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ON PIERIS BRYONIÆ OCHSENHEIMER, AND ITS DERIVATIVE FORMS IN EUROPE AND AMERICA.

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The species, of which *Bryoniæ* is one of the forms, is known as *Napi*, Linn, and is seasonally polymorphic, having in Europe three manifestations, *Bryoniæ*, *Napi* and *Napææ*. The last of these was until recently regarded as a distinct species, or possible species. Westwood, in 1848, is uncertain of the position of *Napææ* Esper, but thinks it is probably a variety of *Napi*, and remarks that "neither caterpillar nor chrysalis have been observed, nor have any circumstances connected with the time or place of its appearance been given," and quotes Stephens as saying: "I think with Godart that it may only be a very large variety of *Napi*, but as it appears to have characters sufficient to constitute a distinct species, the determination of this point must be left for future investigation." Brit. But., Humphreys-West wood, *Napi*. Boisduval, however, Spec. Gen. I, 518, 1836, had given the species as: *Napi* Linn.; "common throughout Europe and Siberia during summer."

Var. A. *Napææ*, "Common in the autumn."

Var. B. *Bryoniæ*, "Alps" &c.

Dr. Aug. Weismann, in his Studien zur Descendenz Theorie, part 1, Leipzig, 1875, gives excellent colored figures of these three forms in both sexes, and the plate is repeated in the English translation, "Studies in the Theory of Descent," London, 1880. In the text, Lond. ed., page 39, Dr. Weismann says of *Bryoniæ:* "This is, to a certain extent, the potential winter form of *Napi*. The male exactly resembles the ordinary winter form (*i. e.*, *Napi*, Esper) in the most minute detail, but the female is distinguished from *Napi* by a sprinkling of grayish-brown scales

over the whole of the upper side of the wings. This type, *Bryoniæ*, occurs in polar regions as the only form of *Napi*, and is also found in the higher Alps, where it flies in secluded meadows as the only form, but in other localities less isolated it is mixed with the ordinary form of the species. In both regions *Bryoniæ* produces but one generation a year, and must then, according to my theory, be regarded as the parent form of *Napi*." On page 44; "In the Alps and Jura, the ordinary form of *Napi* swarms everywhere from the plains towards the habitat of *Bryoniæ*, so that a crossing of the two forms may occasionally or even frequently take place; and it is not astonishing if in some places, Meiringen for example, a perfect series of intermediate forms between *Napi* and *Bryoniæ* is met with. That crossing is the cause of the great variability of *Bryoniæ* in the Alpine districts is proved by the fact that in the Polar regions this form 'is by no means so variable as in the Alps, but judging by about 40 to 50 Norwegian specimens, is rather constant. My friend, Dr. Staudinger, who has twice spent the summer in Lapland, thus writes in reply to my question. A crossing with *Napi* cannot there take place, as this form is never met with, so that the ancient parent-form *Bryoniæ* has been able to preserve its original constancy."

Dr. Weismann, page 40, relates how he obtained eggs from a female *Bryoniæ* in June in a secluded Alpine valley, and subjected the pupae therefrom to a high temperature in a hot-house, but only one butterfly emerged the same summer, in spite of this high temperature, and of what he regards as of more special importance, in spite of the want of cooling at night, and that this was a male *Bryoniæ*. "The other pupae hibernated in the heated rooms, and produced from the end of January to the beginning of June, 28 butterflies, all of which were exquisite *Bryoniæ*. Experiment thus confirmed the view that *Bryoniæ* is the parent form of *Napi*, and the description hitherto given by systematists ought therefore properly to be reversed. Pieris *Bryoniæ* should be elevated to the rank of a species, and the ordinary winter and summer forms should be designated as vars. *Napi* and *Napææ*."

Boisduval describes *Napi* (*i. e.*, the ordinary winter form) thus: "Wings white, with the base a little ash-colored. Primaries have the apex and ordinarily the extremities of the nervures black; the disk *sometimes without spots in the male, and sometimes with one black spot, as in Rapæ*; in the female *ordinarily two spots and a black stripe situated as in the female of Brassicæ and of Rapæ. Secondaries have a black spot on costal margin.* Under side of primaries white, with *two black spots as in the allied species*, the apex yellow; under side of secondaries of a pale yellow, with veins of blackish-green covering the nervures." Westwood says: "The males *generally have a black spot* between the middle and apex of the wing (primaries); the females have *two large black spots* towards the posterior margin, the *hinder one being connected*

with a black dash on the inner margin; on the under side the males have *two black spots* corresponding with those of the females."

Napææ, Westwood says, is of a larger size than the ordinary specimens of *Napi*, and, quoting from Stephens: "The male has the upper surface milk-white, with the tip, a spot, and two or three triangular dashes on the hind margin of the anterior wings black; *beneath two cinereous spots;* the posterior wings are pale yellowish, *with a deeper costal streak*, the basal nervule above (*i. e.*, towards costa) dilated and greenish. The female has the tip of the anterior wings *and three spots*, one of which is subtriangular, and placed on the thinner edge of the wing (the inner margin) black or dusty, and the posterior wings are clearer yellow."

Boisduval says briefly (Spec. Gen. 1,519): "*Napææ*. A little larger than *Napi;* the under side of secondaries shows only some short dusky veins extending from base to end of cell, but only towards costal margin."

