Thesis

The Successive Developments of Pontia Brassicae

by

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Preface
Whilst ransacking memory for something which might be framed into a thesis, as I was enjoying the first week of the recess, last term, among the varied constituents which make up a little village garden, my attention was caught by an old friend of boyhood, the common white butterfly, which used to amuse us so much with his aerial excursions, and lead us many a fruitless race. Like the pleasing dream which Fancy weaves as we recall some old familiar face of School-boy memory, the fickle butterfly gave the spur to imagination and a series of dissolving views, as unconnected as those we have so often gazed upon with strange delight, restored to many happy by-gone moments, that I became once more quite attached to my winged friend. Watching the sunny gambols, the sweet taste and the instinctive care in the provision
for its offspring exhibited by this insect.
And tracing what others have observed
in its successive developments, constituted
so pleasing an interlude to my other
readings. That I resolved to frame into
a Thesis what I could learn of it
in its larva, pupa, and imago states.

I am in the hope of
being pardoned in selecting a subject
seemingly so futile and childish.

Since I am aware that nowadays
Entomology receives more countenance,
and escapes most of the ridicule
which used to be thrown upon it.

One can learn many a useful
lesson from even a butterfly, and no
one dare call its study trifling or
unprofitable unless he has the hardi
= hood to deny that God created it.

And is it not clear, as Dr Paley
has observed (Stat. Theol. 213.) that
the production of beauty was as much
in the Creator's mind in painting a
butterfly, as in giving symmetry to the
human frame, or graceful curves to its muscular
covering.
As regards myself, I am aware I might have chosen some subject from the investigation of which I might have derived much more material benefit, but the bow must be sometimes unstrung, and my intercourse with the Common white butterfly has given me a taste for entomological study, has added much to the enjoyment of a life in the country, and has brought before me much more strikingly that remarkable instinct, so worthy of admiration, with which an All-wise Providence has endowed the minutest of His Creatures.
Introduction

None but one acquainted with the metamorphoses of the insect world would ever imagine that the sportive white butterfly, as it flits as restlessly from flower to flower in the Summer sun, a lightning for an instant on one gay-tinted beauty then off to another, attracting nectar with her flexible proboscis from the tubelike honeysuckle then flying to a rose to feed on what can there be found of the godly feast, was once a "wormlike caterpillar" crawling upon sixteen short legs, speedily devouring leaves with two jaws, and seeing by means of twelve eyes so minute as to be nearly imperceptible without the aid of a microscope. But the change from the one form to the other was not direct. A very singular intermediate state intervened. After the protrusion from the tiny egg the caterpillar continued to eat voraciously, growing rapidly, and casting its skin. Even
Even to the very jaws several times, and attained its full growth. Then it attached itself in some secure spot by a silken girt, its body became greatly contracted, its skin was once more thrown off, and it disclosed an ovoid form without uttering mouth, eyes, or limbs, and showing no other symptoms of life than a slight motion when touched. In this death-like state the insect existed for several months until at length this natural coffin burst and from the shell proceeded the perfect butterfly. The egg, the larva, the pupa, and the imago are the four states through which the insect passes. Limacus gave the name larva (a mask) because he considered the caterpillar whilst under this form as a kind of outwards covering or disguise of the future butterfly within. In the third state Limacus thought that the insect resembled, in miniature,
a body, wrapped up in cocoon-like clothes and therefore called it the pupa or mummy state. In the moths and butterflies the insect in this state is commonly called a chrysalis or auricle, both words having the same meaning, the one Greek and the other Latin, both derived from a word meaning gold. The word chrysalis applies here very well for the pupal garments of the cabbage butterfly take a beautiful golden tinge. The fourth and last state, announced called the imago state, and the animal the imago because having escaped from the mummy case and thrown aside its cocoon band, it assumed the perfect state and became a true representative or image of its species.

Metamorphoses and transformations are more impressive of the sudden changes that occur in the insect creation than any new words, but strictly speaking those changes ought to be termed at
series of developments, as Naturalists now speak. A Caterpillar is not a single but a compound animal. In its three or more skins, one over the other, is included the case of the pupa which itself incloses the germ of the future butterfly. When this succession of masks is thrown off, the insect is displayed in its genuine form. Many celebrated Anatomists, as Balfour, satisfactorily prove that this is the proper explanation of the phenomenon. Dr. Hill's Commodan, we are informed, that this celebrated Naturalist (Commodan) discovered, by accurate dissections, not only the skins of the larva and pupa in cases within each other, but within them the very butterfly itself, with its organs indeed in almost a fluid state, but still perfect in all its parts. "A Caterpillar then may be regarded as a locomotive egg having for its embryo the included butterfly which after a certain period assimilates..."
to itself the animal substances by which it is surrounded, has its organs gradually developed; and at length breaks through the shell which encloses it."

