):81; (5):148). The first two were made by Brunei (about $10,000) and China (material valued at some $4,000). The third from Germany amounted to about $50,000.

See "Introduction" for information on Mexican and Indian malaria programs.

YELLOW FEVER

A valuable contribution on the subject on yellow fever in Middle America has been made by H. Trapido and P. Galindo (Expt. Parasitol. 5(3):285-323). Following a brief history of the sylvan form of the wave in 1948-1954, they summarized the bionomics and distribution of the sylvan mosquito fauna and mammals of the region likely to be related to the maintenance of the yellow fever cycle. Some of the vector species included were *Haemagogus spegazzinii falco* K., O.-M. and B.-M, *H. equinus* Theo., *H. mesodentatus* complex, *Aedes leucocelaenus clarki* G., C. and T., *A. scapularis* (Rond.), and possibly *Sabethes chloropterus* (Humb.). An interesting epidemiological discussion followed.

The Annual Report of the Director of the Pan American Sanitary Bureau for 1955, published in 1956, contained data on yellow fever and *Aedes aegypti* (L.) eradication, pages 39-44. The number of human cases by country, in the Americas was reported for the period 1951 through 1955. Following this were included two useful charts showing the status of *A. aegypti* eradication campaign based on the use of DDT. The Director, Dr. Fred L. Soper, also discussed quarantine regulations and yellow fever vaccine.

O. Pinto Severo (Mosquito News 16(2):115-121) reviewed some of the problems of the eradication of *Aedes aegypti* from the Americas and the actual status of the campaign in South America, Central America, Greater Antilles, Lesser Antilles and North America. A map showing the progress of the campaign as of December 31, 1955 was included.

In a more extensive paper the same author (Bol. Ofic. Sanit. Pan Amer. 40(6):485-498) presented a history of yellow fever and control measures of the vector species since 1900. He discussed in detail the eradication campaign of *A. aegypti* and a summary of its progress to 1955.

C. M. Johnson and S. F. Farnsworth (Bol. Ofic. Sanit. Panamer. 41(2):182-183), in a preliminary note, have briefly summarized the yellow fever movement in Central America. In Guatemala, mosquitoes were collected to determine the species responsible for the transmission of the virus. At the time of writing, yellow fever virus had been recovered from 6 batches of *Haemagogus mesodentatus* Komp and Kumm, from 2 of *H. equinus,* and 1 of *Sabethes chloropterus.* Distribution and habits of the species were reviewed.

Studies on experimental vectors of yellow fever in Middle America have been reported upon by P. Galindo, E. de Rodaniche and H. Trapido (Amer. Jour. Trop. Med. and Hyg. 5(6):1022-1031). A strain of yellow fever virus isolated in Trinidad has been successfully transferred from monkey to monkey by *Haemagogus mesodentatus mesodentatus, H. m. gorgasi* G. and T., and *H. equinus.* These species, in addition to *H. lucifer* Dyar and *H. spegazzinii falco* were found by intracerebral mouse inoculation to harbor the virus from one to four weeks after the infective meal. "No virus was isolated from mice injected with pools of *Sabethes chloropterus* even though the species transmitted the virus by bite from monkey to monkey on one occasion."

A. C. Chandler (Mosquito News 16(2):58-63) stressed the importance of "mother foci" to *Aedes aegypti* in Texas. Mother foci are primary breeding places of the species — containers of such size and position that the mosquito can survive the freezing temperatures that occur even in northern Texas. He concluded that the elimination of many of these breeding places in the years 1942-1945 caused a permanent reduction in the abundance of the mosquito. This was revealed in surveys made in 1952.

"Yellow Fever Vaccination" is the title of an authoritative book by K. C. Smithburn and Others (World Health Organ. Monogr. Ser.

No. 30, 238 pp.). Tens of millions of individuals have been immunized against yellow fever since the vaccination against the disease was first applied in Africa in 1934. The achievements and the vicissitudes of yellow fever vaccination are well described. The two types of vaccine now available are discussed; namely, 17 D and Dakar.

