On the moth of the esere, or ordeal-bean of Old Calabar.

Professor Thiselton,
With the very kind regards of the Author.
(M.)

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ON THE MOTH

OF

THE ESERE, OR ORDEAL-BEAN OF OLD CALABAR.

THE REV. JOHN BAILLIE, of Old Calabar, recently presented me with a parcel containing about eighty seeds of *Physostigma venenosum*, which had been collected because of their showing indications of the attacks of an insect. In a paper on the *Esere*, or Ordeal-Bean of Calabar *, it is stated by me that "the bean has been always received remarkably free from all disease," only one form of slight and unimportant abnormality having been met with. It is therefore a source of gratification to me to have the first opportunity of modifying this expression.

These beans had been collected upwards of three months before they came into my possession. They were contained in a covering of thick soft paper, which was found to be riddled by numerous nearly circular holes, about the sixth of an inch in diameter; and it was evident that these perforations had been caused by an insect. On opening the parcel, the beans were found adhering together by means of an abundance of silky threads. They were easily disconnected, and, on separation, a number of caterpillars were seen (generally alive, though sluggish in their movements), and a large quantity of what was evidently their excrement. The greater number of the cater-

* "On the Characters, Actions, and Therapeutic Uses of the Ordeal-Bean of Calabar," in 'Edinburgh Medical Journal,' July, August, and September 1863.

pillars were enclosed in cocoons, formed in the spaces between either contiguous beans or beans and the enclosing paper. Fifty out of the eighty beans were found with holes—a few with only one, but the majority with various numbers from two to eight. The holes were usually of a round-oval form; they extended through the spermoderm; they were situated on almost any part of the surface of the bean, though generally on the sulcus, towards its broad extremity; they had an average diameter of $\frac{1}{8}$th of an inch; and they had protruding through them, from the interior of the bean, a quantity of excrement, loosely connected into adhering masses by the silky threads already mentioned.

On breaking the spermoderm, the place of the kernel was found to be more or less occupied by *excrement*, *cocoons* or their broken-up remains, and *caterpillars*. In the majority of affected beans, the kernel was entirely absent; in others, portions of various sizes were left, having often eroded margins and other symptoms of the attacks of the caterpillar, and being sometimes fantastically irregular in their outlines. In a few instances, and generally in such beans as had only one or two perforations through the sulcus, the kernel was entire, and a small quantity of entangled excrement only was found in the intercotyledonary spaces. These beans had probably been occupied, at some period, by only temporary boarders.

The *excrement* occurred in large quantity in proportion to the number of caterpillars. It consisted of little, dry, stone-grey irregular cylinders, from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch in length, and about $\frac{1}{32}$nd of an inch in diameter, and it was always connected in loose bundles by the adhesive thready secretion of the caterpillar. The microscopic examination of this excrement showed two principal structures—starch-granules, generally broken up, having the characteristic appearance of these bodies in the kernel of the seed of *Physostigma*, and occupying about one-third of the field, with circular bodies about $\frac{1}{4000}$th of an inch in diameter, having large nuclei and granular contents, and occupying the remainder of the field. Chemical examination proved the presence of large quantities of uric acid and starch, and of a little ammonia. The uric acid, when precipitated by acetic acid from a solution in potash, assumed the form of perfect, very minute crystals of either detached or clustered rhombs.

One or two *caterpillars* were generally found within each bean; only in one bean as many as six were seen, all of whom were alive and active. They are of a pale yellow colour, about $\frac{3}{4}$ths of an inch in length and $\frac{1}{8}$th in greatest thickness, and have six pectoral, eight abdominal, and two anal feet.

The *pupæ* belong to the class *Incased* of Burmeister, are about ¾ths of an inch in length, and of a yellowish-brown colour. The cocoons are greyish white, and always covered with entangled excrement. Sometimes one pupa only occurs in a bean, at others as many as four. In a few instances, cocoons were found with perfect pupæ; in general they contained only the cases of the developed imago.

We have thus the changes of the *complete* metamorphosis of an insect unequivocally traced; and, through the kindness of my friend the Rev. John Baillie, the perfect and several imperfect forms of the imago of this insect have been put in my possession. All of these were derived in a manner which completely precludes the chance of any error. From the same lot of affected beans that are described above, a number of caterpillars were selected at Old Calabar, and placed in a box along with several perforated beans. Cocoons were observed to be rapidly formed, and in a few days four or five live moths were obtained. I am indebted to my friend Dr. John Anderson, of this city, for the identification of this moth. Specimens of the caterpillar, cocoons, and imago were kindly sent by him to the British Museum, and were pronounced by the authorities of the Insect Department to be the *Deiopeia pulchella* (order Lepidoptera, fam. Tineidæ, Leach). The description and figure given in the fourth volume of Curtis's 'British Entomology' appear to correspond accurately with the imago in my possession.

