Some comparisons of the Lepidopterous wings.

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When the students of the agricultural, domestic and general science courses reach the Spring term of their second year, they are required to take up a very interesting subject, that of Entomology or the study of Insects.

Beginning about the first of May and up to the last week in the term you can see students with bug nets in one hand, cyanide bottle in the other, sometimes in twos, sometimes threes and sometimes whole squads; such class of people can be seen at all times, morning, noon and night, and in all places after this bug, that moth or butterfly, in fact nearly every-thing that has six legs and four wings suffers for a short time the ravages of "bug catchers".

Among the numerous organisms that have six legs and four wings, probably the most admired, most attractive, and most sought after are the ones belonging to the order Lepidoptera which includes the butterflies and moths.

These are the most attractive to the little children, student collectors, and advanced entomologists

What little child will not regard a bug with fright and a worm with positive horror little knowing that some of these same worms will in a short time transform themselves into a beautiful butterfly or moth that will cause this same little child to run its little

legs tired in trying to catch it.

Student collectors especially admire them not only because of its beauty but because they take up room in a "bug" box and present a pleasant effect on the eye and thus they try to make their collection attractive to the professor thinking the grades will be much profited by it.

To the advanced collectors of the Lepidoptera, they are most interesting because of the scales that produce the beautiful colors and because of the veins in the wings. By careful study it has been found that each family has its own peculiar venation so it is by this means that we income the difficulty of naming some of the rare specimens

The word Lepidoptera comes from the Greek words — Lepis = a scale; and pteron = a wing, a scale wing because the wings of this order are all covered with minute scales or modified hairs in fact the whole of the body of the insect is thus covered. A more minute discription of the scales will be taken up latter.

The Lepidoptera, the most ornamental division of Entomology, are inferior to the Hymenoptera in intelligences, inferior to the Coleoptera in mechanical adaptation of the parts of the body and second to the Diptera in perfection of metamorphosis, but they are the strictest vegetarians of all orders of insects

In the adult, who needs little nourishment, the mouth parts are very much modified. The mandibles are obsolete and the maxillae forming a long tube which when not in use is coiled up like a watch spring. The larvae eats very extravagantly and it is the stage that causes the damage.

The metamorphosis consists of four stages and is known as Holometabola; they are, egg - larvae - pupa - imago or adult. In each stage the insect is distinguished by radical differences in form, surroundings and requires different food. The pupa is inactive, requiring no food and is often protected by a cocoon.

On escaping from the cocoon the pupa have an outer skin which is armed with a beak or some hard process more or less developed and which cuts the cocoon near the junction of the cocoon and cap, then with the aid of the spines on this outer skin works its way nearly out. When about half way out the pupae stops and this outer skin splits down the back allowing the adult to escape.

Leonastock divides the Lepidoptera into three divisions:-

Moths - known as millers which fly by night. The wings are folded on the abdomen, spread horizontally or wrapped round the body when at rest.

the antennae are of various forms, usually thread like or feather like but hadely ever enlarged towards the tip.

Skippers – These fly in the daytime and dart suddenly from place to place. At rest they hold their wings as do the butterflies, in a vertical position, often however the fore wings are held thus while the hind wings are held horizontally.

The antennae are thread like and enlarged toward the tip. The tip is pointed and recurved and resembles the moth instead of the butterfly.

Butterflies – They fly by day and when at rest they fold their wings vertically over the body. The antennae are thread like with a club at the tip which is never recurved as to form a hook.

John Sterling Kingsley in "The Standard Natural History." divides the order Lepidoptera into two sub-orders; –

The Heterocera – moths.
The Rhopalocera – butterflies.

The former fly by night and if disturbed in the day time fly only a short distance. Most have two simple eyes on the top of the head one on each side behind the antennae. The majority have a frenulum (Fig II Plate III.

or bristle on the upper rib of the hind wing which passes thru a loop on the under side of the fore wing and thus fastens the two wings together when flying.

The latter fly by day but the difference between the two is not very easily distinguished, it is more arbitrary and sometimes it takes only a practiced eye to distinguish the two sub-orders. The greatest difference is in the antennae. The butterflies have no pectinations as do most of the moths.

Altho the moths and butterflies are different in habits and in most cases appearance the wings are all taken as a whole in the classification.

The order Lepidoptera includes a great variety of sizes and forms, extending from the great owl moth (Thysania agrippina) which extends a foot from tip to tip to forms that are almost microscopic in size.

The wings also present a very great variety in form. Plates I and II will show some of the most divergent forms.

Plate I – fore wings
Plate II – hind wings

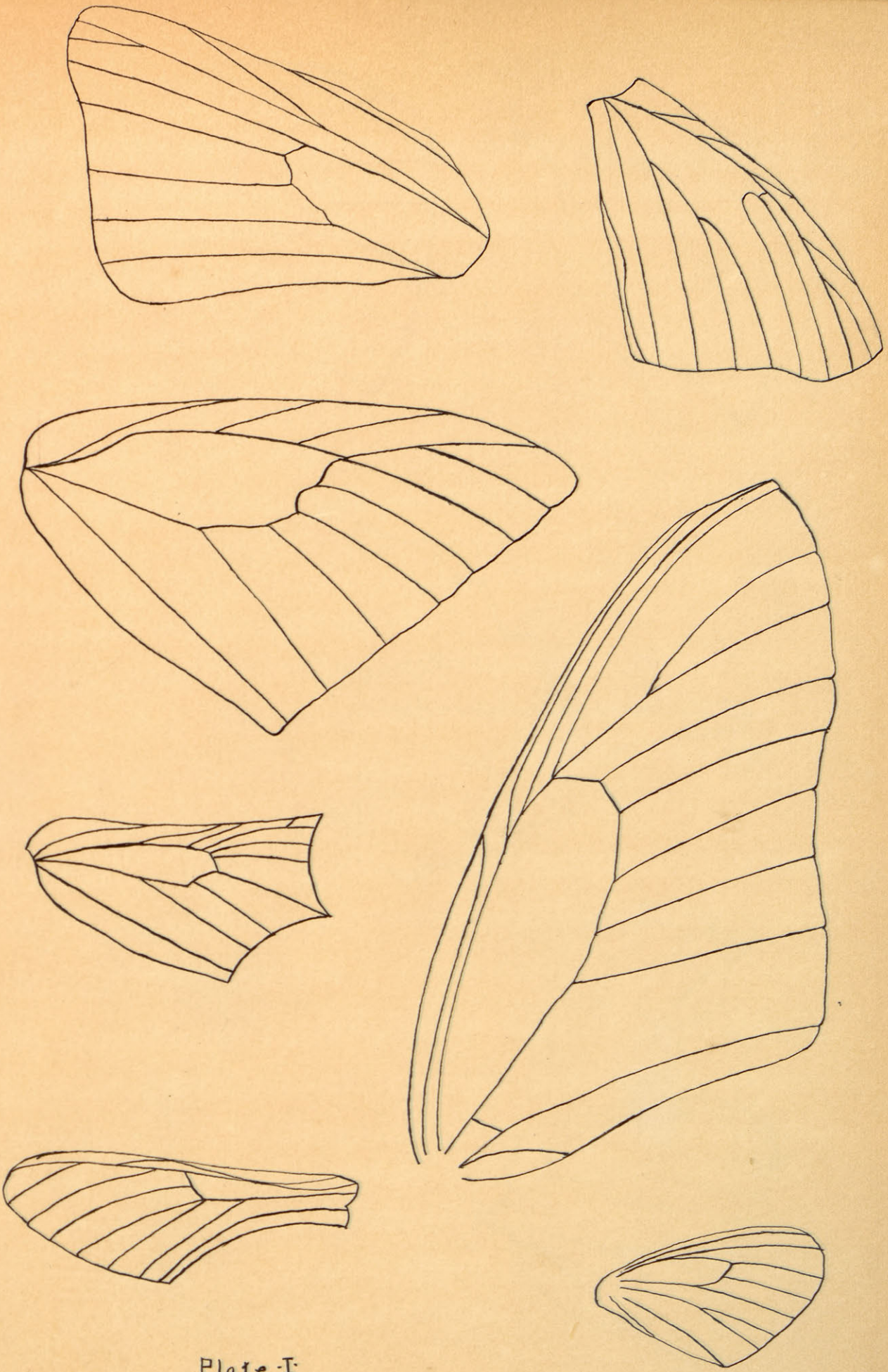


Plate I.