See note in "Introduction" on yellow fever.

OTHER DISEASES

According to information compiled by the Animal Disease Eradication Division of the U. S. Department of Agriculture, infectious equine encephalomyelitis was found in 37 states in 1955 and 1,236 cases among equines were reported. In 1956 the number of recorded equine cases rose to 1,284. Cases among humans that year totaled 303. Deaths among equines reached 662 in 1955 as compared with 493 in 1956. The disease reached epizootic proportions in the South Atlantic section of the country during 1955 and it was thought that the high mortality of equines in that section was due to the prevalence of the eastern type of the virus which is more lethal than the western type and to the fact that the disease was found in areas free of it for several years.

Research by R. W. Chamberlain, R. K. Sikes and D. B. Nelson (Soc. Expt. Biol. and Med. Proc. 91(2):215-216) has revealed that *Mansonia perturbans* (Walk.) and *Psorophora ferox* (Humb.), under laboratory conditions, are susceptible to Venezuelan equine encephalomyelitis virus and are capable of transmitting it. Both species are severe biters of man and are widely distributed in the United States. They should be considered as potential vectors if the virus should enter the country.

According to studies made by Enid de Rodaniche (Amer. Jour. Trop. Med. and Hyg. 5(5): 797-801) the virus of Ilhéus encephalitis has been isolated from mosquitoes of the genus *Psorophora* captured in Honduras. This represents the first isolation of the virus in Central America.

Isolations of Ilhéus virus from wild caught forest mosquitoes have been made in Trinidad by C. R. Anderson, T. H. G. Aitken and W. G. Downs (Amer. Jour. Trop. Med. and Hyg. 5(4): 621-625).

A valuable contribution has been made by R. M. Taylor, T. H. Work, H. S. Hurlbut and F. Rizk (Amer. Jour. Trop. Med. and Hyg. 5(4):579-619) on the ecology of West Nile virus in Egypt. They concluded that the main cycle of the virus is probably through mosquitoes and birds in which man may become involved. The virus was isolated repeatedly from the blood of febrile children and from two *Culex*: *C. univittatus* (Theo.) and *C. antennatus* Becker. *C. univittatus* was found more frequently infected than any other species of mosquito. Although 530 pools of other arthropods were examined, the virus was not found.

ADULTICIDES AND LARVICIDES

A noteworthy piece of research on tests of residual insecticides in window-trap huts against Malayan mosquitoes has been conducted over

a four-year period by J. A. Reid and R. H. Wharton (Bul. Ent. Res. 47(3):433-468). Of the numerous species which entered the traps, *Culex fatigans* (=*quinquefasciatus* Say) was the only one which habitually rested indoors during the day. The others entered to feed at night but rested out-of-doors. DDT was applied at the rate of 200 mgm. per square foot and gamma BHC and dieldrin usually at 40 mgm. A later experiment indicated that deposits of 100 mgm. of dieldrin per square foot may be more promising for controlling mosquitoes in the area. The important fact for Malaya is that the vectors of malaria do not rest indoors and that an attempt at eradication solely by indoor residual spraying seems to be unattainable. The work confirmed the relative effectiveness of the 3 insecticides as reported in recent years by other authors and the present ones. The value of innate physiological differences between species (in Malaya) in their susceptibility to insecticides was stressed. Further details concerning the action of the insecticides were included.

M. Christie and G. Webbe (Bul. Ent. Res. 47(1):1-6) believed that the minimum lethal dose (MLD) was a more practical concept to measure toxicity than the median lethal dose particularly in vector eradication programs. A study was made in Africa of the susceptibility of fourth-stage *Anopheles gambiae* Giles larvae to DDT and dieldrin to secure a basis for comparison with experience gained in North America and as a reference point for future resistance problems. Results showed that the 48 hour MLD for acetone-water suspension of DDT to *A. gambiae* larvae was about 0.06 p.p.m. and for dieldrin 0.01 p.p.m. However, in oil solutions the MLD was about 0.001 pound per acre for dieldrin and 0.02 for DDT, a toxicity ratio of 20 to 1.

