and ridicule, greater than any other man has endured, never kindled a spark of hatred in his breast. Wrapped in the mantle of his philosophy he received no wounds, but lived with and loved mankind.

Let us not gird science to our loins as the warrior buckles on his sword. Let us raise science aloft as the olive branch of peace and the emblem of hope.

DARWIN'S WORK IN ENTOMOLOGY.

By Charles V. Riley.

Charles Robert Darwin was one of the original members of the London Entomological Society, of whom only six are yet living. He always took the keenest interest in the science of entomology, and drew largely from insects for illustrations in support of the theory with which his name will forever be associated. Indeed, I have the authority of my late associate editor of the *American Entomologist*, Benjamin Dann Walsh, who was a classmate of Darwin's, at Cambridge, that the latter's love of natural history was chiefly manifested, while there, in a fine collection of insects; so that, as has been the case with so many noted naturalists, Darwin probably acquired from the study of insects that love of nature, which, first forever afterward, inspired him in his endeavors to win her secrets andi nterpret aright her ways!

Though he has left no descriptive or systematic work of an entomological character, yet his writings abound in important facts and observations anent insects, and no branch of natural science has more fully felt the beneficial impulse and stimulus of his labors than entomology. Indeed, the varying conditions of life in the same individual or species; the remarkable metamorphoses; the rapid development; the phenomena of dimorphism and heteromorphism; of phytophagic and sexual variation; the ready adaptation to changed conditions, and consequent rapid modification; the great prolificacy and immense number of individuals; the three distinct-

ive states of larva, pupa, and imago, susceptible to modification, as well as other characteristics in insects—render them particularly attractive and useful to the evolutionist, and the changed aspect which natural history in general has assumed since the publication of the "Origin of Species" is perhaps more marked in entomology than in any other branch, for its author helped to replace ridicule by reason. During his voyage on the "Beagle" he collected a very large number of interesting species, especially in Coleoptera, and they formed the basis of many memoirs by Walker, Newman, and White, and particularly by G. R. Waterhouse, who named *Odontoscelis Darwinii* after him. These memoirs were published either in the Annals and Magazine of Natural History, and in the Transactions of the London Entomological Society, or in various entomological periodicals, and I append a list, which, in this connection, it is not necessary to read.

Scattered through his memorable works, a "Journal of Researches into the Natural History and Geology of the countries visited during the voyage of H. M. S. Beagle round the world," (which is best known by the publisher's title, "A Naturalist's Voyage Round the World,") and "The Origin of Species by means of Natural Selection," are many interesting entomological facts, and in almost every instance they are illumined by his masterly genius and his keen, penetrating mind. These are so numerous, so varied, and withal so widely dispersed, that I can only make reference, at this time, to a few of the most important and striking of them.

He pointed out the great preponderance of phytophagous over predaceous species in the tropics as exemplifying the relation of the insect and plant worlds, both of which attain their maximum in those zones. Carabidæ are few; Scavengers and Brachelytra very common; Rhyncophora and Chrysomelidæ astonishingly numerous. (Journal of Researches, etc., p. 34.)

He showed by minute observations that the insect faunas of Tierra del Fuego, separated from Patagonia only by the Straits of Magellan, have nothing in common, and he discussed the influence

of primary barriers on the distribution of species, as shown in the marked divergence of the faunas on the eastern and western slopes of the Cordillera. "We ought not," he remarks, "to expect any closer similarity between the organic beings on the opposite sides of great mountain ranges than on the opposite shores of the ocean, except for species which have been able to cross the barrier, whether of rock or salt water." (*Ibid*, pp. 326–7.)

I believe he was the first to draw attention to the paucity of insects on islands, and to establish the principle that the smaller the area, the less favorable it is for the development of insect life. (*Ibid*, p. 391.)

It is a fact of observation that islands predispose to the apterous condition among insects, a fact that is especially noticeable in Kerguelen's Land, as observed by Dr. Hooker, and particularly by our fellow member, Dr. Kidder. Darwin (Origin of Species, etc., p. 109,) first suggested the most plausible reason, viz: that the indiscriminate use of wings might prove injurious to an insular species by tempting it out to sea and to destruction, so that the loss of the power of flight is a positive advantage to the species. The argument against this explanation, viz: that insular species should be gifted with strong powers of flight to fortify themselves against being blown to sea in heavy gales, has little force, because either requirement may be fulfilled; and, in reality, where flight is absolutely necessary, as in the majority of Lepidoptera, and flower-frequenting Coleoptera, the wing capacity, in insular species, is actually increased, or correlated with a diminution of bulk; whereas, in those less dependent on aërial progression, natural selection would decrease wing-power, and there would be just such a correlated increase of bulk as is generally the case.