Humphreys-Westwood figure and describe a small form, *P. Sabellicæ*, thought by Stephens and others to be a distinct species, described as having the veins on each side strongly margined with brown, "dark margins of the veins both on upper and under surface," but they give reasons for regarding it as a variety of *Napi*. Boisduval, in Spec. Gen., says nothing of this form, and Staudinger's Catalogue makes no mention of it. So that it would seem to be an occasional aberration, and, from the description, resembles some of the American varieties. I only know this *Sabellicæ* from H.-W., and I find in the catalogues of Kirby and Staudinger no reference to any other named variety of *Napi*. Whether *Sabellicæ* is an offshoot of the winter or summer form is not said.

Dr. Weismann sent me 1 ♂ 3 ♀ labelled "summer generation, *Napææ*, taken 30 June." The females have a large pale black apical patch, *three large deep black spots beyond cell*, the upper one partly concealed by the paler apical patch, and on costa of secondaries is a *fourth black spot* nearly as conspicuous as either of the others. On the under side are *two large black spots* on fore wing corresponding to the lower two of upper side, the upper spot of that side not being repeated. *The spot on secondaries is repeated.* Under side of secondaries pale yellow, the nervures next base bordered with brown scales most heavily on the costal side. The male has the tip largely pale black, and but one spot on fore wing, another on costa of secondaries. Beneath, primaries have *two spots:* secondaries are pale yellow, with a *deeper yellow edging to costa from base to outer angle.* I have another male which *has two spots* on upper side of primaries and a *black dash along inner margin.* This also has the *yellow edging* spoken of.

These are therefore the three forms under which the species

manifests itself in Europe, *Bryoniæ*, *Napi*, *Napææ*; of which *Bryoniæ* may be considered the parent-form, true to its type in those regions where the climate allows of but one annual generation. But in some localities, as remarked by Dr. Weismann, it is intercrossed by *Napi*, and there must be localities where two generations find existence, made up of *Bryoniæ* and *Napi* more or less intercrossed. But generally, in districts not Arctic or Alpine, the species is represented only by *Napi*, which then is the first or winter generation and *Napææ*, the later or autumnal generation.

Now let us see how the corresponding American species agrees with the European, and wherein it has come to differ.

I. BRYONIÆ. *Bryoniae* of the Arctic and Alpine type is found in America. I have seen several examples from Behring Straits, Alaska, and as they are of one type, I conclude this must there be the only form of the species. The male is white, the bases of all wings much covered with black scales; so is the costa of primaries, especially against cell and base. The apex is usually more or less blackened, and sometimes the hind margin for half its course has black about the ends of the nervules. So have the ends of the nervules on secondaries. Sometimes there is a black spot in the upper median interspace of primaries. Beneath, the hind wings are either white or faintly yellow-tinted, and the nervures and their branches are all heavily bordered with gray-brown, more heavily than any Alpine *Bryoniæ* which I have seen; (Lapland examples I know only from description); the apex of primaries is often yellow and the nervures and branches edged with brown also, but much less than on secondaries.

The female has a much crocked upper surface, the gray sometimes covering primaries almost to the exclusion of white; on secondaries the nervures and branches are all heavily bordered with gray; of four examples before me, three have a black spot in upper median interspace, another in sub-median, and in two there is a third spot in line with these near costa. The inner margins of the three are also bordered with black. The fourth example has neither spots nor border; on the costal margin of secondaries is a black spot. The under side varies from pale to deep yellow, and the fore wings of the three show the black spots, but not very distinctly. (I find the same variability in these spots in *Bryoniæ* of Europe). The Alaskan examples are all small, expanding about 1.5 inch; one ♀ 1.6 inch.

From Newfoundland, Mr. Mead brought many *Bryoniae*, all of large size, expanding 2 to 2.2 inches. The male (of a pair sent me) is white, the female pale yellow on upper side; the female not so much crocked as some European examples, but very like others, the nervures of upper side not quite so much bordered with gray as in the Alaskan examples. On the under side, like these

last, the nervures and branches are all heavily bordered with dark gray-brown, much more than in any of my Alpine *Bryoniae*. Probably Lapland examples would show this same heavy veining. Mr. Mead writes: "The dark winter form (*Bryoniae*) was caught during the last week in July (in Southern Newfoundland), but nearly all were more or less battered, and many caterpillars were nearly full grown at that time." This would make the first appearance of the early butterflies about 1st July, or last week in June. From these caterpillars Mr. Mead obtained several chrysalids, about 50 per cent. of which gave imagos between 15th and 20th August, the duration of the pupa period in such cases being about two weeks. The remainder have over-wintered. I have received from Mr. Mead 1 ♂ 2 ♀ which so emerged in August. These are of as large size as the parent-form, the ♂ measuring 2.2 inch, the two females 2 inches. The females at first glance look like ♀ *Venosa*, and in the clouding and the spots of upper side come very close to a female from Vancouver's Island. They are yellow on both sides like that, but the apical patch is more continuous, and the nervures on upperside are not edged gray. Beneath, the nervures of primaries are scarcely more gray than specimens of *Oleracea æstiva*, the few scales that are present being on subcostal and median inside the cell; secondaries are moderately edged from base to end of cell, and on the nervures the scales diminish regularly to the margin.

The male is white as *Oleracea;* no black veins on upper side; a pale gray apex to primaries, and a little black at bases of wings. Below, light yellow, immaculate, the scales as in the females.

Now clearly this form is not *Venosa*. It is the summer generation in Newfoundland; *Venosa* the winter generation in its territory. But this is between *Venosa* and the summer form of same, *Pallida*. I call it ACADICA.

