

tuning produced by stray capacitance and inductance. The coaxial line, in which one conductor is formed into a tube and the other is enclosed in it, is an excellent expedient. If the central conductor is completely removed, it is still possible to transmit energy down the tube, which then becomes a wave guide. If the tube is filled with insulating material, even the outer conductor can be removed. The coaxial and the conducting tube or wave guide are the most promising of these arrangements. Compared from the point of view of attenuation losses, the coaxial line is better at the lower frequencies; but in the micro-wave region, which is of most importance at the moment, the wave guide has decided advantages. However, below a certain frequency—about 3×10^9 for the wave guide—the wave guide 'cuts off' abruptly.

Wave guides are decidedly useful for conveying micro-waves from their generator to the place where they will be used. They contain no insulating material and so are entirely immune to moisture, while their waves can be radiated by simply flaring out the tube into a horn. A wave guide may also be made into a resonant chamber by blocking one end with a metal plate and closing the other partially by a plate with a hole in it. By varying the length of the chamber, it can be tuned to the precise frequency desired; with a small hole, if the chamber is $\frac{1}{4}$, 1 or $1\frac{1}{2}$ of a wave-length, it will admit energy readily; if $\frac{3}{4}$, $\frac{5}{4}$ or $1\frac{3}{4}$ wave-lengths, it will repel energy, that is, be anti-resonant. Since the wave pattern in a resonator is fixed, it is possible to locate a detector at precisely the right spot in the pattern in order to obtain maximum response.

Somewhere along the frequency scale in the neighbourhood of a billion cycles per second—wave-length about one foot—micro-wave technique undergoes a marked change. Methods using the conventional go-and-return-conductor type of circuit give way to the somewhat simpler hollow pipe, or wave guide, circuit. These newer methods seem to be at their best in the centimetre wave-length range. At the longer wave-lengths, the component parts become inconveniently large. For shorter waves, it would appear that ability to manufacture small parts would become an important limitation. What the technique will be beyond this point is a matter for the future.

THE INSECTS OF GUAM

By DR. A. D. IMMS, F.R.S.

A KNOWLEDGE of the insect fauna of small but important islands is very desirable before such fauna is inevitably changed by the operations of man and species have become extinct. In certain cases this must have happened even before some animals were discovered, as in Hawaii, for example.

The island of Guam is very isolated in the waters of the Pacific Ocean and measures nearly 30 miles long and 4–8 miles wide. A rainfall of about 90 inches per annum is usual and mostly during July–November. The northern half of the island is an elevated limestone plateau originally covered with tropical jungle, of which much still remains. Areas with sufficient soil are occupied by gardens and small farms, and there are a few small settlements. The southern half of the island includes a low volcanic range of mountains

near the western shore, the highest peak being 1,334 ft. Streams on the eastern slope are the larger, and at the mouths of the valleys are located coastal villages. Much of the farming is carried on in the valleys, especially rice culture. On the plateau region are some cattle ranches. Rice is the only irrigated crop: not enough is grown to supply all needs and in 1936 importations were made from Japan. Other crops are corn, copra and many kinds of fruits and vegetables.

The foregoing remarks are mainly taken from an account entitled "Insects of Guam I.", which forms Bulletin 172 of the Bernice P. Bishop Museum, Honolulu (1942). This account is made up of some twenty-seven articles by specialists on different groups of insects, and presents the results of studies made on material collected during an entomological survey of the island in 1936. The survey was conducted under the auspices of the Hawaiian Sugar Planters' Association for the purpose of studying insects of economic importance in Guam. This island is the most important station between the Philippines and Honolulu on the route of Pan-Pacific Airways. Unknown insects were already being found in planes arriving in the Hawaiian Islands, and notwithstanding precautions by fumigation of aircraft, an occasional insect was found which had not fully succumbed. There is concern lest unknown pests, injurious to sugar cane or other Hawaiian crops, might gain an entry and become established in the archipelago. It is noteworthy in this connexion that about fifty species of pests of cultivated plants are known in Guam which are not known in Hawaii. The Sugar Planters' Association has always adopted a broad-minded and scientific policy, and it recognizes that among these insects of Guam are no doubt many that would become pests should they reach the Hawaiian Islands and become established therein. Furthermore, the insect fauna of the island is very inadequately known.

Among the various groups of insects dealt with in this bulletin no discrimination is made of those of economic importance—all come in for discussion and description of their species where necessary. It is noted that eleven species of dragonflies and twenty-two species of Thysanoptera but only three species of Aphididae and a single species of Aleurodidae are recorded. Butterflies number fourteen species, which is in contrast to the whole Hawaiian Archipelago, which only supports ten species. The Guam butterflies are mostly immigrants, possibly some of recent arrival, as only three or four species had been previously recorded. The most notable are the 'Monarch' *Danaida plexippus* and *Hypolimnas bolina*, the latter being widely distributed in countries and islands in and bordering the Pacific Ocean. Moths are not included in this volume except the Sphingidae, which number five species, including the cosmopolitan *Herse convolvuli*. Of the Coleoptera the Curculionidae, with forty-nine species, head the list; among them no fewer than thirty-three species and eight genera are described as being new. Among Hymenoptera twenty-nine species of ants and ten species of wasps are enumerated. Of the ants nine of the species have been already recorded from the Hawaiian Islands. Only a few Diptera are included in this volume: they comprise, among others, five species of mosquitoes, including the notorious *Aedes aegypti*. A second volume of the survey, dealing with other groups of insects, is promised at a later date when these studies have been completed.