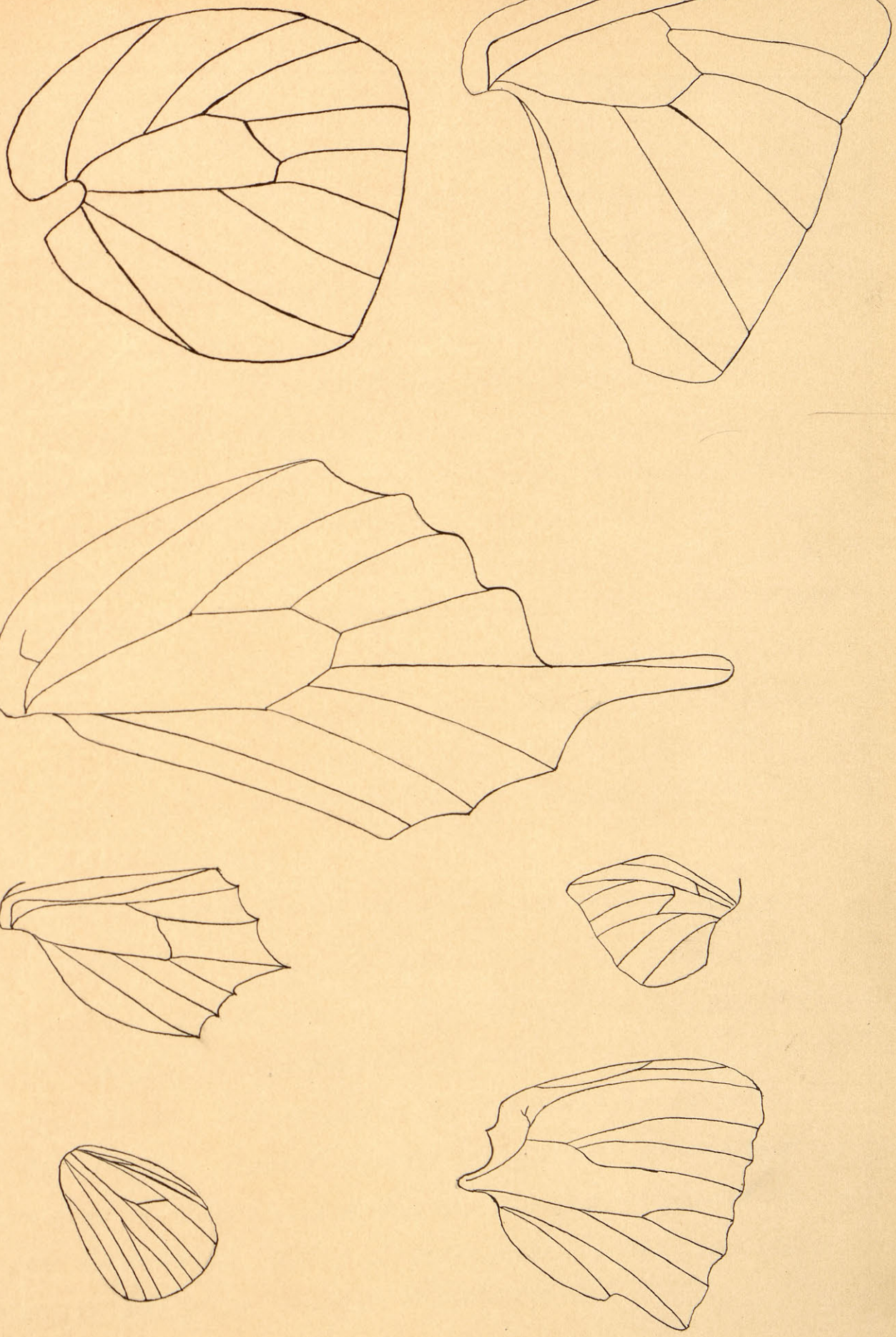


Plate II.

The most highly ornamental parts of the Lepidoptera, the wings, — are four in number. They are borne on the middle and hinder parts of the thorax. The fore wings on the mesothorax and the hind wings on the metathorax. There is no ratio between the size of the wing and the size of the body of the insect. The large winged insect does not necessarily possess the greater powers of locomotion.

The area of the wing is sometimes enlarged from the fact that the outer margin is bored with hairs that project quite a little distance beyond the edge in a sort of fringe. The physiology of the flight has been little studied but it is a well known fact that the two wings on the same side of the body work harmoniously with each other.

One method of aiding this is that the fore wing laps to a considerable extent over the hind wing and in a way they are pressed together. This is the method used in butterflies and moths. To make this lapping more effective the hind wing projects forward in a kind of a shoulder so as to give more surface for lapping. This shoulder is called the humeral angle (Fig I. Plate III. S)

In most moths this shoulder is absent and in its place is a more or less stiff bristle or bristles that project forward under a little

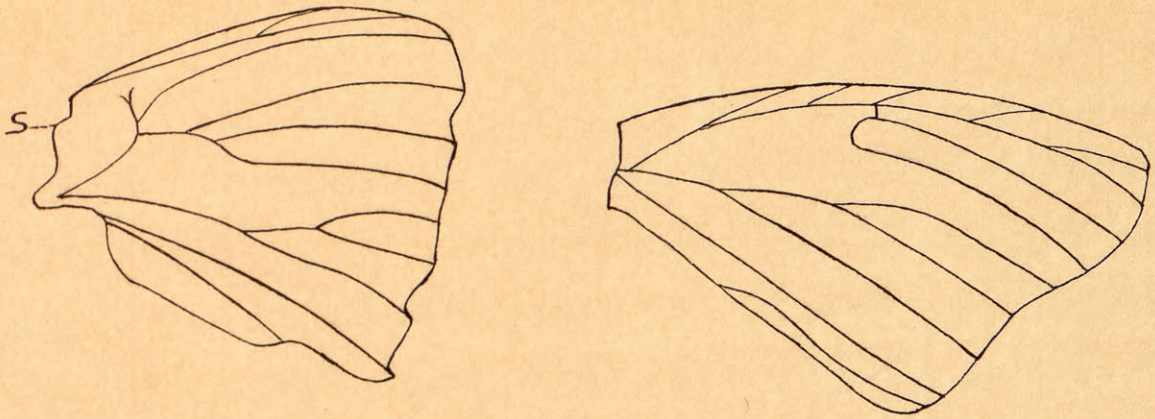
membranous flap or tuft of scales on the under side of the fore wing. This bristle is called a "frenulum" (Fig II Plate III f.) and the process that holds it is called "a retinaculum".

This can be used as one method in determining the sex as the males of all forms that posess it have several hairs fastened together while in the female they are two or three separate bristles and in one case there has been nine found.