Evidently, in Newfoundland there is one annual generation and a partial second generation, and the existence of the species there must mainly depend on the early chrysalids which overwinter. A favorable long summer would allow the larvæ of the second brood to go to chrysalis, but a short or cold summer would not. And, as has been observed in the case of other species of butterflies in northern regions, nature has made provision against extinction by carrying part of the chrysalids of the early generation over to the next year. This partial second generation in Newfoundland has developed a form not seen on the main land, where we find the well-defined winter form, *Venosa*, and its equally well-defined summer generation, *Pallida*. *Acadica* lies between these two, and is yet a summer form.

Of the intervening country between Northern Alaska and British Columbia we know nothing, and therefore cannot say where *Bryoniæ* becomes digoneutic, and *Venosa* comes in. But in British Columbia and Vancouver's Island we know that *Bryoniæ*

has disappeared, and *Venosa*, which is the equivalent of *Napi*, is the winter form, succeeded by a summer form *Pallida*, and the species manifests itself mostly under these two forms to its southern limit on the Pacific Coast.

Except from Alaska and Newfoundland I know of no other *Bryoniæ* having been taken.

Pieris *Hulda* I consider a modification of *Bryoniæ*. When my Catalogue was published, 1877, I had not seen *Bryoniæ* from Alaska, and did not know that it existed on this continent, and I regarded *Hulda* as the extreme arctic type of *Bryoniæ* and its American representative. All the examples of *Hulda* known to me (about 25) came from Kodiak Island, and there is probably something in the climate or food or insulation which has tended to produce this dwarf form. Both sexes expand from 1.2 to 1.3 inch, but one female is 1.5 inch. The males are white on upper side, the apical nervules edged with gray. Beneath, both sexes are alike, the color varying from white to pale and deep yellow; *and all nervures and branches are so broadly edged with ashy-brown that very little of the ground is seen, only in stripes in middle of the interspaces.* I have seen no European *Bryoniæ* whose under surface is anything like so much obscured as these *Hulda*. Three females out of four have the *nerves of upper side bordered with same brown and in same manner as beneath*, the white ground being thereby reduced merely to lines and stripes, and these examples have no spots in the interspaces like the typical ♀ *Bryoniæ*. The fourth example is a little less obscured, and has a dusky spot in submedian interspace only, and the inner margin is bordered dusky, in these respects approaching *Bryoniæ*. As stated above, the fourth Alaskan *Bryoniæ* is without spots, and therein it approaches *Hulda*. I believe *Hulda* to be the first American departure from the European type of the species. At any rate, if this form is Asiatic, as it should be, if found at all in the old world, I have no information of it. It seems as yet to be strictly American.

2. VENOSA, Scudder. This form is described as having "the extremities of upper *nervures broadly margined with black scales, with a spot of same color in the upper median interspace, a black dot at the tips of the nervures on secondaries.* The female differs from the male in having nearly all the *nervures on upper side of primaries somewhat bordered with grayish scales, but most characteristically by the presence of a band of grayish scales along the posterior border of primaries. Beneath, as in the darker forms of Oleracea*," (i. e. *hyemalis*). This describes one phase of *Venosa* ♂, and probably the prevailing one; but some males have no spot on primaries. I have seen no male *which had any spot on primaries beneath, or on costal margin of secondaries on either side*, points which are characteristic of *Napi* (or what Dr. Weismann calls "the ordinary winter form)." The *Venosa* ♂ which are immaculate above,

are nearest *Oleracea hyemalis* ♂, but the nervures are blacker in the former, and the costal margin of primaries is more extensively bordered black. *Venosa* ♀, so far as I know it, has a second spot not mentioned by Mr. Scudder, the one in sub-median interspace, as seen in *Napæ*. In this sex also my examples *show no spot beneath on either wing*, but all have a gray patch on upper side of secondaries on costa. A large percentage of female *Venosa are yellow on upper side*, another departure from the European type of *Napi*.

Comparing *Venosa* ♂ with European examples of *Napi* (winter form) sent me by Dr. Weismann, I find no tangible difference *except in the presence of the two spots on the under side of primaries and the costal patch on secondaries, which is seen on all the Napi*. All the *Napi* have one spot on primaries above, either distinct and black, or a cluster of black scales, and all have a patch on secondaries on both sides. These differences seem to be persistent, and indicate a departure in the American type. The females of the two forms differ also by the *presence of the two spots beneath* (*Napi*), *or in their total absence* (*Venosa*).

Venosa is the winter form in British Columbia, Vancouver's Island, Oregon, Washington Territory and California, and in all that region it is followed in its second generation by the summer form *Pallida*, Scudder. In the middle of the continent and to the eastward another winter form has replaced *Venosa*, viz.; *Oleracea hyemalis*. But not absolutely, for I have from Quebec a ♀ not differing in any particular from *Venosa* ♀ of Vancouver's Island. But this occasional appearance is probably owing to reversion.

Dr. Boisduval, Lep. de la Cal., p. 38, says of *Nasturtii* ♂, described as a Californian species: "Is this Pieris an American modification of our European species or a variety of *Oleracea?* It resembles much our *Napi*, from which it does not greatly differ, except that beneath the ground is less yellow, with the nervules more largely dilated . . . . and finally *because the two black spots of the upper side do not appear below*." This is *Venosa* ♂, resembling *Napi*, as I have before said, except in wanting these spots.