This explanation strips the subject of every thing miraculous yet by no means reduces it to a simple or uninteresting operation. Our reason is confounded at the reflection that a larva, at first not thicker than a thread, includes the germ of its own triple, or sometimes octuple, integuments; the case of a Chrysalis and of a butterfly, all curiously folded in each other; with all apparatus of vessels for breathing and digesting, of nerves for sensation and of muscles for moving; and that from various forms of existence will undergo their successive evolutions by aid of a few leaves received into its stomach. And still less able are we to comprehend how this organ shall at one time be capable of
of digesting leaves, at another only honey, at another none, or how organs at one period essential to the existence of the insect should at another be cast off, and the whole system which supported them vanish."

Marvelous as these changes appear still when we look around as they are not to be so much wondered at, for it seems to be a general law applying to all organized beings, plants as well as animals, that the germ of new individuals shall at first possess a structure much less complex than they are ultimately to present, and adapted to different conditions of existence. The change of a tadpole into a frog is an example somewhat akin to the above. The Crustacean throws off their shell, and snakes and reptiles cast their skin. And we all know the great difference between the germule of the polyp and the structure into which it will be afterwards developed.
In the vegetable creation also the germ of the plant contained within the mature seed often presents little that can be recognised as part of the future structure. Therefore throwing aside our wonders at what seems to be a general law in organic life we will proceed to examine each in its turn of the four stages through which our airy companion passes.

The Egg.

In the several classes of animals the shape of the egg is in general so exceedingly uniform that a peculiar expression has been hence deduced for its definition. But amongst insects few eggs are oval, and in most cases instead of being smooth, like the egg of birds, they are intricately sculptured, as it were, with delicately raised patterns which enrich the whole surface. The aid of the microscope is however requisite to discern this delicate chiselling in most cases.
That of Pontia brassicae may be called a conic egg and to the unassisted eye it appears rough and uneven from its having decided knobs running from the base to the apex in longitudinal ridges and terminating in a circle round the slightly flattened apex. It very much reminded me of a fossil crinoidea. The colour of the eggs of insects is, notwithstanding their great variety not so variable as in the class of birds. They may be found of all tones, but white, yellow and green are the chief colours. The one now under observation is yellow, varying from a pale to a bright yellow as the egg ripens. There seems to be no difference of size among the eggs of one deposit. I thought I might have thus been able to distinguish between a male and female. Such a difference has been observed among the eggs of ants and bees, the female egg being the larger among the ants, and the contrary with respect to the eggs of bees. Its elasticity or increase in size was perceptible either as has been
observed among the eggs of Schneunopus and Ants which positively seem to grow. The egg before us has a comparatively soft and thin shell as it does not require to withstand the inclemency of the winter but is quickly hatched. Observing a butterfly deposit 40 eggs on the 10th of August I watched them and found all out on the 20th with the exception of five which had been displaced by some accident. The length of the hatching seems to vary, as I have seen some eggs ripen before and others after the 10th day. The state of the weather seems to influence the process. That of the female earwig is the only case I am aware of where an insect sets upon its eggs. The eggs of insects then are hatched by atmospheric heat alone and though this has been doubted and even experimented upon to endeavour to disprove the fact still I am inclined to believe from observation that the state of the weather influences the period of incubation and that it is atmospheric heat which hatches them.
The number of eggs laid by a single parent varies to an extraordinary degree, and the deposit at a single time, for butterflies do not choose a single spot for the whole year of a season, also varies very much. I have observed a female fly alone fifty before rising and again only one at a time on different leaves. The fly often seemed to have a difficulty in choosing a spot for her deposit, probably observing that the leaf on which the alight was not sufficiently fitted for the offspring, or finding that it was in a disadvantageous position, or probably about to fall. The under surface of the leaf is the favourite site of deposit and here the eggs are better defended from the influence of cold. They may be easily discovered in the Autumn in this position studding the spots like a tented field. I have found these eggs on the leaves of the turmeric from whence came a very numerous and thriving family. I had never seen where else. It is interesting to observe the
manner in which the egg is deposited.
That of P. Brassicae is among the
one gummula of Barmeister from its
being fixed by a gummy secretion which
so firmly attaches it to the leaf.
In passing from the ovary to the ov:
est this egg is conducted to its proper
destination by the butterfly, drawing upwards
its abdomen, for it is hanging with back
downwards from the under side of the
leaf, and then Curving in the extremity
slightly to bring it, as it were, nearly per:
pendicular to the leaf, in order to press
some pressure upon the egg to ensure its
complete fixation. A Calceatroium or
gumish secretion is appended to the repro:
ductive organs and from this back egg
receives a touch of gumish on its base
which by gentle pressure easily fixes it.
The egg consists of an internal shell
Mr. Kirby doubts the existence of a lining
membrane within this tho: others hold it
does exist. The fluid within is an
aqueous Wattle's fluid and so scanty as
scarcey to admit of observation
Whatever its character it serves for the development of the organs of the germ of the future insect. Observations have also been recorded relating to the embryo within the egg, but the descriptions of so microscopic creatures and annuities are to be taken cum grano when nearly hatched the black head of the young caterpillar may be seen thrust between the shell and apparatus, engaged in something. He is eating his way out which akin to the tapping of the chick against his prison wall with his beak till he forces an exit.