According to J. A. Reid (Ann. Trop. Med. and Parasitol. 50(2): 129-136) DDT emulsion larvicides were effective against *Anopheles maculatus* Theo. in Malaya but failed to control *Culex pipiens fatigans* Wied.(= *quinquefasciatus*) larvae in scummy, stagnant water. However, good control was obtained by the use of 4 ounces of gamma BHC per acre and 3 ounces of dieldrin under certain conditions. Rearing of *Culex quinquefasciatus* in the laboratory was described.

Of three insecticides (BHC, lindane and dieldrin) tested against larvae of *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.) in Brevard County, Florida, R. W. Nowell and D. W. Parrish (Mosquito News 16(3):212-219) found only dieldrin gave a significant degree of control after the second flooding. The insecticides were applied by air as a pre-hatch treatment to test plots in typical salt-marsh breeding areas covered wtih pickleweed, salt-marsh Bermuda or white mangrove.

In laboratory tests against fourth-instar larvae of *Anopheles quadrimaculatus* Say, G. C. Labrecque, J. R. Noe and J. B. Gahan (Mosquito News 16(1):1-3) found parathion and EPN to be the most effective of 25 granular larvicides used. In field tests against *A. quadrimaculatus* and *A. crucians* (Wied.) both of these insecticides and Bayer 21/199 gave the best results.

Diazinon, tested under laboratory conditions, for the control of *Culex*

quinquefasciatus larvae in Kenya, was reported by A. E. C. Harvey (East Afr. Med. Jour. 33(4):117-123) to give complete control with as little as 1 p.p.m. in 24 hours. In a few practical tests good control was obtained by treating septic tanks with 2 p.p.m. of the insecticide. Although no dipping was made before treatment, breeding was so heavy before, and the number of larvae so reduced after, in every case, that control with diazinon in small concentrations was easily discernible.

Malathion in an oil spray, applied by air, at the rate of 0.47 pound per acre over a two-mile-square area near Merced, California, was tested to control *Culex tarsalis* Coq. adults during August 1955. According to light trap collections a reduction of 51 and 97 percent of *C. tarsalis* and *Aedes nigromaculis* (Ludlow) respectively occurred. C. M. Gjullin and R. F. Peters (Mosquito News 16(2):84-86) found complete kills of larvae of *A. nigromaculis* in open water but not in water heavily covered with grass.

TOXICOLOGY

As DDT continues to be the predominant residual insecticide for mosquito control in the world, a report of the effect of known repeated oral doses of DDT in man is of interest. W. J. Hayes, W. F. Durham and C. Cueto, Jr. (Amer. Med. Assoc. Jour. 162(9):890-897) have reported the first experimental study of the storage, excretion and possible effects on man of DDT given in many small, oral daily doses. Of the fifty-one volunteers, one-third received as much as 35 mg. of DDT per man per day. According to the authors, this is about 200 times the daily rate of DDT an average man obtains from his diet. "During the entire study no volunteer complained of any symptom or showed, by the tests used, any sign of illness that did not have an easily recognized cause clearly unrelated to exposure to DDT."

A noteworthy paper, "Toxic Hazards of Pesticides to Man, Report of a Study Group" (World Health Organ. Tech. Rpt. Ser. No. 114, 51 pp.) is the result of a study made by a group of experts on the subject. After defining "pesticides," the toxic properties of these substances were discussed. Following this was a review of the incidence and nature of poisoning, protection for operators, hazards from pesticides in water or food and the role of governmental regulations in the prevention of hazards.