3. OLERACEA. The primary form throughout the polar regions of both continents being *Bryoniæ*, in the next generation there has come to be a divergence, some characters being present in the European (*Napi*) which are not found (or rarely if at all) in the American (*Venosa*), as I have shown above. But further, the American *has developed a second distinct winter form*, viz.: *Oleracea hyemalis*, originating apparently with the immaculate males of *Venosa*. That *Oleracea* was considered by Dr. Boisduval as peculiar to America is evident from his description, Spec. Gen. 1, p. 518: "*Oleracea:* Upper side absolutely as in our *Napi, but without any black mark, so that the four wings are wholly*

white, with the base of primaries a little blackened. Under side as in *Napi except that there are no black spots, and that the origin of costa of secondaries is a little saffron colored. It replaces in the U. S. our Napi.*" Boisduval, in describing *Napi*, says nothing of yellow or orange at the origin of costa of secondaries. When he speaks of *Bryoniæ* he gives that character, "almost always a little saffron colored." I find some European *Napi* without any shade at base of costa deeper than rest of the wing, others with a deeper yellow there, and in three examples the yellow deepens to pale orange. This orange shoulder is a persistent character in *Oleracea hyemalis*.

Dr. Harris described *Oleracea* in N. E. Farmer, and also in Ins. Mass., thus: "Wings white, dusky next the body; the tips of the upper ones yellowish beneath, with dusky veins; under side of hind wings straw-color, *with broad dusky veins, and the angles next the body deep yellow.*" This is *Oleracea hyemalis*.

In Agassiz' Lake Superior, Dr. Harris says: "*Oleracea:* Wings yellow-white, the anterior pair dusky on the front edge and base; tip beneath pale yellow with dusky veins, under side of the hind wings pale yellow with broad dusky veins and *a saffron-yellow spot in the humeral angle.* The tip of the fore wing is often marked with two or three dusky stripes in the males. (The dusky veining of the hind wings is less distinct in the females than in the other sex, and is sometimes entirely wanting. Specimens of the females have been seen, though rarely, with one or two dusky spots on the upper side of the fore wings). The last clauses, which I have enclosed in parenthesis, describe the summer form of the female, but the description of the male is of the winter form.

I am familiar with *Oleracea* as it appears in the Catskill Mountains of New York, having observed it at different seasons of the year, and bred the larvæ from eggs laid by females in confinement. The male of the typical winter form has the bases of the wings largely blackened, the costa of primaries heavily edged with black, and the apex more or less so; the anterior nervules are apt to be edged with black. The under side is either white with the faintest tint of yellow, or secondaries and the apical area of primaries are decidedly yellow, and individuals vary between these extremes. The nervures and branches on secondaries are bordered with gray-brown, sometimes heavily, sometimes moderately; so are the nervures of primaries moderately edged. The shoulders of secondaries are saffron or deep orange-yellow. Sometimes there is an indistinct spot on fore wings of male, usually a mere cluster of scales. The females are colored like the males, but have the gray at base of primaries more extended; so also along costa, but otherwise they agree with the males on both surfaces and vary in precisely the same manner.

But in the southernmost range of the species, where there is

more than one annual generation, some of the early or winter butterflies assume characters of the summer generation, due doubtless to intercrossing, which must take place, as belated individuals of the first brood would be on the wing when the earlier of the second brood appear. In my own experience I have had both heavy-veined and very light-veined butterflies in the spring from chrysalids of same brood of preceding year from the Catskills. Mr. J. Alston Moffat, of Hamilton, Ontario, has sent me 3 ♂ 2 ♀ taken by him between 13th and 26th May, 1877, and therefore of the first generation of the year. One male and one female have the veins moderately heavy; 2 ♂ 1 ♀ light, and like the usual summer generation. And Mr. Moffat wrote that he had 5 ♂ 1 ♀ remaining, caught at same time, of which two males were heavily shaded, one remarkably so, two lightly shaded, and one had the shading scarcely visible, and that the female corresponded to this last male in the light shading.

Although *Venosa* is the winter form of the Pacific Coast, yet occasionally an *Oleracea hyemalis* is brought in by collectors. I have one male taken in 1880, by Mr. H. K. Morrison, on Mt. Hood, Oregon, of the extreme type, so far as indicated by the under surface, which is as heavily veined as a male of *Frigida* sent me by Mr. Scudder. Placed side by side I can see no difference between the two on this surface. But the upper side is neither grimy nor black-veined, like *Frigida*, and is like *Oleracea* of New York.

How far to the north we must go to find *Oleracea* monogoneutic I am unable to say. Kirby says that 3 ♂ were in the collection made by Richardson and submitted to him, and that these came from lat. 65°, which would be not far from the mouth of Mackenzie's River. What is remarkable is that *all of these were of the summer type*,* with merely a few scales on the nervures of secondaries below. This would imply that two generations fly at that high latitude, almost at the Arctic sea. On the other hand, I had, several years ago, from Mrs. Ross, of Fort Simpson, on Mackenzie's River, about 62° lat., a large number of specimens of *Oleracea*, all more or less heavily veined, the winter type. These were the Slave Lake examples referred to by Mr. Scudder in his paper on North American Pierids, 1861, in which he says that the indications therefrom are "that the paler forms are more commonly met with in the more southern localities, and the more heavily marked ones are the characteristic forms of the north." If one might hint that there was a mistake in labelling those pale butterflies of Richardson, the mystery would be cleared up, and otherwise I do not understand at all how *Casta*, Kirby, could be found at so high a latitude. A very large part of the lepidoptera described by Kirby are stated to be from Canada and other more southern localities. I have now before me five males of this lot from

Casta, Kirby, being synonymous with *Oleracea æstiva*.

