Although the "Field Book of Insects" covers a large field, it is convenient in size, 7 x 4¼ x 1 inches, weighs about sixteen ounces, and while printed from small type, the printing is well spaced, clear and easily read. There are 101 plates, of which twenty-four are colored. The plates contain 800 figures, which are well drawn and will be of great aid in the identification of specimens. While the majority of the figures are of adult insects, there are many of nymphs, larvæ and pupæ, illustrating the common and peculiar types.

In the choice of the species to be described and figured, the author has evidently made use of his museum experience. The selection is excellent and includes all the common and anomalous species most likely to be met with by the amateur and general collector in the region covered, the northeastern United States. The discussions are interesting and concise. The introduction includes a general discussion on the number of kinds of insects, the scientific names of animals, growth and metamorphosis, anatomy, collecting and breeding of insects, identification and the control of injurious species.

There follows a brief account of the near relatives of insects, but confined in great part to spiders and their webs. The insects are divided into about twenty orders, of which the greater part of the text and a considerable number of the plates are devoted to the Hemiptera, Lepidoptera, Coleoptera, Diptera and Hymenoptera. While it is evidently intended that the figures should be used mainly for the identification of specimens, in the orders named there are analytical tables for the identification of families and genera and, in certain cases, species. The discussion of the Hymenoptera, the last order treated, is followed by a consideration of the abnormal growths or galls produced upon plants by insects. About the only way in which such structures can be identified is by the use of figures and the last seven plates contain figures of the common galls made by mites, Homoptera, Lepidoptera, Diptera and Hymenoptera. In interesting young people, those who tramp and camp, the student of nature, and the farmer who observes the things about him, this book will prove of great value.

ALEX. D. MACGILLIVRAY

NOTES ON METEOROLOGY AND CLIMATOLOGY

RAINFALL OF THE UNITED STATES

MUCH progress has been made in accurate mapping of the rainfall of the United States, and in careful discussion of our now extensive records. In 1917, the Weather Bureau finished the construction of many maps designed to bring out the rainfall features of most importance in agriculture. Possibly by the end of this summer these will be published as a section of the Atlas of American Agriculture. In fact, the map of average annual precipitation has already appeared.[1]

The most important of the unpublished maps are those of the monthly and seasonal rainfalls, and of the frequencies of rains of different intensities. Since the records of several thousand stations have been used, and since the isohyetal lines have been drawn with a careful consideration of topography, these maps show in much greater detail and accuracy than ever before the distribution of the rainfall of the United States.

The distribution has been ably discussed by Professor R. DeC. Ward.[2] The rainfall of the United States east of the Rockies seems to be from moisture originally coming from the Gulf of Mexico and the Atlantic Ocean; and, judging from the distribution of rainfall, the Gulf of Mexico is of primary importance. From the heavily watered north Gulf coast, where the rainfall is 60 inches a year, the amount decreases inland, slowly to the north, but rapidly to the northwest and west. East of the Appalachians the moisture from the Atlantic keeps the country well supplied—the rainfall being generally 45–50 inches in the south, and 40–45 in the north. The effect of the Appalachians is to increase the rainfall on the borders but to decrease the rain in the interior of the mountain region. Thus there

[1] See the reproduction in the *Mo. Weather Rev.*, July, 1917, Vol. 45, Pl. 76.

[2] *Ibid.*, pp. 338–345.

are local maxima of over 50 inches on the slopes well exposed to moist winds; but minima of less than 40 inches in the valleys. The extremes are over 80 inches on the exposed southern face of the Appalachians where North Carolina, South Carolina and Georgia meet; and under 30 inches in the enclosed Champlain valley. Without the abundant moisture which sweeps northward unobstructed all the way from the Gulf of Mexico, the Great Lakes could hardly exist. Since they are present, they exert a local effect on the climate; and increase the rainfall by perhaps 5 inches, making the total thereabouts 35 inches. Contrasts between windward and leeward shore rainfalls are not marked, for the light precipitation which occurs frequently with the cool westerly winds, and the heavy rainfall which comes with the less frequent easterly winds nearly balance. Of the well-watered eastern half of the United States, Professor W. M. Davis says:

> The world hardly contains so large an area as this so well adapted to civilized occupation.[3]

West of the 95th meridian, the rainfall lines run north and south instead of east and west, as is the case to the east. At about the 100th meridian the rainfall becomes too small for ordinary methods of farming, being less than 20 inches in the north and under 25 inches in the south. From here west to the Rockies the rainfall decreases almost to ten inches; so the Great Plains region is one of grazing, dry farming, or local irrigation. In the outlying highlands and the mountain front, the rainfall again rises to 15 or 20 inches. In comparison with the heavily forested east this open country was easily—in some areas, too easily—settled; but the fluctuations of rainfall in this marginal region make man's hold too precarious to favor a dense population.