The Larva

Wandering through the domains of Pomona during the sultry days of August one is struck with the devastation here and there exhibited among our favourite vegetables. Sometimes we see nothing but the vein and stalk of what was once a stately cabbage, looking like a tree in winter and reminding us of coming frosts & snowdrifts.
This devastation is due to the ravages of the caterpillar of that harmless white butterfly which flits, as it were, unmeaningly among the cabbage leaves. From the eggs she there deposits come those greedy vegetarians. She larvae, when it first emerges from the little egg bears but a very small portion to its subsequent bulk. One little aperture possesses a distinct head when born, and also rudimentary legs on which he at once begins to travel and search for a dainty morsel for his infant mouth. He possesses a pair of legs on each of the three segments of the body next the head, the rudiments of the legs of the perfect insect. But the posterior segments of the body are also supported by legs. These are however only gummy tubercles which are cast off in the metamorphosis and are termed pro-legs. There are five pairs of these, four of them called the abdominal legs on the seventh, eighth, ninth, and tenth segments, and another pair arising from the last segment of the body, the anal pair.
In searching for the derivation of the word 
caterpillar I found it given thus by Mr. Duncan 
in Sir W. Jardine's Nat. Hist. - "The origin 
of this word is not very obvious, but it no doubt 
refers to their (the caterpillars) destructive 
propensities. The most probable derivation 
is that which assigns it to the two old 
French words "aceat" food or provisions. 
more recently written "Cates" as in Paradise 
Lost. - Alas, how simple to these Cates 
was the crude apple that diverted Eve! 
and "filler" to rob or plunder whences 
also we have the word pilage". 
The food consumed by the young 
caterpillar is much greater, in proportion 
to its bulk, than that required by 
larger animals. Sometimes it eats twice 
its weight of leaves. Kirby tells us that 
a probable proximate cause for this 
doracity in the case of herbivorous larvae 
has been assigned by John Hunter, 
who attributes it to the circumstance 
of their stomach not having the power 
of dissolving the vegetable matters received 
into it, but merely of extracting from them a juice."
Any examination of their fermentation seems to prove this. Repeating the experiments of Kirby the finds, by throwing it into water and uncoiling it, that it consists of coiled-up and hardened particles of the leaf. The quantity of these creatures destroy is also far in advance of their increase in bulk. The increment likewise bears a great proportion to the quantity consumed. I could not make any satisfactory experiments with regard to these; but to show how little some caterpillars do increase in proportion to the food they consume I shall add an example from experiments made by Colonel Mackell of Beverley (Kirby & Spence's Entomology) on the caterpillar of Euprepia Caja. He ascertained that though a larva, weighing thirty-six grains, voided every twelve hours from fifteen to eighteen grains weight of increment, it did not increase in weight in the same period more than one or two grains. When irritated or taken into the hand, roughly the caterpillar emits a dark green juice staining the fingers.
just like the juice of the cabbage leaf. By a process of regurgitation I suppose, it throws this out from its stomach as a means of defence. It cannot be saliv because in this larva state the salivary glands are very rudimentary. We might infer from this that it is the juice only of the leaf upon which the caterpillar feeds. Be it as it may the creature seems to reach the food and thrives well on it, so much so that he outgrows his coat which splits along the back and is thrown off for a new one. Several which I kept under observation moulted four times before attaining the chrysalis state. Before moultting they spin themselves a bed of silk and on it remain at rest for a day or so, their skins becoming very dark coloured and withered looking, and at length splitting along the back they thus allow an idea express to the animal. The caterpillars come from under their old coats in quite holiday attire with their trimmings of yellow and black, and like wedding guests after they have
tripped it some hours on the light fantastic toe; begin their feasting again in right earnest. I observed one fine morning, as I turned up the leaf on which I had a family feeding that they gave strange spasmodic twitches, tossing their heads in air like an irritated herd of cattle, not taking to their heels however, but holding on firmly by their abdominal and legs. They often did this when disturbed before their second moult but after wards they left off these childish pranks and when irritated any way would drive off the offer'd insult by a butt of the head or a stroke of the tail. I wondered whether it would be an instinctive dread of some unknown enemy which threw them into such hysterical fits of passion. Troublesome as the Catarpillar is to the gardener, the cook and the connoisseur it would be a hundred fold worse were it not for a fly so small as hardly to be noticed but from its effects.
This small fly can effect the destruction of many a caterpillar.
On looking among the cabbage beds you may observe it running restlessly over
the leaves with antennae and wings in constant motion. Watch it awhile
and you will discover the object of its
search. Here is a fine large caterpillar
eating contentedly from off the juicy leaf.
The sharp eyes of the little fly have
spied him and she walks up quite
unanimously to the monster & thrusts
fold her size to make him her victim
reminding us of Jack and the giant:
Killer of childhood - She perches
herself upon his back like the Jack:
draw on the fleecy coat of a sheep;
but however for something to live her
distant need with, but there, in the
body of the caterpillar, to deposit
her store of eggs and leave them for
ever like those of the cuckoo to be
hatched at the expense of their
unconscious protector. Having
stationed herself she begins with her
drill to form a small hole in the body of the caterpillar and in it deposits an egg. The poor victim winces under the sting, stops his meal and tosses his head in air like a spirited steed to throw his rider from his back. But the little Icneumon keeps his seat, looks quite unconcerned, and immediately continues to deposit another egg. And so on she goes braving every danger to secure the safety of her future progeny. And when she supposes enough has been deposited for one caterpillar to bring up away she flies to trim her wings and dress her little body to meet some small companion.