Slave Lake, and they are alike, immaculate, and heavily veined on under side. I have no female from Slave Lake to compare with others.

Several males from Godbout, Pr. Quebec, and from Anticosti, are like the Slave Lake examples, and four females from Anticosti are immaculate, and like the males, heavily veined, etc. These are *Oleracea* var. *Borealis*, Grote, Bull. Buf. Acad., 1873; described as having "the markings on the wings much darker and broader than usual, especially beneath." I had both the Godbout and Anticosti examples from Mr. William Couper, who spent two summers on the island and visited Godbout, which is on the main land, north shore of the St. Lawrence. As Mr. Couper did not meet with *Bryoniæ*, it cannot inhabit Anticosti, although that island is but one hundred miles from Newfoundland. This var. *Borealis* is of great interest in one respect. On the Continent we do not know where *Oleracea* becomes single-brooded. In New York and Canada it is double-brooded. It may be single or double at Slave Lake; except for Kirby's statement the evidences are in favor of its being single. At Godbout, where the snow lies nine feet deep in winter, and the summers are short, probably it is single. But in Anticosti, we know from Mr. Couper that the summer embraces only part of June and all of July, and that by 1st August the weather is turning cold. And it is his opinion that no species of butterfly on that island has more than one generation. Originally coming from the main land, *Oleracea*, whatever were its habits there, is, or becomes, single-brooded on the island, and breeds true to one type, the heavy veined extreme variety of the winter form. *Bryoniæ* in Newfoundland is a relic of glacial times, maintained by its insulation.

Frigida, Scudder, seems a little removed from typical *Oleracea hyemalis*. It is described as coming from Cariboo Island, Labrador, 2 ♂.2 ♀. The nervures of both wings are said to be more heavily marked than in the darkest individuals of *Oleracea;* "the black scales at base on upper side are more profuse and more widely spread, frequently bordering the nervures quite heavily; indeed, gray scales are more or less scattered over the whole upper surface, giving the insect a grimy appearance, increased by the slightest possible yellow tint." "The extreme limits of variation of *Oleracea* do by no means permit us to include within its boundaries this form; it is more heavily marked than the extremes of *Oleracea*." It is also stated that the hind wings of the male "are proportionately narrowed across the hind margin, and broader across a line parallel to it, near the base of the wing, than in male *Oleracea;* or, in other words, *the secondaries of Frigida are relatively more quadrate and those of Oleracea more triangular.*" No special mention is made of female *Frigida*, and it is to be presumed that in general it resembles the male. In reply to a recent note on this subject, Mr. Scudder says: "I have only 2 ♂,

no ♀. The ♂ is like *Oleracea hyemalis*, but is duller, yellower, *and has longer hind wings with much longer discoidal cells.*" In originally describing this form Mr. Scudder had before him my Slave Lake examples, and when he says that *Frigida* "is more heavily marked than the extremes of *Oleracea*," he included in this last individuals as extreme as var. *Borealis*. *Frigida* is another island form brought over from the main land, beyond doubt single-brooded, and seems to have acquired some peculiarities of its own.

The summer brood, *æstiva* of *Oleracea*, is often of larger size of wings, and the wings are thinner, and purer white on upper side than in *hyemalis*. So the base is less obscured, the costa, apex and hind margin not at all. On under side it is either white or delicate yellow; the veins of both wings are but scantily edged with brown scales, and often not at all over considerable areas. The females have the basal and apical areas pale gray, and not infrequently there is a trace of the spot of *Napi* on upper median interspace. Sometimes also a trace of the second spot (in sub-median interspace), and of the gray bordering to inner margin of primaries. The veins beneath are rather more edged with brown scales than in the male. The shoulders of hind wings are of a *very pale yellow* (in *hyemalis* decidedly yellow or saffron), and often there is no color at all. There is some difference in the shape of the wings in each sex, some individuals having the apex of primaries more rounded than others, and secondaries more narrow.

I have found that eggs laid by females of *hyemalis* in confinement produce the same season butterflies, *aestiva*, and that eggs laid by *æstiva* produce the following spring *hyemalis*. But in one instance from eggs of *æstiva*, laid in the Catskills, there emerged, at Coalburgh, the following March, *two butterflies, one of which was* as *true æstiva as the parent, the other hyemalis.*

The summer form is identical with *Casta*, Kirby, described as having the wings white; black scales sprinkled over costa of primaries; secondaries beneath, with a few scattered black scales along the nervures. The female *Oleracea* of Harris, in Agassiz' Lake Superior, is this *æstiva*, as before mentioned.

Boisduval also described P. *Cruciferarum*, Spec. Gen., 519, ♂. A little smaller than *Rapæ*. "Upper side of the wings almost the same white, immaculate; primaries having only the anterior third of the costa and a part of the base dusted gray. Under side of secondaries and summit of primaries washed with very pale sulphur-yellow; secondaries have the origin of costa of a light yellow-orange. *It replaces our Rapæ in the middle U. S.*" As *Rapæ* was then (1836) unknown in N. A., this could only be *Oleracea æstiva*. That is, it is the summer generation of what Boisduval had before described as *Oleracea*.