On the wings that posess the frenulum and retinaculum the fore and hind wings differ a great deal from each other

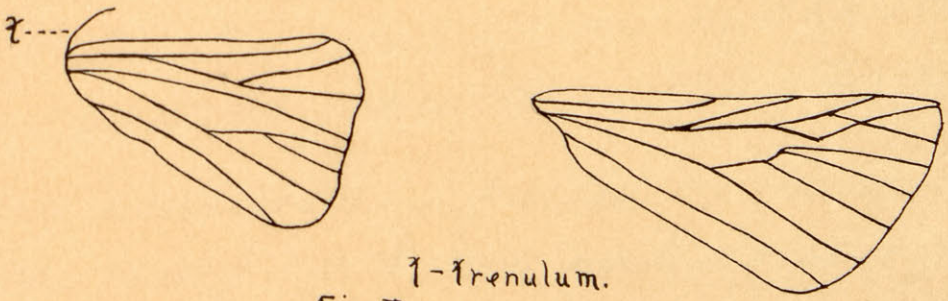
The front part of the fore wing has many veins and the front part of the hind wing has not. The front wing of course be strengthened to resist the air when flying but the hind wing being protected by the fore wing does not need to be so strengthened.

Another method of the connection of the wings on the same side of the moth is by, what Professor Comstock calls, "the jugum" (Fig III Plate III j) This is a lobe that projects back from the base of the fore wing and laps over the hind wings. This connection is not very perfect and the wings that are connected this way are very little different in form from each other and a little different in venation and they may be said as acting as four separate wings instead of two pair.



S-shoulder.

Fig. I.



T-Trenulum.

Fig. II.

J-jugum.

Fig. III.

Plate III

The wings of the Lepidoptera begin to develope as far back as in the larval stage. They have been detected but are not visible until late in the larval life & until the pupa state is attained. Dewson says their "origin is due to a modification of some of the hypdermal cells that occupy the spots where the spiracles of the second and third thoracic segments might be looked for. Then when the catapillars skin is shed and the true chrysalis appears, the wings are free external appendages but they are soon fastened to the body by an exhalation that hardens so as to join the shell of the chrysalis."

As the scales only partially form until late in the pupal life & do not get their pigmentation until then, this early part of pupal life presents the best chance for the study of nerves and veins.

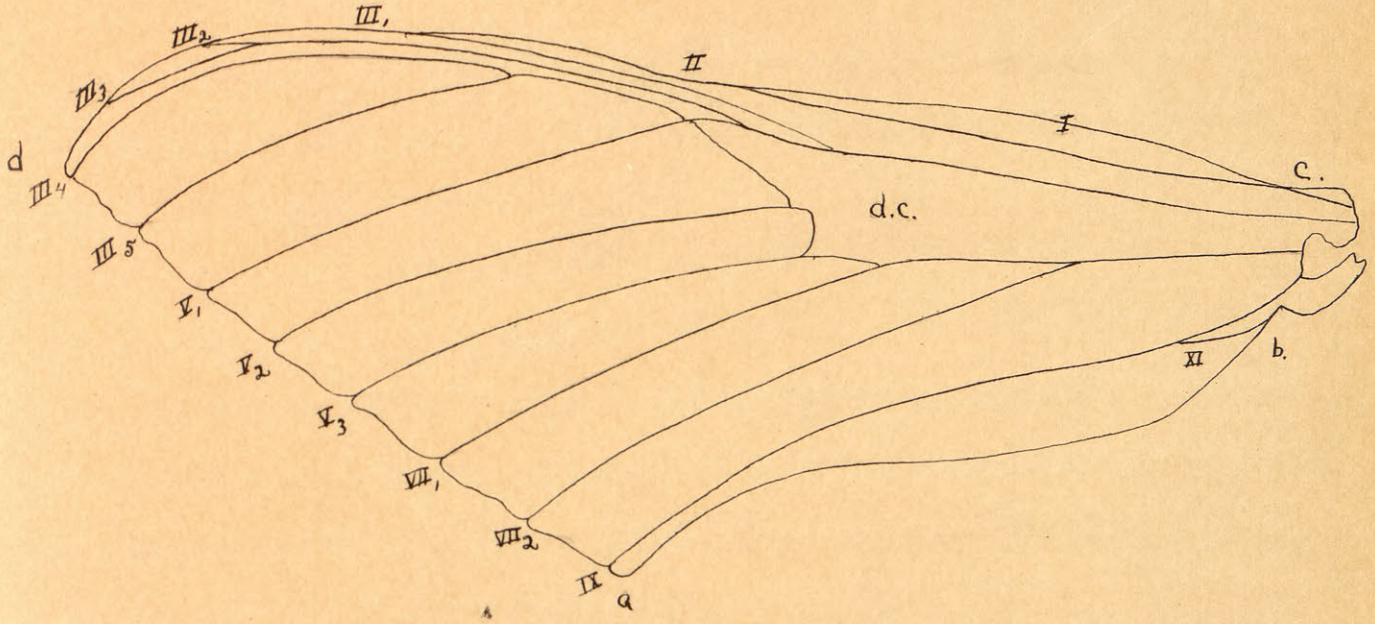
These nerves & veins are situated between the upper and lower layers of the wing and are so formed as to give lightness and strength to the wings. In studying these veins it will be noticed that the wings that have no scales have many cross veins as for instance the corydalus cornuta & Dobson fly.

the principal veins are formed along the course of the trachae and the cross veins do not. In the adult Schäffer was unable to find any remains at all of the trachae. It had entirely disappeared. But for the study of the veins with the view of classification and comparison we take the adult wings.

For the best results it is best to remove the scales. For a better determination of the insect you can remove the scales with a camel's hair brush and chlorophorm. But where a more careful study is wanted the following method of bleaching suggested by Prof. Comstock is a very good one.

1- Remove the wings carefully
2- Dip wings in alcohol to wet them.
3- Immerse them in HCl. 1 part HCl to 9 H_2O.
4- Put in Labaraque solution to bleach the wings.
5- Put in alcohol to wash Labaraque off. Leave till it floats.
6- Put in clearing mixture.
   2 parts weight carbolic acid crystals.
   3 " " rectified oil of turpentine.
7- Mount.

There is not much uniformity in the method of naming veins of the wings but the most used method is taken from Prof. Comstock and illustrated on Plate IV.



c.d costal margin.
ad outer margin.
ab. inner margin.
c humeral angle.
d apex of the wing.
a anal angle.
d c. discal cell.

I costa vein.
II sub-costa vein.
III radius.
IX media.
VII cubitus.
IX, XI } anal veins.

III 2, III 3, III 4, III 5.
V 2, V 3
VII 2
} branches of { III. V. VII.

Plate. IV.

In some orders there are two other veins the Premedia number IV and the Post media number VI.

The costal margin of the wing is usually strengthened by a vein or vein like structure called the costa vein.

The second principal vein is the sub costa. It extends nearly parallel with the costa. In orders where there are many wing veins there are numerous small branches to this vein. In orders where there are not many veins it is generally an unbranched vein.

The third vein is the radius and the most prominent one in the wing. It also has a great variety of modifications and thus it is the principal vein for use in the classification.

The fifth vein is the media. In its primitive form it is three branched but as it has been found in so many orders it is believed it was originally four branched.

The seventh vein is the cubitus, it is two branched.

The other veins, eight, nine, and ten less always are anal veins. Three anal veins is the usual number.

In taking up some of the principal orders of Lepidoptera we see the difference between the venation.

In the sub order jugatae (fig I. Plate V) is the only place we find the jugum. The veins in both wings are similar his also is the shape of the wings.

All veins are present except VIII, IX in the fore wing and in the hind wing vein XI is absent.

The discal cell is small compared with the majority of the other sub-orders and families and also with the wing itself. The veins are nearly of the same degree of strength. Judging from the veins the wings are very strongly built.

In the sub order frenatae the jugum is replaced by the frenulum or its substitute a very large humeral angle. Another large characteristic of the wings of this sub order is that the wings are different from each other in form and in venation. The veins in the hind wing are fewer than in the fore wing. It is thought that the wings that have no frenulum have descended from those that had and are so classed with them.