I have observed Icneumons, not setting castribe at all upon their victims, but walking up to the side of the caterpillar making stimulations with their long flexible antennae, and after having secured a sitting spot, draws their abdomen forwards between the legs and in this awkward position.
deposit their eggs in the side of the caterpillar. I have observed them thus deposit thirteen, fifteen, and eighteen eggs; and from what I have seen this appears to be the more frequent method, at least with the tormentor of Portia brassicae. The great being of beings preserves this his wonderful universe from permanent injury from redundancy of any individual species by employing one creature to prey upon another. The ravages of the cabbage caterpillar are thus kept in check by the ichneumons. The Scheremoniidae are a very numerous family, three thousand species being known in Europe alone. From the constant habit of passing the lawn state as parasites upon other insects they have received the name of Entomophaga. They all belong to the diencean order Hymenoptera, the order of the bees. Insects of every order and in every stage of existence are subject to the attacks of these parasites.
They are not daring enough to attack man himself. The eggs are introduced into the bodies of their victims by their piercing them with the osipetor, an instrument inserted at the apex of their abdomen. It is sometimes concealed, sometimes exerted and of a great length. It appears to consist of three bristles, the outer pair of which are the terminations of the sheathes, and the middle one when examined is found to be composed of three bristles forming a minute tube for the passage of the egg. The long osipetor ichneumone seeks the burrows of wood-boring insects. Minute size is no protection for the ichneumones are so numerous that scarcely an insect exists which, in its larva state, is not subjected to the attacks of one or other of them. The pupa and the very young are not safe from their insidious manoeuvres. Each species usually infests a peculiar species of insect and the size of the different species varies...
in proportion to that of the bodies which are to be their food. Some are so small that the egg of a butterfly, not larger than a pea's head, is of sufficient magnitude to nourish two of them to maturity. Others are so large that the body of a full-grown caterpillar is not more than enough for one. The perfect ichneumon is a four-winged fly which takes no other food than a little honey; and this great object of the female is to discover a proper niche for her egg, in search of which she is in constant motion. The great enemy of our caterpillar is Ich. microstictus. Look over the cabbage leaves in autumn and the little creature may be observed restlessly flitting about and moving wings and antennae to ward off larger and warn any other dwartish companions of her approach, as she searches for her victim. She, having found the unfortunate object of her search, walks round it as if hammering that no Hindred
friend has preceded her, and being satisfied that such is not the ease she inserts her sting into its flesh and deposits her egg. The caterpillar, as before mentioned, in vain brings all its organs of defense into action, for the brave little ichneumon sticks to her beet until she has succeeded in distance for one of her future progeny. The larvae hatched from the egg thus ingenuously deposited find themselves in a storehouse which is constantly being filled for their benefit. They eat the fatty parts of the caterpillar, carefully avoiding the vital organs, as if aware that their own existence was dependent upon that of this insect upon which they prey. The caterpillar moves about eating and digesting, apparently little injured, and at last dies when they no longer require its aid. At some instances the creatures remain in their living home until perfected, but generally, as may be observed in the Cabbage caterpillar, the parasites break out.
out before undergoing their transformation which then takes place in the interior of a little cocoon which each of them weaves for itself. These yellow silk-like little masses may often be observed attached to posts and other places where the caterpillar may have chosen a retreat to pass its winter sleep in.