The Interior Plateau and Basin region, walled off by high mountains, is arid. The rainfall of the northern Rockies exceeds 40 inches in Idaho, but is under 30 inches elsewhere; the central Rockies locally enjoy more than 30 inches, but the high plateaus of the south receive but 15 to 25 inches. The lower mountains and plateaus and the valleys in the rain-shadow of the Cascades and Sierras are arid, with less than 10 inches of rainfall. This aridity becomes extreme in the south; there, with lesser cyclonic activity, and greater heat, the rainfall averages under 5 inches a year. Water for the irrigation of these driest regions is not altogether lacking, for, except in the south, they occur in the lee of the wettest mountains. Thus, the Cascades with rainfall 10–15 times as great as that in the Yakima valley, supply abundant water for this great orchard.

The cause of aridity in the rain-shadow of the Cascades and Sierra Navadas is apparent from a glance at the excessive rainfall on the western side of the coast ranges and these higher mountains. South to the 40th parallel the rainfall exceeds 80 inches, and on the west flank of the Olympics, even 120 inches. In California, the rainfall decreases rapidly southward, while on the mountains of southern California, the amounts are under 30 inches, and on the coast at San Diego even less than 10. The cause of the heavy rainfall is the rapid cooling of the moist air which is blowing almost continuously from the Pacific. This cooling is brought about (1) by the expansion of the air as it is forced to rise over the obstructing mountains; (2) by the similar cooling as this air rises in the numerous cyclones; and (3) by cooling to the cold ground in winter. Diminishing cyclonic activity and increasing warmth of the land cause a southward tapering of the rainfall. The trough between the coast ranges and the higher mountains on the east receive only half as much rainfall as the mountains on either side; thus in many parts of the valleys irrigation is necessary particularly in the San Joaquin valley and in southern California. Water is supplied abundantly by the slow-melting mountain snows. Unlike the eastern United States, then, the western United States has sharp contrasts of rainfall in short distances; and because the rainfall is excessive on the moun-

[3] "Elementary Meteorology," Boston, 1894, p. 301.

tains, where it is not needed for agriculture, it is deficient on the lowlands, where man has to irrigate. However, the aridity of parts of the West has some compensation in the extensive forests of tremendous trees on the soaking slopes of the Pacific.

SEASONAL DISTRIBUTION OF RAINFALL

In some respects, the distribution of rainfall throughout the year is more important than the amount. On this depends the rainfall usable for agriculture, and likewise the effects of rainfall on soil. Thus the 25 inches of rainfall in Nebraska are as useful for crops as 40 inches in Virginia. In fact, the extra 15 inches in Virginia may do more harm than good, on poorly kept farms at least, by washing and leaching the soil.

Rainfall comes (1) in general cyclonic rains, (2) in local convectional (thunder) showers, and (3) in topographically produced falls. The cyclonic rains are greatest with frequent strong cyclones in regions where there is abundant moisture. The thundershowers are most numerous in mid-summer[4] unless at this time the supply of moisture is not abundant. The topographically produced rains are heaviest when there is the greatest cooling of the moist winds. In the United States, general cyclonic rains on the Pacific coast and in the eastern third of the country are heaviest in the colder months. Thunderstorms are common in summer in the wetter parts of the country west of the Sierra-Nevada-Cascades. Topographically produced rains are important on the Pacific, Gulf and Atlantic coasts, and on the windward sides of mountains; they are essentially early winter rains.

Professor Ward has picked out 14 well-recognizable rainfall types in the United States; and he has made composite curves and discussed each.[5] The rains east of the Rockies tend to be heaviest in summer, and those west, in winter. The type covering the greatest region is the continental "Missouri" type. It has a summer rainy season with a maximum of over 4 inches in June and a minimum of 1 inch in January. This shades off into many types on all sides. The Ohio type may be considered as the Missouri type with 1 to 2 inches of cyclonic rain added through the cold half of the year. The New England type has still more of the cyclonic winter rainfall, with 3 to 4 inches of rain every month. Farther south the Atlantic has an intensification of the July and August rainfall with the very favorable moisture conditions for thunderstorms and with the occasional heavy rain of tropical cyclones. The Tennessee type includes so much rainfall from the strong cyclonic action in February and March that the principal maximum, 4½ inches comes at this time; and there still is the summer maximum.