The principle he laid down, that the accidental introduction of organic beings amongst others to whose interest they are hostile, may be a powerful means of keeping the latter in check, and of finally destroying them, finds vivid exemplification in insects, as I have shown in discussing those imported into this country.*

*Second Annual Rep. on the Insects of Missouri, 1879, pp. 8–13.

He gave reasons for the belief (now generally accepted) that the usual gaudy coloring of intertropical insects is not related either to the heat or light of those zones, but rather to the conditions of existence being generally favorable to life.—(Journal of Researches, etc., p. 381.) He has written on the Phosphorescence of Fire-flies, and on the habits of the larva of one of them—*Lamphyris occidentalis*. —(*Ibid*, pp. 29–30.) He discussed the food-habits of stercovorous beetles, with reference to the origination of a new habit and the power of adaptation to new conditions.—(*Ibid*, p. 490, note.)

At Port St. Julian, Patagonia, he found a species of Tabanus extremely common, and remarks: "We here have the puzzle that so frequently occurs in the case of mosquitoes—on the blood of what do these insects commonly feed? The guanaco is nearly the only warm-blooded quadruped, and is found in quite inconsiderable numbers compared with the multitude of flies." He has discussed the question of hibernation of insects, and shown that it is governed by the usual climate of a district, and not by absolute temperature. (*Ibid*, 98–9.) He gave the first true explanation of the springing power of the Elateridæ when laid on their backs, showing how much depended on the elasticity of the sternal spine. (*Ibid*, p. 31.) He was the first, I believe, to record the exceptional powers of running and of making sound, in a butterfly, viz., *Ageronia feronia* of Brazil.

In his most famous work he lays stress particularly on the following facts and generalizations, for which he draws from insects: the individual differences in important characters; the remarkable manner in which individuals of the same brood often differ, dimorphism and trimorphism being only the extreme exaggeration of this fact; the difficulty of distinguishing between species and varieties; that geographical races are local forms completely fixed and isolated; that representative species are better distinguished from each other than local forms and sub-species; that the species of large genera vary more frequently than those of small genera, and that specific differences in the former are often exceedingly small;

that fecundity does not determine the rate of increase; that the struggle for life is most severe between species of the same genus; that secondary sexual characters are generally displayed in the same parts of the organization in which the species of the same genus differ from each other; that distinct species present analogous variations; that similar structures are often independently developed; the varying importance for classification of the same important organ in the same group of beings; that analogical or adaptive resemblances are misleading for classification; that the great frequency of mimicry among insects is associated with their small size and general defencelessness, as no species furnished with a sting, or other defensive property, is known to mimic other species; the importance of relative position or connection in homologous parts; the remarkable changes of structure effected during development; that adaptation to the conditions of life in the insect larva is just as perfect and beautiful as in the adult animal, and that, consequently, larvæ of different orders are often similar, and larvæ belonging to the same order often very dissimilar; that larval and pupal stages are acquired through adaptation, and not through inheritance; that rudimentary organs plainly declare their origin and meaning.

Finally he brought together a large body of interesting facts in entomology, bearing on the development and perpetuation of mimicry, and of secondary sexual characters—all more or less explicable by, and furnishing convincing argument for, the general theory of natural selection; while he freely acknowledged that he found among insects facts that seemed to be most fatal to the theory. This is especially the case in social insects where the colony contains neuters and sterile females which often differ widely in instinct and in structure from the sexual forms, and yet cannot propagate their kind. This is not the place to enter into a discussion of the subject, and I will simply remark that there are reasons for the belief that, in his candor, he has been led to exaggerate the difficulties in this case.

But Darwin's chief investigation into insect life were in its relations to plant life, and his work "On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the good effect of crossing," as also that on "Insectivorous Plants," are monuments of skill, industry, and lucid exposition.

Entomologists had often noticed the pollen masses of orchids attached to the proboscis of various moths, and in commenting upon the fact had pronounced it "curious." Darwin in this, as in so many other cases, gave meaning to the curious, and brought light out of darkness.

Before his time we find frequent reference to the injury caused to plants by insects, and Sprengel, Gaertner, Herbert, and others had shown that insects were, also, in many cases, beneficial and even necessary to plants, the color, form, odor, secretions, and general structure of which have reference to their necessary insect pollinizers.