Internal Anatomy of Caterpillar

In order to obtain a view of the internal organs of the caterpillar a few preliminary steps are necessary. Having provided a good large one you deprive it of life by immersing it in boiling water or in spirit of wine. Get a shallow vessel about an inch or more in depth, and fill it nearly to the top with water. Cut a slice from a large cork, load it with lead so as to keep it steadily below the water, and place it in the centre of your dish as a table for your dissection.
Lay your caterpillar on its back on the cork, fasten it at both extremities by small pins piercing only its skin. Then begin your dissection by carefully slitting up the skin the entire length of the creature with a pair of fine scissors or a very fine scalpel. Then draw the skin right and left and pin it down to the cork. Clean away the fat with great care, and a number of organs, closely packed together, will be observed mostly stretching along the entire length of the creature. The throat, stomach, and intestines is the largest and most conspicuous of these, running from head to tail and constituting the digestive apparatus. Along this surface the nervous system of the creature stretches, consisting of a number of ganglia, leading numerous branches right and left, connected to one another by a double nervous thread. The next organ is the silk bag. Two of these exist, one on each side of the digestive tube.
Having a bulge in the centre and tapering to either extremity with a curiously twisted appearance. These organs terminate in the spinneret which opens from the mouth, and from this the silk issues in a fine double thread. When viewed through the microscope the double thread is easily recognizable, its two parts lying nearly parallel to one another. They come from each silk gland, and the two are united as they issue from the spinneret. Before the caterpillar enters the cocoon state these silk-making organs are fully developed but after the silken cocoon and girdle are woven these organs diminish to a mere thread and are soon altogether absorbed.

The salivary glands may next be examined. They lie right and left of the throat and may be seen beautifully developed in the larva of the goat moth.

In the higher animals lungs and gills...
as the case may be, constitute the breathing apparatus; but the caterpillar, with other insects, possesses a respiratory system of a different nature altogether. Not gathered into a mass, but running entirely over round, and through the body. The tracheal tubes surrounds and envelope every internal organ and are greatly in the way of the dissector. They can often be raised in a net but it is better to remove them separately. These tubes possess the hinged structure of the human trachea, but differing thus that the skeleton of the tube consists, not of a series of rings, but of a long spiral wire like a bell-spring. The tubes open in the spiracles arranged along the sides of the insect which present a beautiful contrivance to keep out every particle that could clasp or injure them. Delicate hairs from the sides of the spiracles cross the range of one another like the shot from the
batteries defending a war harbour, thus excluding any intruding enemy with this difference however that if any thing obnoxious enter it cannot be driven out again that they may get rid of some threatening wasp or bee as it buzzes from window to window. I have often seen the hand-loom weavers watch it till it alighted, then take the reed from their little oil bottle and let a drop of oil fall upon it to get rid of their tormentor. They thus stop up the spiracles and the supply of air is cut off from every part of the body at once, but they think some special virtue resides in the oil. There is no liver or a solid matter in the caterpillar as in the higher animals, but a set of bilary vessels exist ranged on each side of the stomach and towards its distal extremity and these are in fact the insect's liver, a series of tubes with simple closed extremities.
The vascular system consists of a vessel which passes along the back from the head to the arms, and is kept in place by suspensory structures from the back of the caterpiller. Malpighi was its discoverer and he has described it as a great pulsating vein. It was at first believed to be a simple and wholly closed vessel. CarolusClarius observed the motion of a fluid in this dorsal vessel as well as in other parts of the body. More recent observers point out a number of appendages in this elongated heart which divide it into so many chambers, for behind each opening there are valves which separate the preceding space from that behind the opening. At each opening the walls contract giving the vessel a noduliform appearance. The blood enters the heart through these openings from the general cavity of the body and is propelled from behind forwards, the valves being so constructed as not to permit of the passage of the
blood backwards when the heart contracts. External longitudinal and internal transverse muscular fibres, and very probably an inner, most structureless mucous membrane escaping observation from its delicacy form the walls of the heart. When these membranes contract the heart becomes straitened and propels the blood to the head; and again as soon as the membranes become placid the vessel dilates constituting the systole and the diastole of the heart.

As no system of absorbents exist the portion of food to be assimilated passes through the walls of the stomach into the cavity of the body when it mixes with the blood bathing the surface of the organs and thus comes into the general circulation. As it returns it comes in contact with the respiratory organs and, so to speak, gets aerated. After passing to the thoracic extremity of
the heart the blood passes into the spaces left between the internal organs, as has been mentioned. Through a small opening at the anterior extremity neither arteries or veins existing to confine it.

We may now take a general view of the muscles of the carpellae. It has levators and depressors, abductors and adductors, flexors and extensors, and constructors like animals more advanced in the scale of existence. The attachment and insertion of these muscles in general is to the interior of the crust, or to some of its internal processes as a fulcrum, and to the organ to be moved. They may be divided into dorsal, ventral, and lateral - of the longitudinal muscles there are four principal rows, and their principal object is that of flexion and extention, shortening and lengthening the body, or to act on any particular segment. The muscles which elevate and depress the head arise from the
anterior part of the trunk and are inserted into the posterior part of the head. The muscles of the legs are situated in the interior of the articulations that form the legs. They consist of several bundles appropriate to each, which have their attachment in the pareties of the preceding joint, near the margin and are inserted in the margin of that they move. The muscles surrounding the alimentary canal consist of threads beautifully interwoven and resembling fine lace. The mandibles [*sic*] have all their peculiar muscles but these are too difficult and may be omitted.