The Gulf coast is always moist. There are three types of rainfall—different combinations of thunderstorm and cyclonic rains—all with maximum intensity in the warmer half of the year.

In the East Rocky Mountain Foothills type, the rainfall in spring starts off like the Missouri type, but the winter snows are insufficient to supply moisture for increasing thunderstorm rains beyond May. The winters are dry in spite of numerous cyclones, because the air can contain so little moisture at the low temperatures. West of the crest of the Rockies, the moisture from the Pacific is precipitated topographically most in winter. In the plateau region, summer convection, especially before the ground is thoroughly dried, brings another maximum early in summer. In the south, however, the winter precipitation is so light and so soon evaporated that the summer showers do not occur till July when moisture arrives in sufficient quantity from the Gulf of California and the Pacific. On the north Pacific coast where there is much cyclonic activity throughout the winter the maximum comes in December (over 7 inches) when the topographic rainfall tends to be heaviest. In the south, cyclonic activity is more important than the cooling of on-shore winds in producing rainfall, so the heaviest rains in the "Southern Pacific" type occur from January

[4] See *Mo. Weather Rev.*, Vol. 43, 1915, pp. 322–340, 13 charts; and pp. 619–620.

[5] *Geogr. Review*, Vol. 4, 1917, pp. 131–144.

to March. Correspondingly, without cyclones, the summers are practically rainless.

The diverse rainfall types of the United States as well as the essential features of the distribution of rainfall may be held in mind if the essential faetures which produce rainfall are remembered.

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SPECIAL ARTICLES

A PARALLEL MUTATION IN DROSOPHILA FUNEBRIS

A mutant of *Drosophila funebris* Fabr. has recently appeared that is so strikingly similar to a well-known mutant of *D. melanogaster* Meig. (*ampelophila* Loew) that there can be litle doubt that the same mutation has occurred independently in the two species. The new form, called notch, agrees with the notch *melanogaster* in at least eight different respects, as will appear below.

Origin.—A female *funebris* of a stock from Mitchell, S. D., was mated to a male of a stock from New York City. The descendants were mated in pairs for several generations, and no variations were observed except an occasional fly with one of the anterior scutellar bristles missing. Such flies were found also in the uncrossed New York stock. In the line under consideration selection was carried on, in an attempt to increase the percentage of such flies, but no marked result was obtained. In F_5 one pair (5201) produced 35 normal females, 34 notch females, and 36 normal males. The sex ratio here is significant, since an excess of males is more frequent than an excess of females in this species. The pair from which the parents of 5201 came produced 19 females and 31 males, which is not an unusual excess when complete counts are not obtained. In *D. funebris* the males usually emerge in a little less time than the females. This relation is just the reverse of that found in *D. melanogaster*. Evidently the female parent of 5201 was genetically notch. She was not observed to be abnormal, and had been destroyed when her offspring began to emerge. It seems probable that she did not have notched wings, but she may well have had the characteristic veins and acrostichal hairs, since these would more easily have been overlooked.

Description.—Notch *melanogaster* is characterized by having the wings somewhat nicked, more especially at the apical posterior corner. But this character is somewhat variable, being often unlike in the two wings of the same female, and sometimes even entirely absent.[1]

In addition the eyes are often smaller than those of the wild-type flies and somewhat roughened.[2]

Furthermore the veins of notch are somewhat thickened, more especially the apical portions of the second and fifth longitudinal veins. This character is the most invariable and convenient index of the presence of the notch gene. The anterior scutellar bristles of notch are often doubled. The acrostichal hairs are more numerous than those of the wild-type fly, and are irregularly arranged, instead of being in eight fairly definite rows.[3] The notch gene thus produces an unusually large number of morphological peculiarities.

Notch *funebris* agrees in all of the above respects. The wings are nicked in the same way, but are often asymmetrical and sometimes normal; the eyes are often small and roughened; the wing veins are thickened even more than those of notch *melanogaster*, the second and fifth being affected most, and this character being again the most convenient and reliable for purposes of classification; the anterior scutellar bristles are often doubled, in spite of the fact that notch arose in a family selected for the absence of these bristles; the acrostichal hairs are irregularly ar-

[1] See Morgan, 1917, "The Theory of the Gene," *Amer. Nat.*, 51, for figure and a discussion of this variability.

[2] Bridges has shown that notch is probably an allelomorph of the roughened eye known as facet. Metz and Bridges, 1917, "Incompatibility of Mutant Races in *Drosophila*," *Proc. Nat. Acad. Sci.*, 3.

[3] The peculiarity of the acrostichal hairs was not observed here until it was looked for after notch *funebris* was found to have unusual acrostichals.