Venosa, therefore, represents *Napi* (winter form) at the extreme west, and *Oleracea hyemalis* represents the same *Napi* to the eastward, in almost all known localities. Specimens from

Nevada and Colorado are usually immaculate and not distinguishable from *Oleracea hyemalis*. This form and typical *Venosa* are considerably unlike, but their summer generations approach and are often precisely alike. The summer generation of *Venosa* is *Pallida* Scudder, described; ♂ as "immaculate, yellowish beneath, with sometime a few indistinct grayish scales scattered along the nervules; otherwise quite immaculate. The female has, in addition, a *band of grayish scales on the posterior border of primaries*, and *a spot or cluster of grayish scales in upper median interspace.*" All this is but the description of many examples of *Oleracea æstiva* ♀, and of all males. But the variety of the summer form of *Venosa*, which has a black spot on primaries, was not before Mr. Scudder when he drew up his description. This is *Castoria*, Reakirt, the male only described; it is said to have "*a rounded black spot on the medio-superior interspace of primaries;* no other markings; underneath immaculate." *Castoria*, then, is one sub-form, *Pallida* the other, and both undoubtedly appear in same brood, *i. e.*, in the generation following and proceeding from *Venosa*.

Of four ♂ under view from Lake Lahache, Brit. Col., 2 are immaculate (*Pallida*), 2 have a light spot (*Castoria*). I have but one ♀ and that has no spot, but the marginal border is gray. From Vancouver's Island 1 ♂ is immaculate, one has half a dozen scales only in place of a spot; but a third ♂ has a black spot. With these are 2 ♀ and both have the two spots of *Napi* and dark border. 1 ♂ from Oregon is immaculate. Four males from Washington Terr. are immaculate; but the 2 ♀ with them have both spots and the border. *One of these is yellow on upper side.* Two males from California have the upper spot only, their females both spots and the border. One female from southern Colorado has both spots and border, but the males accompanying are immaculate, and may be called either *Pallida* or *Oleracea æstiva*.

It appears therefore that while several males from the Pacific coast, under view, are immaculate (*Pallida*), about one-half have the spots in greater or less degree (*Castoria*), but that all the females except one have, on the upper surface, the spots and dark border to primaries which characterises *Napi*, and the one exception has the dark border. One female *Pallida* from Washington Terr. is of a pale but decided yellow on both surfaces—another departure. I have noticed this in no *Oleracea æstiva*. Just as from *Rapæ*, in New England, there has developed a yellow form, the *Nova-Angliae* of Scudder.

We have seen then that starting with the common form *Bryoniæ*, the next generation, *Napi* in Europe, *Venosa* in America, differs perceptibly. Also that *Venosa* has an offshoot in *Oleracea hyemalis* which occupies a more extensive territory than the parent. Now the second generation of these two, which corre-

sponds to *Napææ*, is far removed from that form. *Pallida* ♂ is immaculate on both sides, its co-form *Castoria* has a spot on primaries, otherwise immaculate on both sides. The common ♀ has a gray border to inner margin of primaries, and a spot on same wing: otherwise immaculate on both surfaces. *Oleracea æstiva* ♂ is immaculate on both surfaces, the ♀ also, except that a few scales sometimes suggest a spot on upper side, and sometimes there is a slight and pale bordering to inner margin.

But *Napææ* ♂ has *one or two black spots* and marginal border, *two spots on under side, a spot at outer angle of hind wings on both sides; the whole costal edge on under hind wing deep yellow*, things never seen in American examples. The ♂ *has two or three large and deep black spots, &c.* In fact, THE ♂ NAPÆÆ RESEMBLES BRASSICÆ ♂ MORE CLOSELY THAN IT RESEMBLES THE FEMALE OF THE CORRESPONDING AMERICAN FORM.

4. VIRGINIENSIS. I described this form as Pieris *Virginiensis* in Butterflies of N. A., vol. 1, and gave accurate figures of both sides of both sexes. The male above is more or less obscured by brown, or dusted with brown, and often to a considerable degree. In some examples the brown scales are scattered over the whole surface, but are dense on apex, costa and basal half of primaries, and at base and along the principal nervures of secondaries; a gray patch also on costa of secondaries. Under side *always white* (*Oleracea* and *Pallida* are most often yellow), the *nervures and branches bordered with ashy-brown of a shade not found in any American form except Hulda.* Individuals vary in the extent of this brown, from slight to very considerable. The female has the upper surface more obscured, and the brown edging to the nervures and branches is sometimes so extensive as almost to conceal the ground color, as in *Hulda*. *Virginiensis* is smaller than *Oleracea*, the males averaging 1.7, and no female examined expanding over 1.9 inch. The wings as a rule are longer and narrower than *Oleracea*, though the latter, as before stated, varies in this respect; and they are delicate as in *Oleracea æstiva* if any thing more delicate and thinner.

The first examples of *Virginiensis* ever seen by me were received from Mr. Wm. Saunders, the ♂ having been taken in Ontario, the ♀ at Quebec. They were sent as *Oleracea* with several of the latter. I have three males from north and south Colorado. In my collection I have 12 examples, 5 being those mentioned, and 7 from Coalburgh. Mr. Mead has taken a female at Stony Clove, Hunter, N. Y., on the Catskill Mountains.

For several years, and up to 1872, a few individuals were taken at Coalburgh in each year, usually in April, once in last half of March, and once only in May, and there was no other Pieris flying at the same season in these years except *Vernalis*, the spring form of *Protodice*, and that was seen very rarely, some years not

at all. The dates of capture of *Virginiensis*, or when they were seen, but not captured, are recorded in my journal thus:

1867,	11th	April	took 1 ♂.	1871,	20th	March	took 1 ♂
	21st	"	" 2 ♂.	"	7th	April	saw 2 ♀
1868,	24th	April	" 1 ♀.	"	8th	"	saw 1 ♂
1869,	25th	"	" 1 ♂.	"	9th	"	took 4 ♂
	28th	"	" 12 ♂.	1872,	17th	"	" 1 ♂
1870,	15th	May	" 1 ♀.	"	29th	"	" 5 ♂

The spring of 1870 was cold, and we had ten inches snowfall on 18th April. In 1871, on the other hand, we had fine weather all through March, and peach trees were in bloom on the 11th. Therefore the appearance of *Virginiensis*, so early as 20th March, 1871, and so late as 15th May, 1870, is accounted for. Strictly, it is an April butterfly, coming with the early flowers.