Yet their writings had produced but slight impression outside of a limited circle. It remained for Darwin to impress the world with a broader sense of the actual interrelation between the two, and to inspire a number of observers in this field, in all parts of the globe, who are now constantly adding to the rich store of facts we already possess on the subject. I need only refer to the work of Hooker, Bennet, Axell, Delpino, Hildebrand, H. Müller, and others abroad, and to that of Dr. Gray, and Mr. Wm. Trelease at home.

The importance of insects, as agents in cross-fertilization, was never properly appreciated till after Darwin's remarkable work on Primula, and his researches on Orchids, Linum, Lythrum, etc.

He established the principle that "nature abhors close fertilization," and though some less careful observers in this country—exaggerating the importance of their isolated and often inaccurate observations—have opposed his views, the scientific world has been convinced alike by the force of his logic as by the eloquence of his innumerable facts.

We all know how palæontology has verified many of his anticipa-

tions as to missing links being supplied with increased knowledge of the geological record, and in connection with his work on the fertilization of orchids, we have a remarkable instance of similar verification. The nectaries of *Angræcum sesquipedale* were found by him to sometimes reach 11½ inches in length, with only the lowest 1½ inches filled with nectar. He said "there must be moths with probosces capable of extension to a length of between 10 and 11 inches." In *Nature* for July 17, 1873, or some years later, Fritz Müller recorded, through his brother, Herman Müller, the finding of a Brazilian Sphingid having a length of proboscis of 0.25 meters, or between 10 and 11 inches.

I cannot do justice to Darwin's work on Insectivorous Plants within the time to which these remarks have been limited, nor without trenching on the ground to be covered by Prof. Ward. I must be content to remark, therefore, that he demonstrated the new and wonderful fact in physiology that many plants are capable of absorbing soluble matter from captured insects, and that they have special contrivances and sensibilities that facilitate the capture of their prey: in other words, that plants actually capture and digest animal food; for the secretion of *Drosera*, and other insectivorous plants, with its ferment acid belonging to the acetic series, resembles the gastric juice of animals with its pepsin and hydrocloric acid. The fact of absorption demonstrated, it follows that the process would prove serviceable to plants growing in very poor soil, and that it would tend to be perfected by natural selection.

The pleasure Darwin took in observing the habits and ways of insects, and the simple and lucid manner in which he recorded his observations are frequently exemplified in his Journal of Researches, and his account of sundry Brazilian species on page 35, and following, may be consulted as an example.

In the same way that he has influenced all lines of thought and investigation, he has influenced entomology. We find everywhere, in his treatment of insects, the same acute perception, the same candor and impartiality, the same clearness of expression, the same

aptitude to get at the significance and bearing of facts observed, as well as the same readiness to deduce a theory which is only equaled by the devotion with which he clings to the truth, whether favorable or unfavorable to the theory.

In the light of Darwinism, insect structure and habit have come to possess a new significance and a deeper meaning. It has, in short, proved a new power to the working entomologist who, for all time, will hold in reverence the name of him who, more than any other man, helped to replace scholasticism by induction and who gave to the philosophic study of insects as great an impetus as did Linnæus to their systematic study.

In his private life Darwin has given us a lesson of patience, courtesy, and consideration, that will be best appreciated by those who have the misfortune to be endowed with more irritable and aggressive natures.

As the above account of Darwin's entomological work is doubtless rather uninteresting to most of those gathered here, I will close, by request, with a few personal impressions.

I have had the pleasure on two occasions of visiting Darwin at his invitation. On the first occasion, in the summer of 1871, I was accompanied by Mr. J. Jenner Wier, one of his life-long friends and admirers. From Mr. Weir I first learned that Darwin was, in one sense, virtually a confirmed invalid, and that his work had been done under physical difficulties which would have rendered most men of independent means vapid, self-indulgent, and useless members of society.

It is eloquent of the indomitable will and perseverance of the man that, during the long voyage on the Beagle, he suffered so from sea-sickness that he never fully recovered from the shock to his system, and could not again venture on the ocean. He had, in fact, on his return from the voyage, to go through a long course of hydropathic treatment. We also now know that though he had suffered much for some months past from weakness and recurring fits of faintness, and had been confined to the house, yet as late as

Tuesday evening before the day of his death, at 4 P. M., Wednesday, he was in his study examining a plant which he had had brought to him, and that he read that night before retiring, while as late as the 16th of March, he read two papers on special botanical subjects before the Linnean Society.