The wings of the Lesiidae (fig II Plate V) present a marked change.

The fore wing is very narrow making the anal area very small but they have a large discal cell.

Vein I of the fore wing seems to be separated only for a little distance from veins II and III. Veins II and III seem to coincide together

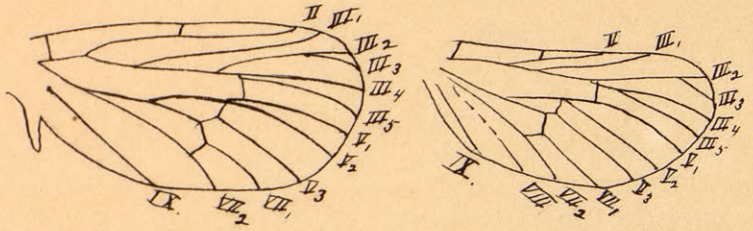


Fig.I.

Jugatae.

Hepialus gracilis.

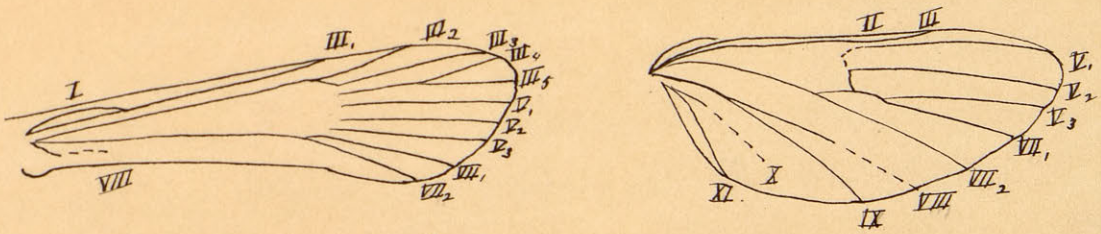


Fig.II.

Sesiidae.

Sannina exitiosa.

Plate.V.

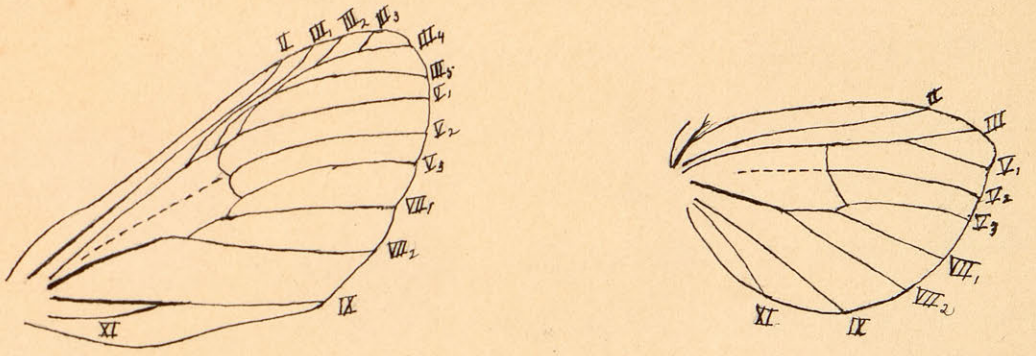


Fig.1.

Notodontidae.

Notodonta strangula

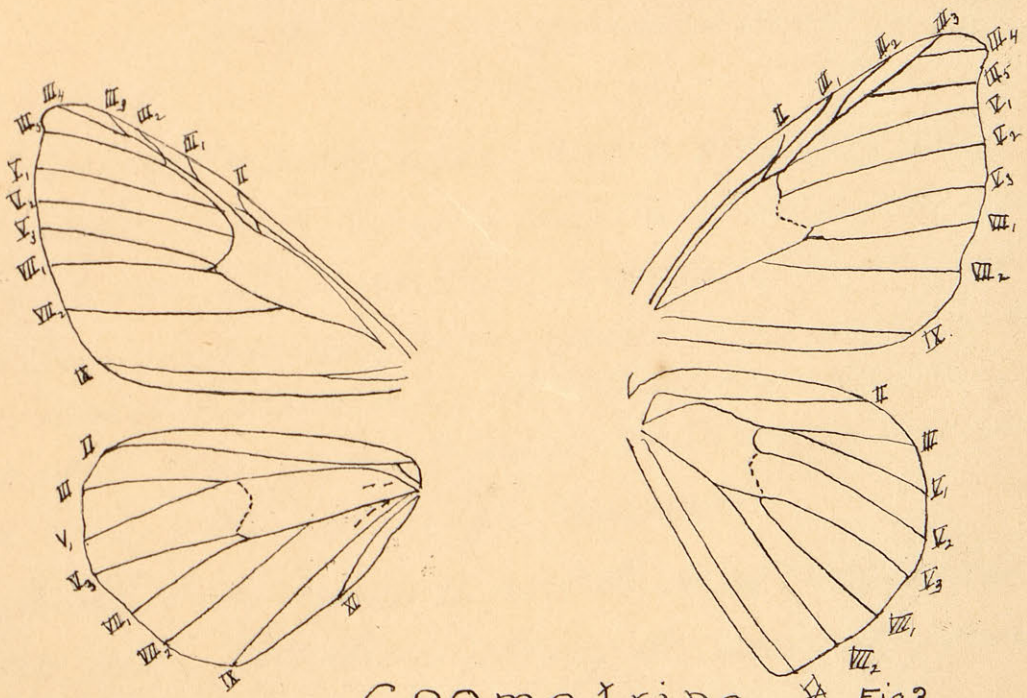


Fig 2.

Geometrina.

Fig.3.

Ennomidae

Caripeta angustiorata.

Geometridae.

Geometra iridaria.

Plate. VI.

for the full length of the wing making practically one vein.

Vein III has the five branches.
Vein V has the three branches.
Vein VII has the two branches.
Vein VIII is nearly obsolete, just a faint trace of it is left

Veins III, V, and VII are not connected by cross veins at the outer end of the discal cell.

In the hind wing:-

Vein II present.
Vein III only one branch.
Vein V three branches.
Vein VII two branches.
anal vein IX, XI fully developed.
anal vein VIII developed partially and in this family the anal veins seem to pass beyond their usual number three and has anal vein X partially developed. The discal cell is smaller and the anal area larger than in the fore wing. The outer end of the discal cell is enclosed by cross veins except at the top where veins III, VI, V, do not unite

In the Notodontidae (Fig 1 Plate II) we find a very strong fore wing, the veins are all enlarged thus presenting a very stiff costal margin.

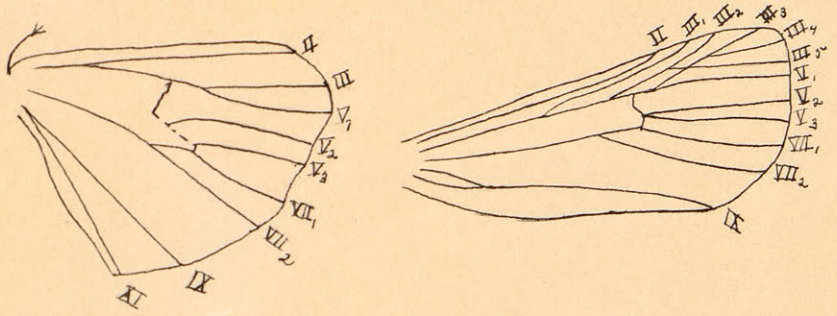
Vein II single branched and vein III has its regular five branches also veins V and VII have their allotted number. But we find only one anal vein IX. The discal cell is not particularly large and is well developed and in it is sometimes found the basal section of vein V. The accessory cell is also found.

In the hind wing we find the jugulum. Vein II is single branched. Vein III is reduced to a single branch, veins V and VII are present with their usual number of branches. The anal area of the hind wing differs from the fore wing in having two anal veins IX and XI. One point is noticed here and that is that the vein II does not form an angle in the humeral angle of the wing as it generally does in most forms.