Little beyond conjecture can be advanced on the method of the introduction of this insect into the Calabar beans. The holes in the spermoderm have always a sharply defined margin, which opposes the idea of a deposit by the *ovipositor* of the imago into the unripe and growing kernel; and the distance from the exterior of the mature pod to the seeds renders it still more improbable that the imago could reach the ripe beans for such a purpose. The most probable view is that the ovum is deposited in the cellular texture beneath the soft exterior of the young pod, that it is there hatched, and that thence the caterpillar makes its own way to the interior of the bean. It is perfectly able to perforate the hard spermoderm of the ripe seed, and has been observed to do so; indeed it has been known to make holes of considerable depth into a hard wooden board.

The Ordeal-bean of Calabar is a poison of extreme activity: hitherto no living being had been known to be able to resist its action; and, from my knowledge of its properties, I confess to having been sceptical of the existence of any animal form which could be fairly subjected to its influence and still retain its hold on life. It appeared of importance to determine, as exactly as possible, the connexion between this caterpillar and the kernel of

the bean, as, supposing the kernel to be received into its alimentary system, the existence of a special assimilative selection might be shown, or it could be determined if the caterpillar were proof against this deadly poison.

That the kernel is received into the digestive system is evinced by the presence of the characteristic starch-granules in the excrement, and is rendered certain by the following experiment.

(*Exp.* 1.) A small piece of kernel, weighing exactly 7 grains, was placed in a porcelain vessel with six active caterpillars. At the end of forty-eight hours, the kernel was found to have lost one grain in weight, and to have two holes (almost perforations) on its inner surface, of nearly the same form and size as those which occur through the spermoderm. The caterpillars were active and lively, and continued so six days after. A quantity of excrement was found in the dish, with the characters already described.

That the starch-granules of the kernel were not received into the alimentary system separated in any way from the poisonous principle was shown by the following experiments with the excrement. This was carefully separated from the numerous aggregations found outside the bean, to avoid as far as possible any admixture with broken-up kernel.

(*Exp.* 2.) One detached fragment was washed, then triturated with a little water, and a drop of this applied to the conjunctiva of a rabbit. In six minutes, it caused a contraction of the pupil, which became extreme in ten.

(*Exp.* 3.) Half a grain of the detached cylinders of excrement was triturated, moistened, and formed into a small pill, which was placed in the pharynx of a linnet. Perfect paralysis of the legs was caused in four minutes, together with marked contraction of the pupils (from $\frac{1}{16}$th to $\frac{1}{32}$nd of an inch in diam.), defæcation and lachrymation. In seven minutes, life was extinct. The post-mortem appearances showed that death had occurred by syncope.

From these experiments it was evident that no bad consequences resulted from the presence of the active principle of the bean in the alimentary canal of the caterpillar. To determine the result of an introduction into the vascular system, experiments 4 and 5 were tried.

(*Exp.* 4.) An incision was made through the epidermis of a lively caterpillar, and a little of the active principle of the bean (the alkaloid eserinia) was introduced. No evident effect was produced, and the caterpillar was quite active four days afterwards.

(*Exp.* 5.) With Wood's hypodermic syringe, half a minim of a solution of eserinia (a grain to 8 minims of distilled water) was

injected beneath the epidermis of two caterpillars, and into a third the same quantity of distilled water. They were all swelled out, and suffered apparently from the distention, but equally, and in forty-eight hours were all equally recovered.

(*Exp.* 6.) Several caterpillars were subjected in various ways to the action of hydrocyanic acid, and all quickly died. From this it was proved that this caterpillar possesses no mithridate, no universal panacea against all poisons.

It may be fairly inferred, from the preceding experiments, that

(1.) The caterpillar of *Deiopeia pulchella* feeds on the virulent poison contained in the kernel of the seed of *Physostigma venenosum*; and that

(2.) This caterpillar is unaffected by the poisonous principle of the kernel—eserinia.

The bearing of the second result on our ideas of vital action should not be overlooked. A somewhat analogous case is furnished by the *Anthonomus druparum*, which feeds on the kernel of *Prunus cerasus**; and the poisonous properties of this kernel are well known to depend on the hydrocyanic acid it contains†. Here, then, our difficulties are increased: *Deiopeia pulchella* is unaffected by one poison, but is rapidly killed by hydrocyanic acid; and this latter occurs in the food of another insect, *Anthonomus druparum*. If life be "the sum total of the functions which resist death," we have in these examples two organisms, each furnished with an exceptional potency of one or more of these death-repelling functions, or having bestowed on each, for a necessary purpose, a special, almost unrecognized, and certainly uninvestigated alexipharmic. Unfortunately, we have no knowledge of those intimate and primary structural changes which accompany every vital action, and our acquaintance with the perversions of such changes is quite as unsatisfactory.

Edinburgh University, April 1864.

* A Manual of Entomology, translated from the German of Dr. Hermann Burmeister by W. E. Shuckard, M.E.S., 1836, p. 356.

† A Treatise on Poisons, by Robert Christison, M.D., &c. &c., 1845, p. 787.

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