distribution of the bottles which left the Bay of Fundy from two of these sets is shown in the figure, where the interrupted lines merely join the points of setting out and finding of the bottles, and are not intended necessarily to indicate the course which the bottle may have taken. The bottles were set out between June 18 and September 26 in sets spaced in lines across the bay at various distances from on the Cape Cod peninsula, the other two on the coast of Maine. (See figure which shows only the bottles of the first two sets.)

The times when the bottles were found are significant since they establish a minimum rate for the drift. Seven out of the eleven bottles which went to Cape Cod were found between 70 and 80 days after being put out, the shortest time being 73 days. The distance

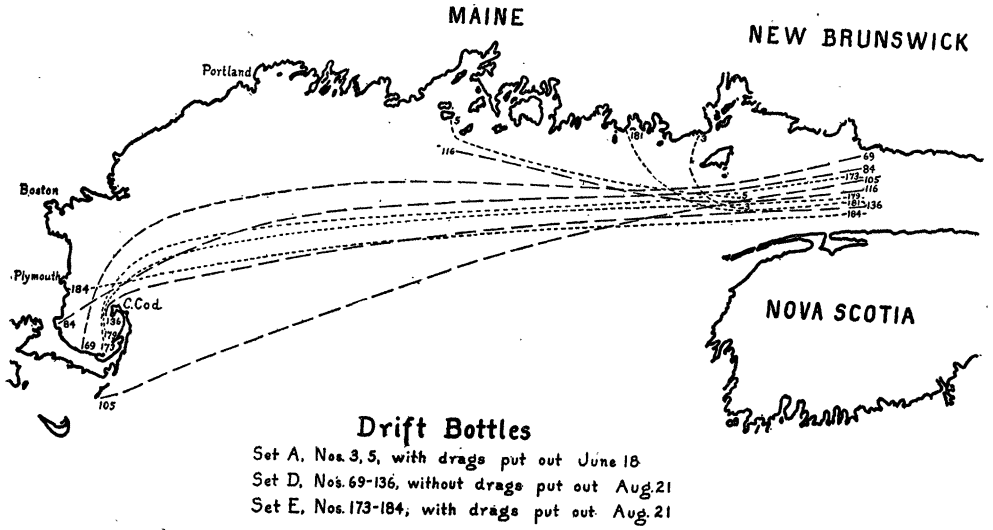

FIG. 1.

its entrance. Each bottle contained a Canadian postcard on which was printed besides the address of the Biological Station the offer of a reward to the finder who wrote the time and place of finding and posted the card. The bottles were of two kinds; two-ounce bottles and eight-ounce bottles; to the latter a galvanized iron drag was attached to hang at a depth of three fathoms, the object of the drag being to minimize the direct effect of the wind. Fifty-five of these latter bottles with drags were set out and six have been found and reported from outside the Bay of Fundy, to date (August 6, 1920). Three of these were picked up on the Cape Cod peninsula, the rest on the coast of Maine. Of the two hundred and seventy-five bottles without drags, ten have been reported from outside the bay. Eight of these ten were picked up in a straight line from the Bay of Fundy is about 300 nautical miles. The rate of the drift was therefore about four nautical miles per day.

The drift of these bottles, set out at various times during the summer, indicates a surface movement of the water from the Bay of Fundy through the northwestern part of the Gulf of Maine and striking Cape Cod, the rate of this drift being about four nautical miles per day.

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SCIENTIFIC BOOKS

La Vie Psychique des Insectes. Bibliothèque de Philosophie Scientifique. By C. L. BOUVIER. Paris, Ernest Flammarion, 1918. 299 pp.

In this interesting little volume Bouvier endeavors to present an up-to-date sketch of insect behavior. In the introduction he quotes the following remarkable passage from Maeterlinck's paper on Fabre and his work:[1]

> The insect does not belong to our world. Other animals and even the plants, despite their mute lives and the great secrets they enfold, seem not to be such total strangers, for we still feel in them, notwithstanding all their peculiarities, a certain terrestrial fraternity. They may surprise or even amaze us at times, but they do not completely upset our thoughts. Something in the insects, however, seems to be alien to the habits, morals and psychology of our globe, as if it had come from some other planet, more monstrous, more energetic, more insensate, more atrocious, more infernal than our own. With whatever authority, with whatever fecundity, unequalled here below, the insect seizes on life, we fail to accustom ourselves to the thought that it is an expression of that nature whose privileged offspring we claim to be. . . . No doubt, in this astonishment and failure to comprehend, we are beset with an indefinable, profound and instinctive uneasiness, inspired by beings so incomparably better armed and endowed than ourselves, concentrations of energy and activity in which we divine our most mysterious foes, the rivals of our last hours and perhaps our successors. . . .