The most prominent of the external anatomical features may be now glanced at. The body is cylindrical in form and is composed of thirteen segments of which the anterior forms a horny head, with jaws, and antennae, and small eyes. Six of which exist on each side. The antennae are of a conical form with three joints
ending in one or two hairs or bristles, and are situated near the base of the mandibles. The mouth consists of an upper and an under lip, two pairs of jaws answering to the mandibulae and the maxillae, and maxillary and labial palpi. The labrum or upper lip retains the food during mastication. It is a transverse movable plate attached posteriorly to the maxillae and situated just above the mandibles.

The mandibulae or upper jaws are two plates of horny consistence, slightly concave and triangular, planted in the side of the mouth to move transversely, and are wrought by very powerful muscles.

The maxillae or under jaws are placed immediately under the mandibulae. They are conical in form, consist of two joints and are of a softer consistence than the mandibulae. They do not seem to have any action upon each other and probably they rather assist in submitting the food to the action of the
Mandibulate than in commination of it. The last of the joints is surmounted by two smaller jointed palpiform organs. The labium or under lip is situated between the two maxillae. On each side of its apex (for it is of a conical form) is a minute feeler, and in the middle between these is the contractile spinneret through which the silk is drawn.

The true legs are six in number and each of the three segments following the head, and corresponding to the thoracic segments of the perfect insect, has a pair of these. They are of a horny substance terminating by a single claw and consist of the same parts as those of the Imago viz. the coxa, trochanters, femur, tibia, and tarsus, suspended to each other by membraneous ligaments. These are the principal instruments of locomotion. The pro-legs are merely props and stays by which the long body is kept from trailing, and by which the animal takes hold of surfaces. The sole of these fleshy feet...
is surrounded by a coronet of slender hooks, a short and a long one arranged alternately, by means of which the animal is enabled to cling to smooth surfaces and to grasp small twigs.

When the sole of the foot is open these claws are turned outwards and when the animal wishes to move the true legs it draws in the retractile ripple in the middle of the sole and the hooks and the toes lay hold on the surface.

The spiracles or breathing pores are small orifices, opening into the tracheae, by which the air enters the body or is expelled from it. There are eighteen of them altogether, nine on each side, and they may easily be recognised from their being surrounded with a dark ring.

This is many other important points, worthy remark in connection with the external anatomy of the caterpillar, but time and space cannot permit of their notice here.
The Pupa

The resemblance which the insect, in this state, has to a young infant "swathed" after the Continental manner procured it this name, and which has been before mentioned. Previous to its entering this state, some unerring instinct correctly interprets to the caterpillar an approaching change, and it starts off on a journey of a day or so to seek some situation in which it is likely to remain secure during the period of its lethargic slumber. The habitation, or clothing (as it is close fitting) which it assumes is at first soft, but it becomes hard and coraceous, and has an angular shape; altogether unlike the comfortable houses of silk and other analogous substances which the larvae of moths form for themselves as retreats in which to undergo the pupa state. This form is what naturalists call a "cased pupa." The caterpillar presses a solid support to which to attach itself.
when undergoing this important stage and
Which nature sagget as most convenient;
And here it begins to weave its silken
Couch and fasten its gossamer cable -
It is very interesting to watch it thus
Engaged. After resting for some time it
Gets the Spinneret in order and commences
to lay the ground-work of its operations.
You observe it moving its head right
and left, somewhat in a figure of
Right direction, over a space about
Three times the breadth of itself and
Laying its delicate double thread which
Adheres quickly to the surface it comes
in contact with. Then it brings its live
Down along its sides, moving back a
Little, and continues the operations till
The whole is woven into an intricate
Silken network - Turning itself around
It plants the abdominal portion of its
Person on this woven surface, and con-
Tinues its web over the ground it
Prolegs previously occupied - It turns
Again and again till the whole has
 Been woven into a connected web.
and thus stretching itself along this elegant mattress it begins to raise at one extremity a beautiful little hillock of snowy whiteness tapering precipitously to the summit with its sides lying away in the further extremities of the plane. You wonder what the intent of all this is but the caterpillar turns round once more and your curiosity is satisfied. It has been raising a mound to which the tapering extremity of the last segment of the chrysalis is attached. It fixes itself to this and the silk, still moist and soft, hardens and makes past the posterior extremity of the caterpillar. But it has its silken girth to weave yet by means of which the anterior portion of the body is kept steady. It spins from its mouth a small knot of silken thread which it fastens on one side of its body near the front pair of ventral legs. Then passing the head over to the other side it carries a thread with it and attaches it to a corresponding position.
on the opposite side of its body. In this way a loop is formed which will effectively prevent the caterpillar from falling as it bricks into a dormant state. But it is not yet strong enough. The thread being of excessive fineness and therefore the process is repeated from forty to fifty times when the number of threads is generally deemed sufficient. Every time the thread is carried along the side of its predecessor, is which is at once adheres on account of its viscosity, to the base of the cord, the caterpillar runs it along the surface of the groundwork to secure its complete fixation. The cord thus formed is further secured by its lying in a groove on the back, the sides of which almost close over it nearly converting it into a canal. The caterpillar has often a difficulty in getting its head out of the loops, or rather proper underneath it. It is often entangled for some time
but by a backward and forward motion it soon frees itself. After some days the old coat is cast off by the continence of a wriggling motion, and the perfect chrysalis appears as yet soft and yellowish green in color. It soon however becomes hard and darker.