No second generation appeared here in these years. In the first place, it is hardly possible that I, myself, should have failed to take or see individuals of a later generation if there were any. One single example during these six years would have served to attest the existence of a second generation. Also, I had boys in my employ instructed to take everything; and of *Virginiensis* subsequent to May, or of a second generation, none appeared in their collectings. In the next place, between 1867 and 1872, the late Mr. Ridings, a most indefatigable collector, spent one whole season here, and again the month of September. Mr. Julius E. Meyer, a month in midsummer of two years, and again in September. Mr. Mead collected here repeatedly, both before and after 1872. All these gentlemen were experts with eye and hand, and thoroughly acquainted with North American diurnals, but no one of them found an example of the second generation of *Virginiensis*. Therefore I assert with confidence that such a generation has no existence here.

In 1874, *Rapæ* first made its appearance in this valley. I recorded as follows: 1874, 17th September, "took 1 ♂ *Rapæ*, the first of this species ever seen here by me." On 6th Oct., "saw several *Rapæ*.' In 1875, 8th April, "saw several *Rapae*," and from that day to this the species has abounded all the season. I was absent from home from 1st April to 15th May, 1873, and so know nothing of *Virginiensis* that year; but since 1873 I have not seen one example, though I have carefully sought for it in the hope of breeding from the egg, and so learning its history.

But so long as *Rapae* is a thousand to one, the weaker species will be overlooked at least, being undistinguishable on the wing among so many white butterflies of same size, and probably will soon become extinct. Perhaps it is already extinct in this locality. I hear from Massachusetts, New Hampshire, New York and Canada, the same story of the absolute disappearance of *Oleracea* where, fifteen years ago, it abounded, before *Rapæ* had conquered the country.

I have no information as to the month in which *Virginiensis* has been taken in any northern or western locality, except in the one instance spoken of, when Mr. Mead captured a female, which was in the last week of June, 1873, in the Catskills. This was undoubtedly one of the first generation. (Stony Clove has an elevation of 2,500 feet, and the trees there are not fully in leaf before June.) Mr. Mead set this female in a bag on the food plant and obtained many eggs. In a letter dated July 10th, he says he had then but one larva, one quarter grown, which would be after the second moult. July 18th, he had sent the chrysalis from this larva to Miss Peart for a drawing, and the drawing I have. Mr. Mead informs me that from this chrysalis emerged *Oleracea*.

We must conclude, therefore, that *Virginiensis* is an offset of *Oleracea hyemalis*. It is singular that it should be so, differing as this form does from *hyemalis* in *the delicacy of the wings, their pure white color beneath, and in the paleness of the yellow humeral border*. All which is in direct contrast to *hyemalis*. So the wings are narrower than in *hyemalis*, and the gray brown dusting and bordering of the nervules is in strong contrast with the same form. It would seem in several respects more likely to have come from *æstiva*. In West Virginia, this form *Virginiensis* is also of the winter generation, and breeds true to its type, as appears by all the examples taken during a series of years. As I have said before, it has no second brood in Virginia. The offshoot of a polygoneutic species has become single-brooded or monogoneutic. This is probably the result of climate. *Oleracea*, *Napi*, *Bryoniae*, all are northern forms. The fauna of this region is southern, whether botanical, ornithological or entomological, or at least much more southern than northern, and the long hot summers are not favorable to this Pieris. The mild winter permits a modified form, more like the summer generations of the north than the winter generation, and this is held true to type by there being no second brood.

The first or original winter form, *Bryoniæ*, was left in the sole possession of its arctic territory, after, by its southward emigration, a climate had been reached which allowed two annual generations to mature, and what then began as the summer form ended by displacing its parent over the sub-boreal regions, and itself became the second winter form, *Venosa;* developing a second generation of its own, *Pallida*. But, collaterally, through *Oleracea hyemalis* comes *Virginiensis* which along the southern limit has in its turns displaced *Venosa*, being in sequence of derivation the third winter form. But this has no second generation, and in habit is like an *Anthocharis*, in which genus the butterflies appear in spring, and have no second brood, all the chrysalids going over to the next year. In fact, *Virginiensis* has parted company with *Venosa* and the rest, and has become a true species, although unquestionably, in a higher latitude, it appears as an occasional aberration only of *Oleracea*.

The chrysalis of *Virginiensis* as appears by the colored drawing spoken of is of precisely the same shape as that of *Oleracea*. It has a minimum of black dots over its surface. On the other hand the chrysalis of *Bryoniæ* from Newfoundland shows a maximum of these dots, and several little dusky clouds or spots, as might be expected from the clouded and spotted wings which are to issue therefrom. The chrysalis of *Venosa*, from California, comes next to *Bryoniæ* in these marks: that of *Oleracea* var. *Borealis*, from Anticosti, having few marks, like *Oleracea* in New York. I have drawings of all these; and of all but *Virginiensis* have preserved chrysalids also. There is not the least difference in shape in these chrysalids.