And Bouvier adds:

> We have the feeling that the psychic evolution of these animals must be no less original than their structure and that they never differ so greatly from us as when they seem to resemble us most closely.

Bouvier's discussion of the psychic life of insects is divided into two parts, a "methodical" part, comprising Chapters I. to IX. and a "special" part, comprising the five concluding chapters. The methodical part treats of the tropisms, vital rhythms, differential sensibility, organic, specific and individual (associative) memory, the learning process, the modifications of habits, the evolution of instincts and in the ninth chapter of the comparative or historical method as illustrated by a single Hymenopterous family, the Psammocharidæ (Pompilidæ). Loeb and Bohn are at first rather rigidly followed, and the author is not very favorable to the position of Jennings. He attributes the "trial and error" activities to differential sensibility and even tries to use this as a partial explanation of "death feigning." But later his treatment of the problems of insect behavior broadens out and he reveals himself as a sane and catholic Neolamarckian, with strong eclectic tendencies and willing to utilize natural selection, Mendelism and mutationism in accounting for certain phenomena such as the sexual differences in instincts and the evolution of the worker and soldier castes in social insects. His general position is summarized at the end of the eighth chapter in the following paragraphs:

> Owing to their tropisms, their rhythms, the adaptive manifestations of their differential sensibility, but especially their ability to transform habits into automatisms, the Articulates are essentially creatures of instinct, whose activities are largely made up of automatisms, but automatisms dominated by cerebral control ("puissance cérébrale"). They can not be regarded as simple "reflex machines," because they can adapt themselves to circumstances, acquire new habits, learn to remember, and manifest discernment. They might be regarded as somnambules, whose minds awake and give evidence of intelligence when the need is felt, and this takes us a long way beyond the mechanism of which Bethe has made himself the protagonist.
>
> The activity of insects is characterized by two essential peculiarities: first, the presence of multiple, more or less perfectly adapted appendages, and second, the power very quickly to transform acts originally intelligent into automatic acts. This latter character is without doubt a consequence of the former, for the appendages are instruments both structurally and functionally almost congealed (figés). At any rate, there can be no doubt that this is the principal factor in the evolution of the Articulates. Owing to this peculiarity, in fact, the automatic activity of the animal can go on enriching itself with new elements borrowed from intelligence and thus adapted to new necessities. A substratum of activity is thus produced and develops, permitting intelli-

[1] *Ann. Polit. Lit.*, 2 Avril, 1911.

gence, as Bergson says, to mount on the wings of instinct. It does not soar far, nor very high, because its efforts very soon congeal in automatic form, but with each attempt the instinctive substratum is augmented to give the animal a vaster field of activity. Thus we reach the higher Articulates in which the most complex automatic activities, fringed with intelligence, become concatenated and purposive as if they had been regulated by reason. Hence we repeat here what we said at the beginning of the present work: The Articulates never differ so greatly from us as when they seem to resemble us most closely.

Chapter IX. on the behavior of the Pompilids, drawn very largely from the valuable researches of Pérez and his pupil Ferton, is admirably written and can be recommended to those who are inclined to underestimate the value of ethological and historical methods in comparative psychology. An even more interesting chapter could, however, be compiled from the literature on these solitary wasps. On page 161 Bouvier tells us that "it is unfortunate that no biologist up to the present time has been able to witness the oviposition of *Ceropales*," thus overlooking completely the very interesting observations of Adlerz[2] on the surreptitious oviposition of this parasite in the lung-books of the spiders that have been captured by the host Pompilid. The extraordinary habits of one of the American Pompilids, described by Needham and Lloyd in their "Life of Inland Waters," 1916, also deserve mention in such a chapter as the one under consideration. According to these authors,

> There is a black wasp, *Priocnemis flavicornis*, occasionally seen on Fall Creek at the Cornell Biological Field Station, that combines flying with water transportation. Beavers swim with boughs for their dam, and water striders run across the surface carrying their booty, but here is a wasp that flies above the surface towing a load too heavy to be carried. The freight is the body of a huge black spider several times as large as the body of the wasp. It is captured by the wasp in a waterside hunting expedition, paralyzed by a sting adroitly placed, and is to be used for provisioning her nest. It could scarcely be dragged across the ground, clothed as that is with the dense vegetation of the waterside; but the placid stream is an open highway. Out on to the surface the wasp drags the huge limp black carcass of the spider and, mounting into the air with her engines going and her wings steadily buzzing, she sails across the water, trailing the spider and leaving a wake that is a miniature of that of a passing steamer. She sails a direct and unerring course to the vicinity of her burrow in the bank and brings her cargo ashore at some nearby landing. She hauls it up on the bank and then runs to her hole to see that all is ready. Then she drags the spider up the bank and into her burrow, having saved much time and energy by making use of the open waterway.