J. Haworth (WHO/Insecticides/60, Oct. 23, 3 pp.) observed that dieldrin used as a 50% wettable powder and as an 18.5% emulsion appeared to be toxic to some animals in northern Nigeria. Bats caught in the spray died very rapidly. In houses which were sprayed with dieldrin emulsion or suspension, some cats, mainly immature ones, showed signs of disorder of the central nervous system and many died within 24 hours to several days. Rats and mice were reported killed. Four laborers out of 40 employed showed symptoms which were diagnosed as due to exposure to the insecticide.

A study of human exposure during aerosol application of malathion

and chlorthion was made by D. Culver, P. Caplan and G. S. Batchelor (A. M. A. Arch. Indus. Health 13(1):37-50). A group of 7 entomologists, in the course of their work, were exposed to wind-borne aerosols (containing these insecticides) which were drifting downwind from generators as they moved along the edges of pasture lands. None showed any adverse reactions. The results suggest that malathion and chlorthion might be used in aerosol form against adult mosquitoes in populated areas without risking personal injury.

RESISTANCE

Insecticide resistance of *Anopheles gambiae* was studied by J. A. Armstrong, V. Ramakrishna and C. D. Ramsdale (World Health Organ. WHO/Insecticides/52, 10 pp.) in three check areas of western Sokoto, Nigeria. One area was sprayed with DDT, another with BHC and a third with dieldrin. A high degree of resistance was encountered in the BHC and dieldrin zones. "It appears that DDT is the best of the three insecticides in use, in that neither adults nor larvae of *A. gambiae* were collected from within the DDT zone."

Two papers by G. Davidson (Nature (London) 178(4535):705-706; (4538:863-864) on insecticide resistance of *Anopheles gambiae* Giles are of interest. In the second paper the author reported that a strain of *A. gambiae,* resistant to dieldrin and some other hydrocarbon insecticides but not to DDT, has been colonized at the Ross Institute. Crossings between the resistant and susceptible strains of the species have shown that inheritance of resistance to the dieldrin-chlordane-gamma-BHC group is monofactorial. This may mean a change in field detection of resistance. Such a technique instead of comparing the LC 50 would involve the whole LC 100 for the local susceptible strain and selecting survivors of this dosage.

Current information on insecticide resistance of insects has been summarized in the Chronicle of the World Health Organization 10(12): 397-402. The function of WHO in stimulating and coordinating research on the problem was briefly discussed.

H. P. S. Gillette (Mosquito News 16(2):121-125), in a brief review of the 1954 occurrence of yellow fever in Trinidad, stated that eradication of *Aedes aegypti* was not achieved by means of DDT in any single area of the island. In fact, *A. aegypti* soon developed resistance to DDT and as a result, BHC was substituted. By means of the latter insecticide, it was felt by the author that eradication of the mosquito may now be possible. [By early 1957, it had been demonstrated that *A. aegypti* eradication could be attained by this method. H.S.]

J. R. Busvine (Nature (London) 177(4507):533-534) has reported upon the "Normal Resistance-levels of *Anopheles gambiae* to Various Insecticides."

In Bolivar County, Mississippi, field studies by W. Mathis, H. F. Schoof, K. D. Quarterman and R. W. Fay (U. S. Pub. Health Serv. Rpts. 71(9):876-878) showed *Anopheles quadrimaculatus* Say to be

highly resistant to dieldrin, BHC and chlordane deposits but susceptible to DDT residues. The high level of resistance of this species to these insecticides was considered due to their use to control agricultural pests.

Larvae of *Anopheles stephensi* Liston have been observed by N. Rajagopalan, J. C. Vedamanikkam and H. Ramoo (Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 4(4):126-128) to have become tolerant to DDT in Erode Urban, Madras State. In preliminary laboratory tests only 43% of larvae from Erode Town were killed after a 24-hour exposure while 99% of the larvae from another area, which had not been treated, were killed in one hour.

For a further discussion of resistance see "Introduction" and section on "Malaria" under World Health Organ. Bul. 15(3/5).

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