While in the Geometrina (Figs 2, 3. Plate VI) we find it well developed. It is probably developed more in this super family than any other. The superfamily contains many families which are separated by their venation. It presents quite a variety of differences.

In the family Ennomidae (Fig 2. Plate VI) the fore wing contains all the veins with their regular number of branches. Vein III, branches and coalesces with vein II for a short distance then coalesces again with the main branch of III, then branches off again to the margin. This uniting of the veins makes a very strong costal margin.

In the hind wing veins II and III do not coalesce but are very near together along the second fourth of the discal cell and veins III and IV, do not unite beyond the apex of the discal cell. Vein III is present in only one branch but III_2 is entirely absent, both branches of VII are seen and anal veins IX and XI present, and vein VIII being absent.



Noctuidae.

Agrotis ypsilon.

Plate VII.

In the family Geometridae we have all divisions of the Lepidopterous veins except there is but one anal vein (IX) in the fore wing, and the fore wing the costal edge is well strengthened by the branches of vein III lying close together. Vein II does not extend to the costal margin.

Veins V_2 and V_3 are not well connected and they seem to grow farther apart from each other.

In the hind wing vein III makes a prominent bend in the humeral angle and it is best developed in this family. Vein III only one branch. Vein V present in all its branches also VIII and one anal vein (IX). The same characteristics between veins V_2 and V_3 appear in the hind wing as well as in the fore vein (see fig 3. Plate VII.)

Vein V_2 in the fore wing of the Noctuidae (Plate VIII is different in its origin than in the former cases. It seems to rise nearer V_3 than to V_1 as it generally does. The other veins are all present in regular number and vein III_3 branches from III_2, thus crossing over III_3 and making an accessory cell as well and making the wing stronger.

In the hind wing veins II and III coalesce for a short distance near the base and vein V_2 is sometimes very much nearer than the other veins. VII, and $VIII_2$ are both present. V_3 seems to branch from $VIII_1$. Anal veins IX and XI both present.

The most distinctive feature of the venation of the Sphingidae (Plate VIII) is that there is a cross vein between II and III. Veins II and III grow together for a short distance then II divides and joins I. Vein I is seldom present in the hind wings of Lepidoptera.

Many cases veins III_2 and III_3 coalesce and thus the vein III is only four branched instead of five

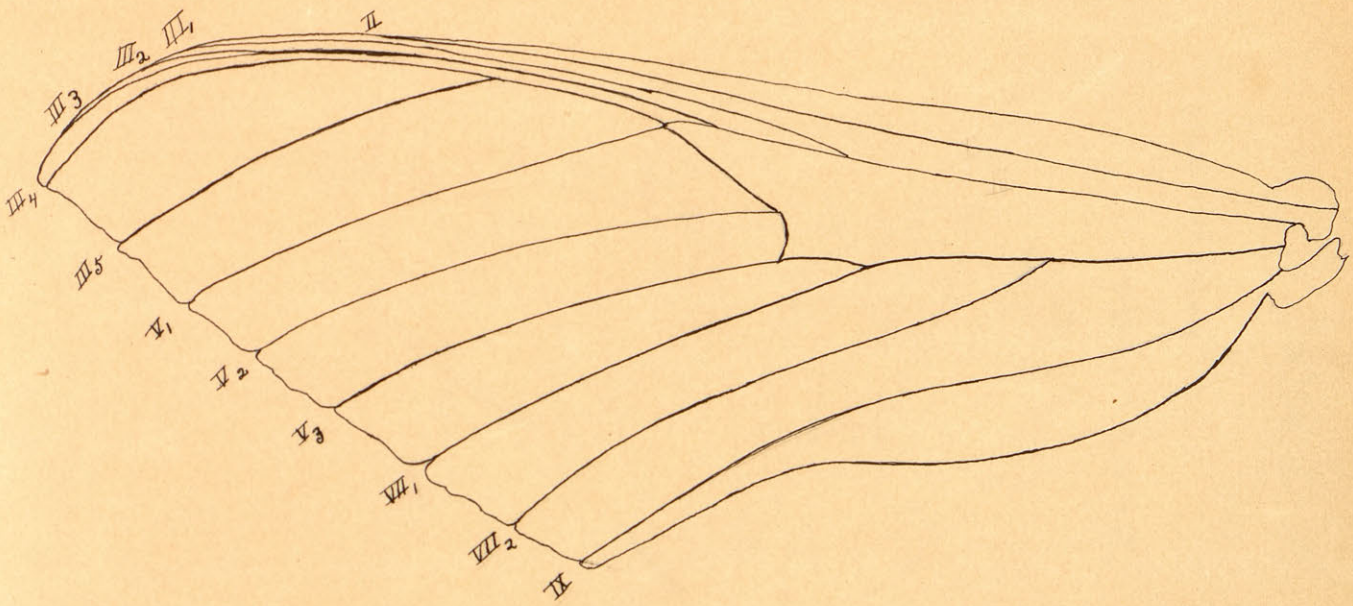
In comparing the super family Saturniina we will take representatives from families Bombycidae and Saturniinae. (Plate IX Fig 1+2.)

The frenulum is nearly dropped in this family and in the other families of the Saturniina it is dropped altogether and is replaced by a large humeral angle.

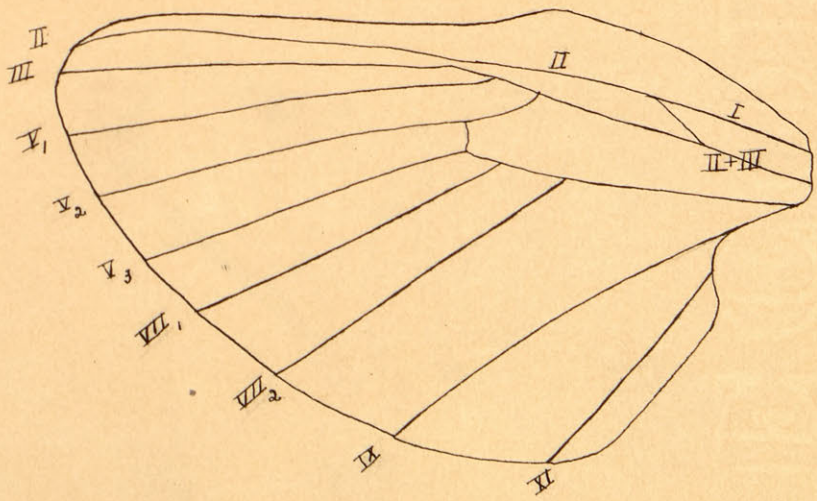
In the fore wing of the Bombycidae vein II is present also all branches of III together with all branches of IV and VII. There is a faint indication of the basal part of vein V. Veins V_2 and V_3 are not well connected. In the anal area vein IX is the only one that is well developed, a faint trace of vein XI and vein VIII is developed only at the outer end.

In the hind wing we have vein I present in a small degree, vein II present, one branch of vein III vein V all present also VII.

The connections of branches of vein V are obscure and there is, like in the fore wing an



Fore Wing.



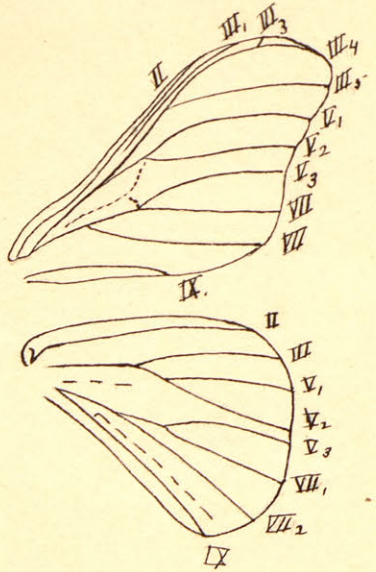
Hind Wing.