The last skin is cast inside the pupa case and may be found within the shell after the perfect insect has escaped.

The only appearance of life now remaining is a motion from side to side when touched. All the markings on the outside of the caterpillar's chrysalis denote something, and Mr. Kirby gives each a name. The delicately raised ridges beneath the head contain the antennae and the radiating marks on each side, not unlike a half expanded fan are the folded wings of the future butterfly. In this dormant state the insect passes
the dreamy winter and appears as the perfect representative of its species when summer decks the earth with garlands

The Imago

The insect is called perfect when it quits the pupa state. The enlargement of the little wing-case with which the butterfly first issued from its chrysalis is amazingly rapid, the whole growth taking place in not much more than an hour.

On first taking flight, like other of its family, it seeks one or more drops of particle fluid, remembering one of the preconiums of the infant. In certain seasons insects are known to come forth in vast swarms, and the Cricket's Globule they let fall in their first flight used to excite the greatest alarm, and were looked upon as an evil omen of the very worst description.

In its perfect state the butterfly lives for three or four weeks, much about the same length of days as in the larva condition.
and generally dies shortly after the eggs are deposited. It is one of the lepidoptera, (the Butterflies and Moths). The "scaly-winged" family of Linnæus. The delicate creamy white wings; the slender antennæ tipped with the peculiar knots which distinguish the antennæ of butterflies from those of moths; the elegant tube which sucks the juices from the deep nectaries of flowers, and which is held so gracefully coiled beneath the palpi till its use is required; and the large quick-lighted, eyes all attract the attention of the natural type in Entomology; and we shall look at these in their turn when glancing over the External Anatomy.

The second divisions of the body have now become more distinctly separated than they were in the larva stage of the insect's existence; and the three distinct divisions of the head, trunk, and abdomen are now clearly seen. Aristotle gave the name "Evropid" to our little favourites, a word which
is derived from "*Euterpus" to cut in, referring to the divided body of insects. The head consists of the skull, the antennae, the eyes, and the parts of the mouth or buccal organs which are fundamentally merely the masticating ones transformed, or stopped upon a lower stage of development. The word "proboscis," properly speaking, belongs to the Diptera only. The spiral tongue or sucker of the butterfly consists of the labrum and the mandibles, covered by the large forward-bent labial palpi, and are here reduced to mere rudiments, along with the two lateral tubes of the sucker proper which represent the maxillae and which have minute maxillary palpi at their base. The compound eyes are placed at the sides of the head above the oral apparatus, and consist of an incredible number of lenses, whence the quick sight of the creature is readily explained. The antennae are two jointed organs, one of which is placed on each side of
of the head between the angle of the mouth and the eyes.
The neck connects the head to the thorax which consists of three segments from each of which a pair of legs originate.
The two posterior segments bear besides a pair of wings united to them by means of joints. The wings consist of a double membrane which is traversed by numerous veins or ribs and by means of which they are held expanded. There are four of them, the anterior pair are the larger and superior covering the posterior in repose. The superior pair are white except at tips and base which are of a dark tone softened by several shades of ashy gray into the almost snowy-cream colour. In the middle of the anterior wing of the female there are two black spots. The under side of the posterior wing is of a yellowish buff colour with numerous small black specks.
The legs are placed upon the lower part of the three segments of the thorax, and
and consist of many joints. The hips or coxal are the upper parts and are received into the acetabula. Then come the trochanters succeeded by the thighs, the largest joints of the legs. The tibiae or shin are the fourth and are nearly as long as the thighs though thinner and more slightly framed. The tarsus or foot, the last division of the legs, is attached to the tibia and consists of a series of consecutive joints the last of which is armed with claws and appendages at its termination.

The abdomen consists of nine segments following upon each other and is cylindrical in form. The anus is in the last abdominal segment, a sort of cloaca, and into which the rectum with its two valves, and the sexual organs with their appendages, terminate. The spiracles are arranged along the side of the butterfly as in the larva but are more difficult to find on account of their being defended by hairs &c which somewhat conceal them.
Internal Anatomy.