Additional peculiarities of habit among the Pompilids have been described by other authors, notably by F. X. Williams in a recent work on the wasps of the Philippines.[3]

In the second part of the work Bouvier discusses certain selected phenomena which have been long and intensively studied by entomologists, the relations of insects to flowers, the homing of bees, ants and other insects, parthenogenesis and the determination of sex among the Hymenoptera and social life among the Articulates. When we consider that the researches on all these subjects have resulted in vast accumulations of observations, often hidden away in inaccessible journals and monographs, and a most bewildering diversity of interpretations, the author deserves high praise for his brief, concise and orderly presentation. Inadequacy of treatment was unavoidable in many cases, as, *e. g.*, the omission of any consideration of the important experimental contributions of Brun (1914) to the subject of the orientation and homing of ants and other animals. Any adequate treatment of even a portion of insect ethology at the present time would, of course, require several volumes and would transcend the powers of any entomologist. Most readers will be delighted with Bouvier's book as it stands, with its lucid diction, its lack of dogmatic assertion, its kindly and

[2] Bik. K. Svensk. Vet. Akad. Hand., 1902.

[3] Bull. No. 14, Exper. Station Hawaiian Sug. Plant. Assoc., 1919.

stimulating tone and its frank acknowledgment of our ignorance in regard to many matters of fundamental importance. So valuable a work should have been printed on much better paper, but the exigencies of the war probably made this impossible. One could have wished also that the author had provided the volume with an index and had seen fit to give careful citations of the many interesting works to which he refers.

W. M. Wheeler

SPECIAL ARTICLES

ON THE PROTEIN CONTENT OF WHEAT

Wheats of the Pacific coast states are conspicuously low in protein, so much so that western millers are obliged to ship in large quantities of high protein wheat to mix with their domestic wheats in order to manufacture flour of good baking qualities. The cause of the low protein content of western wheats has been the object of considerable investigation on the part of interested agronomists and plant physiologists for the last two decades. Results obtained from these investigations have led to a rather common belief, that the cause of the low protein content of Pacific coast wheat is primarily attributable to peculiar influences of climate.

In an investigation by the writer on the effect of applications of certain forms of soluble nitrogen to plants at different growth phases, results obtained with wheat, one of the plants studied, throw new light upon this protein question. In this paper, only that part of the plan and the results that pertain to the subject under discussion, need be given. These are essentially as follows:

Glazed stone jars were filled with a soil very low in nitrogen. This soil, as taken from the field, had a very low crop-producing power when cereals were planted, but upon receiving a moderate application of soluble nitrogen salt would yield large crops. This soil was planted to a pure strain of White Australian Wheat. Two hundred and fifty milligrams of nitrogen per jar, that is, at the rate of 100 pounds of nitrogen per acre, were added in single applications to different jars, at different times during the growng period of the plants. The nitrogen was added in two forms, $NaNO_3$ and $(NH_4)_2SO_4$, respectively, for two different series that were tested. Every application was made in triplicate. The first application of nitrogen to the first set of triplicates of each of the two series was made at the time of planting, the second was made to other jars 17 days after planting and so on at intervals until the last sets in each of the $NaNO_3$ and $(NH_4)_2SO_4$ series received their nitrogen application 110 days after planting. Every application of nitrogen made to the several sets in the series was, therefore, made at different ages of the plants and obviously represents more or less different growth phases of the plants. The tabulated data for a $NaNO_3$ series will serve as an example of the plan of the investigation and gives the results obtained.

EFFECT OF $NaNO_3$ APPLICATIONS ON THE PROTEIN CONTENT OF SPRING WHEAT APPLIED AT DIFFERENT GROWTH PHASES OF THE PLANTS

Results Average of Triplicate Jars

Date of Planting	Date of Nitrogen Application	Days After Planting When Nitrogen was Applied	Yield of Grain Grams	Commercial Grade	Per Cent. Crude Protein
11/14/19.	11/14/19		9.4	2 Soft white	8.6
11/14/19.	12/1/19	17	10.6	2 " "	9.3
11/14/19.	12/16/19	33	21.0	1 " "	10.4
11/14/19.	1/1/20	48	19.9	2 Hard	11.8
11/14/19.	1/24/20	72	21.9	1 "	13.2
11/14/19.	3/2/20	110	13.1	1 "	15.2

It will be noted that the data show a decided increase (about 77 percent.) in the protein content of wheat obtained from the plants that received nitrogen when they were 110 days old over those that were treated with nitrate at the time of planting. The protein content of the wheat obtained from these two different treatments are respectively 15.2 per cent., and 8.6 per cent. The data show that for each of the different applications of nitrate made after the time of planting, there was a corresponding increase in the protein content of wheat. As these increases in the