SPHINGIDAE.

Phlegethontius celeus.

Plate. VIII.

Plate IX.

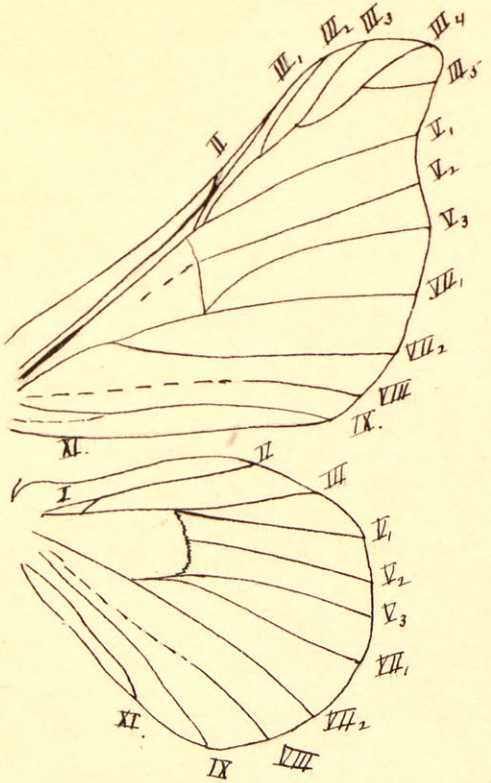


Saturniina

Saturnidae.

Samia cecropia.

Fig 1.



Bombycidae.

Bombyx mori.

Fig 2.

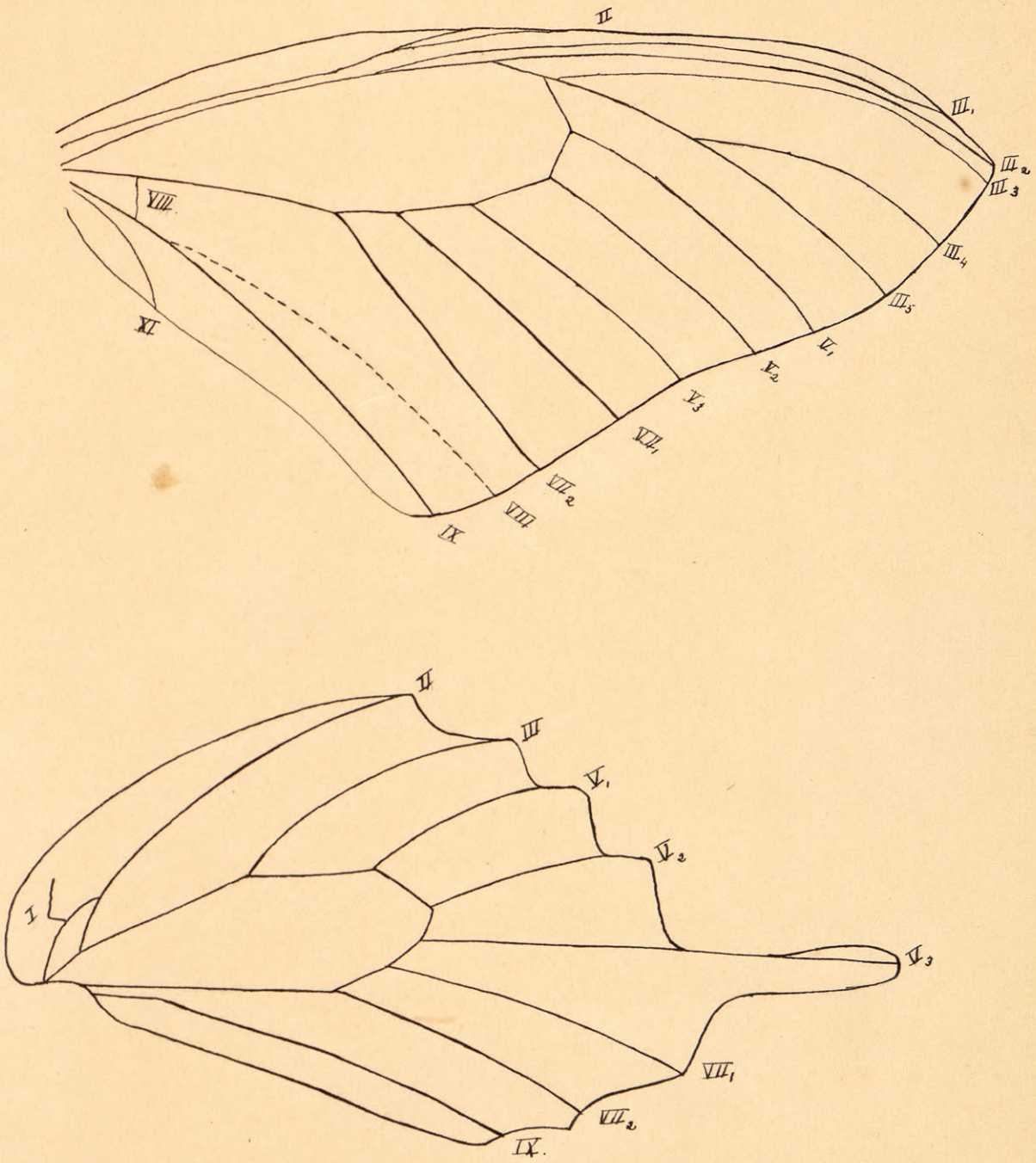
indication of basal section of vein V. In the anal area veins IX and XI are well developed but VIII is developed only at the outer end as in the fore wing.

In the family Saturniidae (Fig 1, Plate IX) we find an alteration that has not been noticed before, that is, of the absence of III_2 in fore wing. Vein II present. also V in all its branches. There is no connection of veins V_2 and V_3 leaving the discal cell open at this point. There is a very faint trace of the basal section of vein VI. Vein V_3 seems to be a part of vein VII from the way it is connected with it. Vein IX the only anal vein present.

In the hind wing vein II present. Vein only one branch and also vein VI. The same fact is noted about vein V in the hind wing as in the fore wing. Vein VII all present and vein IX absent with a trace of anal vein VIII.

We will now note some comparisons in the veins of the butterflies of superfamily Papilionia

The first example will be of the family Papilionidae the species Papilio polyxenes. In the fore wing the distinguishing feature is that veins VI_2 and V_3 appear as branches of VII making vein VII appear as a four branched vein. (see Plate X). Vein II present, vein III appears in all its branches as also does veins V and VII. Anal veins are all present but vein



Papilioninae.

Papilio polyxenes.

Plate X.

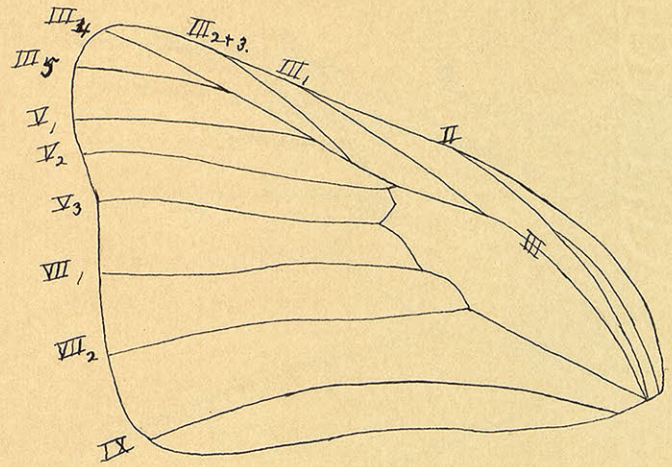
VIII is developed only as a cross vein between basal section of VIII and IX. It can be traced with difficulty to the outer margin. Vein IX well developed and vein XI as a little short vein reaching to the inner margin about one fourth the way from the outer margin.