In the larva the acesophagus, the small intestine, and the rectum were short and thick. After being two days in the pupal state the acesophagus and small intestine are much lengthened and become very slender. The stomach contracted both in length and size; the rectum also changed; and the silk vessels contracted and disappearing.

In a pupa eight days old (Herbst in Kirby & Spencer's Entomology) the silk-bag had disappeared; the gullet has become still longer; its base is dilated into a crop or honey stomach; the stomach is still more contracted, and instead of a cylinder represents a spindle; the small intestine also is lengthened. At a still more advanced period, when it is near appearing under its last form the gullet and small intestine are still more drawn out; and the honey bag, though minute, has become a lateral appendage of the gullet; and lastly in the butterfly it appears as a large vesicle; the small intestine is from very long; and the rectum has changed.
its form and acquired a cecum. The
bucket stomach is not a receptacle for
nutriment, but in promoting the suction
of food by distending at the bill of the
insect, and thus by the rarefaction
of the air contained within it, facilitating
the rise of fluids in the tongue and
cricopharynx. The stomach is very small
and takes the shape of an egg, its function
being now, not to digest vegetables but the
honey from the nectaries of flowers.
The entire canal consists of three layers
of membrane, the external of which are the
vascular ones. The reticulations of the
air vessels of the fat in help it in its
proper situation. It appendages are the
biliary vessels which open into the ileum
immediately beyond the pyloric sphincter
of the stomach. They are narrow fleshy
fibrous tubes free and closed at the distal ends,
and float in their nutrient fluid.
There are three in each side terminating
in a common duct and entering the ileum
as one vessel. The vascular and respiratory
systems are almost the same as has been described under the
The sexual organs lie in the abdomen and open in one evacuating duct at the end of the abdomen beneath the anus.

The female sexual organs consist of internal and external; the internal ones of ovaries, oviducts and uterus, other peculiar appendages, and the vagina; the external ones of the orifice of the vagina and its appendages. Four long tubes originate at one spot upon the very short common egg-duct and run upwards in a long feliform point. The spermatheca is an appendage destined to the reception of the male semen during copulation, and into which the male directly deposits it. It opens into the egg canal or uterus where the eggs are impregnated in their passage down. The glutinous gland or varnish secretor is a tolerably long tapering vessel which discharges itself into the duct continuously to the spermatheca, and the varnish serves to fasten the eggs to the leaves. There is another little vessel, opening into the oviduct, filled with a thick white fluid.
probably for the lubrication of the passage.
Of the male organs, the external are the
genus and the prehensile organ connected
with it; and the internal are the
testes, vas deferens, pecora licunales,
and ductus ejaculatorios. The testes
is of a singular globular form the
earlier separation of the parts of which
is indicated by a ring, and each of
the hemispheres divided by this ring
has its own peculiar duct which unite
afterwards together. In the larva,
on account of the greater similarity
of the different segments, the ganglia,
united by the double nervous cord, follow
one another more regularly; but in the
butterfly, since the segments have become
more or less amalgamated, the individual
 ganglia are fused in a corresponding
degree into larger masses. The cord
here has a central position as in the
larva, and originates from the cephalic ganglion
above the acesophagus which gives off two filnons,
to join the first ventral ganglion and
thus a nervous ring is formed round the acesophagus—
Such is a brief sketch of the successive developments of Pontia brassicae, the herald of summer; the friend of sportive childhood; the study of riper years; and, following out the Greek feeling, the emblem of the soul's departure from the body.

"With the Greeks we find that the term Psyche prevailed as the common name of the butterfly, being the same word as that signifying either "the soul" or "the breath of life." It is thus evident that the poetic Greeks must have closely watched the career of the caterpillar, toiling, like man, on the surface of the earth for a time, and feeding on its productions; and eventually burying itself in the earth, or melding itself in a sculpture-like sarcophagus in apparent death, from which it arose, in due time, a glorious winged creature, to enjoy what seemed a higher kind of existence. Having observed these singular changes, and the seeming resurrection after death, they called
the butterfly by the same name as the soul, and no doubt looked upon the issue of the beautiful insect from the sarcophagus of the dead caterpillar as one among many other extraordinary evidences of a future state after death. In their personification of the soul, a human spirit—among a series of deities founded on a system of imbodying in divinity forms the human passions and aspirations, and even the general power of nature—they gave to the divinity representing the soul, the wing of a butterfly (Vanessa do); thus carrying out the popular feeling; and the deified personage also bore the name of the soul. In the Inquisitive story of Psyche we may trace, also, the poetic theory of a spirit gradually purified by passions and misfortunes for the eventual enjoyment of true and pure happiness."

"Stay near me—do not take thy flight!
A little longer stay in sight!
Much converse do I find in thee,
Historian of my infancy!
Float near me; do not yet depart!
Dead times revive in thee:

Finis

[Signature: Wordsworth]