The village of Down is fifteen miles southeast of London, four miles from Orpington station on the Southeastern Railway. The country is among the most beautiful agricultural suburbs of London, and I shall never forget the impression of peaceful, quiet seclusion experienced, as we drove from the station and finally through one of those characteristic English lanes, just wide enough for one vehicle, and worn down several feet below the general level—the sense of confinement being enhanced by the luxuriant hedge on either side. This lane skirts the orchard wall for 100 yards and then goes in front of the house, from which it is separated by a grass plot and flint wall overgrown with ivy.

The Darwin residence is a plain, but spacious, old-fashioned house of the style so common in England, and which, with the surrounding well-kept grounds and conservatory, convey that impression of ease and comfort that belong to the average home of the English country gentleman. A noticeable feature is a bow window extending through three stories and covered with trellis and creepers. In Darwinian phrase the environment was favorable for just such calm study and concentration as he found necessary to his health and his researches.

Upon introduction I was at once struck with his stature (which was much above the average, and I should say fully six feet,) his ponderous brow and long white beard—the moustache being cut on a line with the lips and slightly brown from the habit of snuff-taking. His deep-set eyes were light blue-gray. He made the impression of a powerful man reduced somewhat by sickness. The massive brow and forehead show in his later photographs, but not so conspicuously as in a life-sized head of him when younger, which hung in the parlor.

In the brief hours I then spent at Down the proverbial modesty and singular simplicity and sweetness of his character were apparent, while the delight he manifested in stating facts of interest was excelled only by the eagerness with which he sought them from others, whether while strolling through the greenhouse or sitting round the generously spread table.

Going to him as a young entomologist with no claim on his favor, he seemed to take delight in manifesting appreciation. I had occasion in my third report on the insects of Missouri, published in the spring of that year, to discuss the question of Natural Selection in its bearings on Mimicry, as exemplified in two of our North American butterflies, (*Danais archippus* and *Limenitis disippus*.) This report I found in his study with many leaves turned down, and he appeared to take especial pleasure in conveying a sense of his appreciation of particular parts.

The few letters which I received from Darwin were in his own hand-writing, which was rapid and better calculated to save time than to facilitate the reading. I take the liberty of reproducing here the first and last as indicating his attitude toward all workers in the field of natural science, however humble or however undeserving of his praise they may have been; and this generous trait in his character will explain, in some measure, the stimulus and encouragement which he gave to investigators:

DOWN,
JUNE 1, [1871.] BECKENHAM, KENT.

MY DEAR SIR: I received some little time ago your Report on Noxious Insects, and have now read the whole with the greatest interest. There is a vast number of facts and generalizations of value to me, and I am struck with admiration at your power of observation. The discussion on mimetic insects seems to me particularly good and original. Pray accept my cordial thanks for the instruction and interest which I have received.

What a loss to natural science our poor mutual friend, Walsh, has been: it is a loss ever to be deplored.

Pray believe me, with much respect,
Yours, very faithfully,
CH. DARWIN.

DOWN,
SEPTEMBER 28, 1881. BECKENHAM, KENT.

MY DEAR MR. RILEY: I must write half-a-dozen lines to say how much interested I have been by your "Further Notes" on Pronuba, which you were so kind as to send me. I had read the various criticisms, and though I did not know what answer would be made, yet I felt full confidence in the result, and now I see I was right. * * * *

If you make any further observation on Pronuba it would, I think, be well worth while for you to observe whether the moth can or does occasionally bring pollen from one plant to the stigma of a distinct one; for I have shown that the cross-fertilization of the flowers on the same plant does very little good and, if I am not mistaken, you believe that the Pronuba gathers pollen from the same flower which she fertilizes.*

What interesting and beautiful observations you have made on the metamorphoses of the grass-hopper destroying insects!

Believe me,
My dear sir,
Yours sincerely,
CH. DARWIN.

My own experience in this regard is the common experience, for an interest in natural science was an open sesame to his generous soul. His consideration, without aggression, was the secret of the gratitude and respect which all felt who had the honor to know him, either personally or through correspondence.

His approval of the work of others was coupled with a depreciation of his own, which was very marked on the occasion of my second visit to Europe, in 1875, when I crossed the ocean with his son Leonard on his way from the Transit of Venus expedition. "Insectivorous Plants" was just finished and Darwin was worn and in feeble health, staying, in fact, at Abinger Hall for rest. He was quite disgusted with the book, to use his son's expression, and doubted whether it could prove of sufficient interest, with its long and dry records of experiments, to be read by any one.

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*This is a misapprehension. Pronuba is an effectual cross-fertilizer, running from flower to flower, and often flying from raceme to raceme with one and the same load of pollen. The omitted passages in this letter refer to the work of a gentleman still living.