The discal cell is comparatively large. In the hind wing we find vein I present, first projecting up and forming a small drop at the humeral angle of the wing. Veins II and one branch of III all of IV and VII present. The anal area in the hind wing is greatly reduced and only contains one vein that is vein IX.

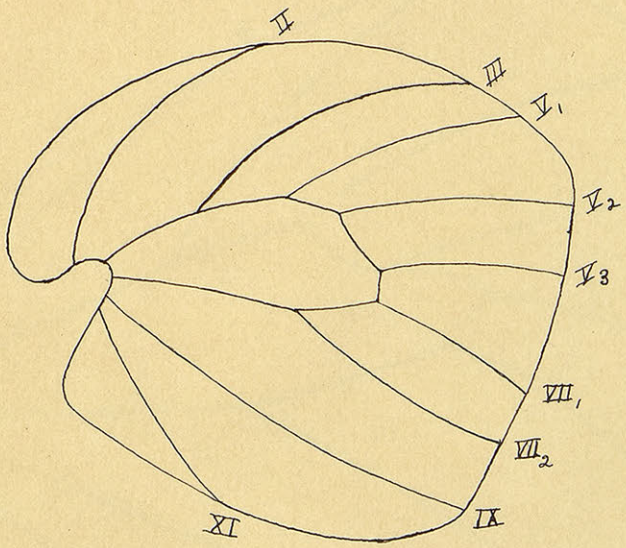
As a type of the Pieridae (Plate XI) we will look at the wings of Terias caesonia. In examining the fore wing we find vein I present for a short distance where it coalesces with vein II. Vein III is all present except that vein III_2 and III_3 have coalesced and appear as one vein (III_{2+3}). Veins V and VII present and in the anal section only one, IX, is present.

In the hind wing vein II one branch of III and all of IV and VII present. The anal area is well developed and in it we find two veins, IX and XI.

In the family Nymphalidae we will use for illustration the wings of the common butterfly Anosia plexippus (Monarch) of the sub family Euploeinae (Plate XII)



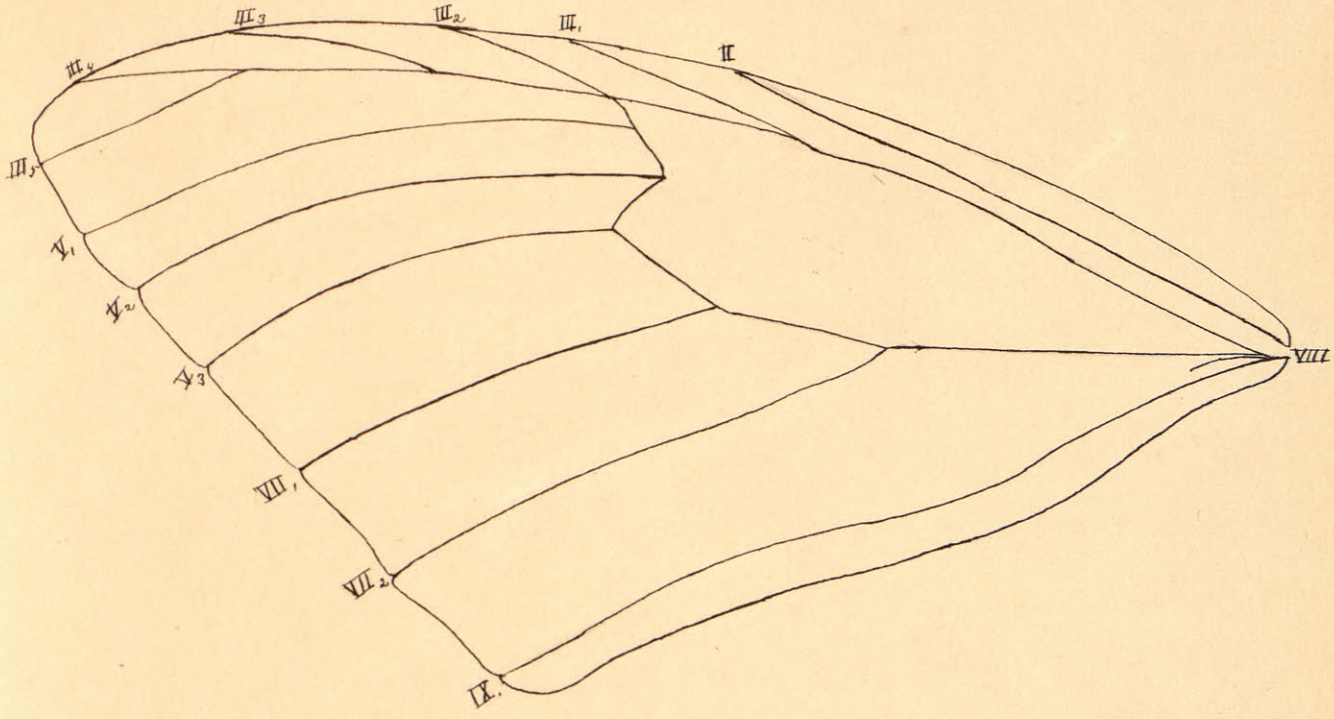
Fore Wing.

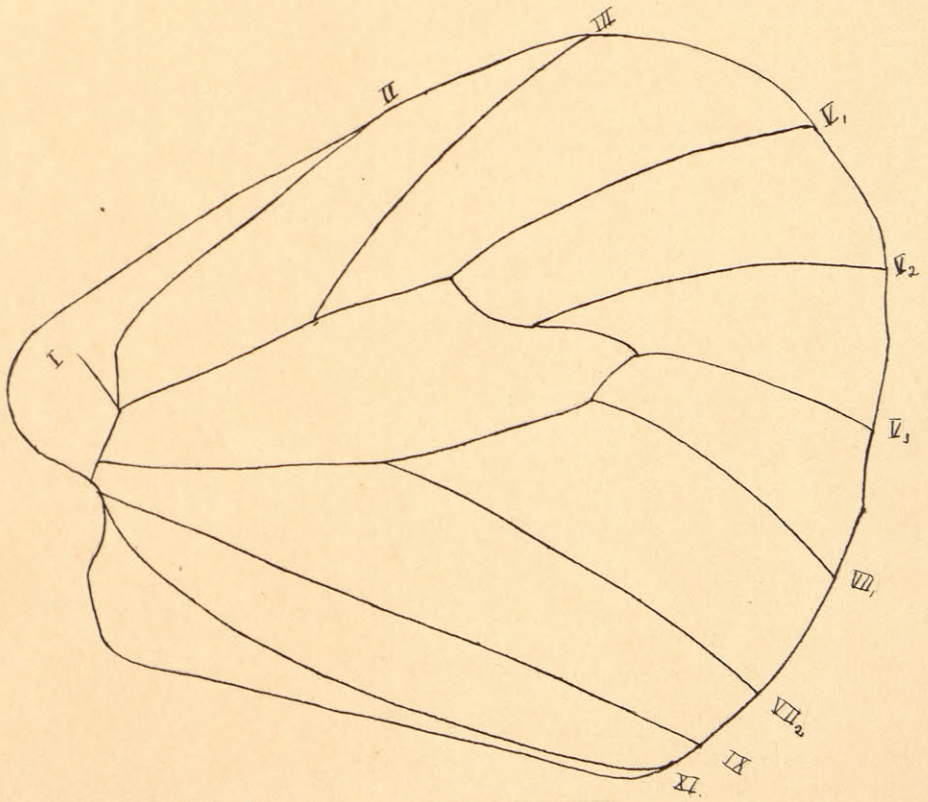


Hind Wing.

PIERIDAE.

Plate. XI.





Nymphalidae.

Euploeinae.

Anosia plexippus.

Plate XII.

In the fore wing veins II, III, V and VII all well developed & in all their branches with the addition of vein IV in the anal portion. In the discal cell is about medium size. In the hind wing vein I is slightly developed extending upward into the humeral angle veins V, one branch of III, veins $I_{1,2,3}$ and $VII_{1,2}$ all developed. The anal area is developed well and contains anal veins IX and XI.

Normally in fore wings of the Lepidoptera vein I is seldom present and when it is only extends a short distance, vein II always present unbranched, veins III always present in five branches but sometimes veins III_2 and III_3 coalesce and cannot be seen as separate veins. Veins V always present in all the branches although they are not always connected at the outer edge of the discal cell. Vein VII always present in two branches. Anal veins always present and sometimes XI, rarely VIII.

In the hind wing vein I is seldom present and when it is only forms an angle in the humeral angle of the wing. Vein III present always as a single branch. Vein V present in three branches but with a rare exception, of the absence of vein V_2. Vein VII present in both branches. The anal area

of the wing may be more or less developed and has always vein IX and in the majority of cases vein XI. And vein VIII is rarely present and when it does occur is but partially developed

If we touch the colored spots on a Lepidopterous wing we can obliterate all color and there remains no more fingers fine dust. If we take this dust and look at it under a microscope we see little scales of various colors and shapes. These scales also cover the body of the insect.

"The primary use of scales", says Kellogg, "is for protection", but another use of nearly equal importance is for the production of color and patterns of colors and markings. While sometimes certain scales have the function of external openings of scent glands these are called "Androconia".

The origin of the scales was worked out by Lempe 1886. He said "they arose from large roundish cells just under the hypodermis". They do not all form at once but arise one after another so on the same wing there may be several stages of development. They commence to form early in

pupal stage. The scales are originally filled with protoplasm but this gradually disappears leaving the cells full of air.

The pattern occurs in the wings before the exit of the adult and the coloration is first begun in four and commences 48 hours before the adult comes forth and the time occupied was less than twenty four hours. (Bucknell).

"The color of insects is due to the action of light and air" says Hagen. "heat and cold, moisture and dryness also play an important part. Hagen divides the colors into optical and natural.

The optical colors are produced by the interference and can be done in two different ways, by thin superposed lamellae or by many very fine lines or small impressions in very close juxtaposition. But in the Lepidoptera there must be something else present because, tho the Lepidoptera have these fine they do not change color by much hence there is natural color in combination with the optical.

The natural colors are divided into two classes. dermal and hypodermal. The dermal colors are due to pigments in the form of nuclei in the cuticle and are the darker shades and are more changed, or obliterated

after death.

The hypodermal colors are situated in the hypodermis and are of lighter shades and change after death. Most of the white color is due to the air enclosed in the scales.

The scales of the Lepidoptera are in regular rows overlapping each other like shingles on a house († fig 1 Plate XIII.)

The scales are fastened as seen in † fig 2 Plate XIII. the pedicel on the bottom of the scale fits into a little socket in the wing membrane. The upper side of the scale is corred with parallel longitudinal ridges while the under side is smooth († fig 3 Plate XIII.).

There are only two general forms of scales (a and b † fig 4 Plate XIII.). Both of these are modified but (a) is modified more than (b).

1, 2, ------- 13, 14 Plate XIII † fig 4.

The highly colored scales are, in a great majority of cases, like a and modifications. The dull colors like b and modifications. Their appearance on the wings will vary with the color

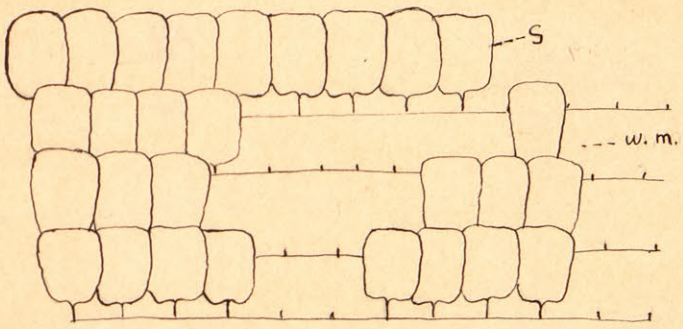


Fig 1.

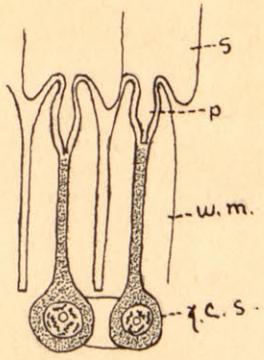


Fig 2.

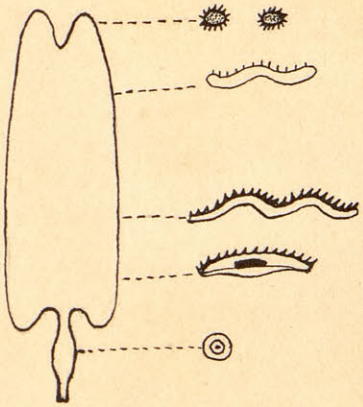
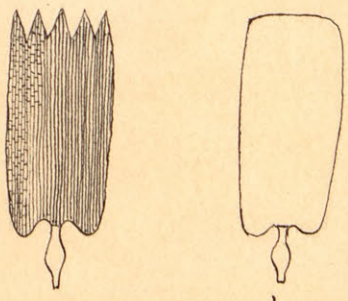


Fig 3.



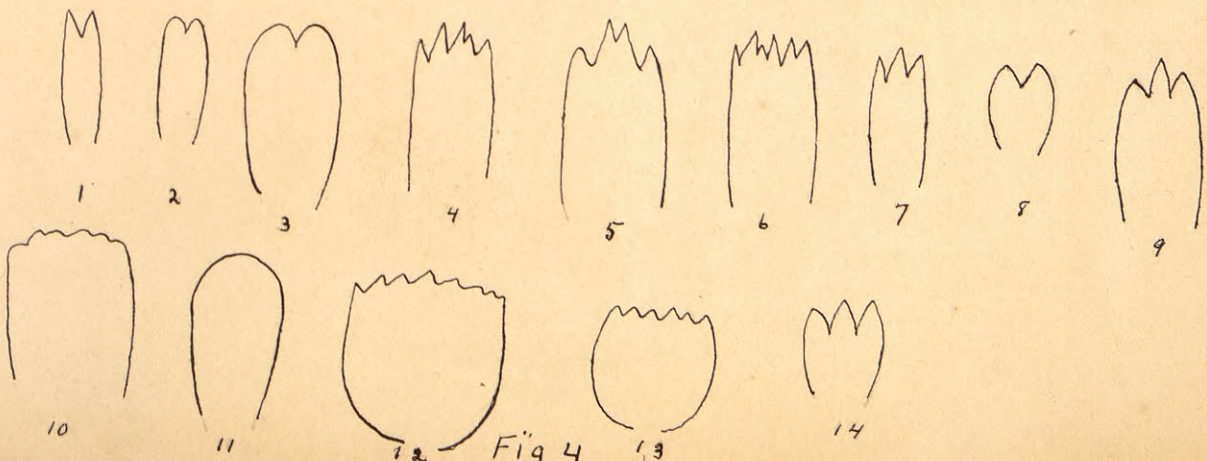


Fig 4.

The study of the Lepidopterous wing is really very fascinating and in making a permanent collection of this order it would be exceedingly interesting and add greatly to the appearance of the collection if one could spend time enough to prepare mounts of fore and hind wings of any species so as to show the formation and peculiarities of these wings.

It would also be interesting to make a few mounts of the scales to show show their form and few mounts of sections of wings to show the manner of fastening the scales to the wing.