We are now prepared to tabulate the American forms derived from *Bryoniæ*, and I contrast them with the corresponding European forms:

EUROPEAN.	AMERICAN.
1. Arctic form BRYONIÆ, Ochs.	1. Arctic form BRYONIÆ, Ochs. var. HULDA, Edw.
2. Winter form NAPI, Esper.	2. 1. Winter form VENOSA, Scud. *Nasturtii*, Bois. aberr. ♀ FLAVA. 2. Winter form OLERACEA HYEMALIS, Harr. *Oleracea*, Bois. var. A. BOREALIS, Grote. " B. FRIGIDA, Scud. aberr. VIRGINIENSIS, Edw.
3. Summer form NAPÆÆ, Esper.	3. 1. Summer form ACADICA. 2. Summer form *a*. PALLIDA, Scud. *b*. ♂ CASTORIA, Reak. aberr. FLAVA. 3. Summer form OLERACEA ÆSTIVA, Harr. *Casta*, Kirby. *Cruciferarum*, Bois. 4. SPECIES (Southern) VIRGINIENSIS, Edw.

I believe this to be an accurate statement of the phases of the American forms derived from *Bryoniæ*, and it is based on my own acquaintance with them. Not being so familiar with the European derived forms, and restricted to descriptions, plates, catalogues and such specimens as I could collect by the aid of friends, I can only give the three principal and well-known manifestations, doubtless omitting some important variations not named. But the general statement on one side, and the particular one on the other, are sufficient to show how climate and environment affect the descendants from a common parent-form. How the differences, at first slight, gradually become

considerable, and at last the outcome of the derived forms on the two continents is distinct, the late descendants being parted by specific differences. How an aberration leads to a permanent variety; how insulation produces permanent varieties; how a variety becomes a species, breeding true, not subject to reversion, and adapted by change of habit to altered circumstances

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NOTE.—Since this paper was put to press, I have received from Dr. Staudinger 2 ♂ and 2 ♀ of Lapland *Bryoniæ*.

One of the males has the nervules and branches of under side of secondaries bordered with brown in same manner as the Alpine examples spoken of; but the other has an excess of the brown edging, so that nothing of the ground color of the wing is seen except a narrow stripe in cell and streaks in the interspaces of the nervules. In this respect this example resembles *Hulda*.

NOTE ON PLATES.—These were drawn and printed in London, and no opportunity for correction of errors could be given. Figs. 7, 11, and 13 would represent the forms as having black spots on under side of primaries, contrary to the statement of the text. The artist has mistaken discoloration caused by the transparency of the wing, and only apparent when held to the light, for spots; but in all these butterflies the surface is absolutely free from black scales at the points indicated, and is white or yellow, whereas in *Napi* and *Napææ* the black spots of underside are caused by black scales laid on.

DESCRIPTION OF PLATES.

PLATE 2.

WINTER FORMS.

EUROPEAN.

1. *Bryoniæ* (Alps) ..... ♀
2. *Napi* (Germany) ..... ♂
3. *Napææ* " ..... ♀

AMERICAN.

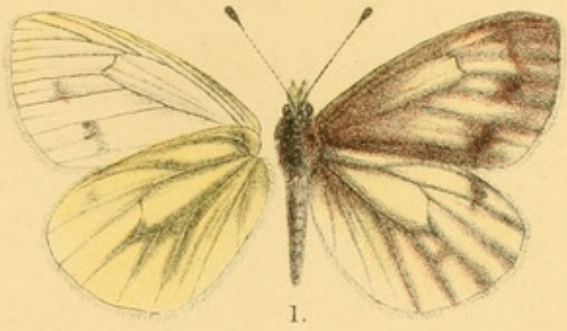
4. *Bryoniæ* (Newfoundland) .. .. ♀
5. *Hulda* (Alaska, &c.) ..... ♀
6. *Venosa* (California) ..... ♂
7. " " ..... ♀
8. *Oleracea hyemalis* (New York).. ♂
9. *Borealis* (Anticosti) ..... ♂

PLATE 3.

SUMMER FORMS.

AMERICAN.

10. *Acadica* (Newfoundland) ..... ♂
11. " " ..... ♀
12. *Pallida* (Vancouver's Island).. ♂
13. " " " .. ♀
14. *Castoria* (California) ..... ♂
15. *Oleracea æstiva* (New York)... ♂
16. " " " ... ♀
17. *Virginiensis* (Coalburgh, W. Va. ♀
18. " " " .♂



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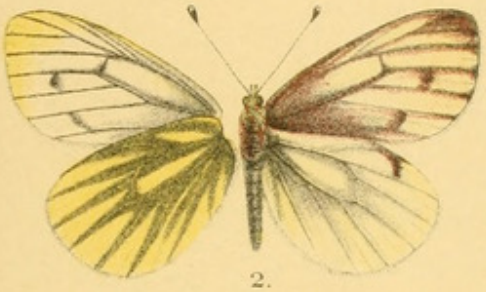

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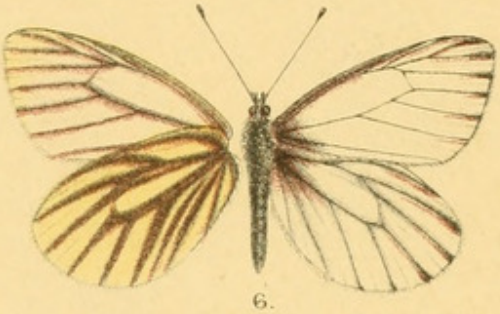

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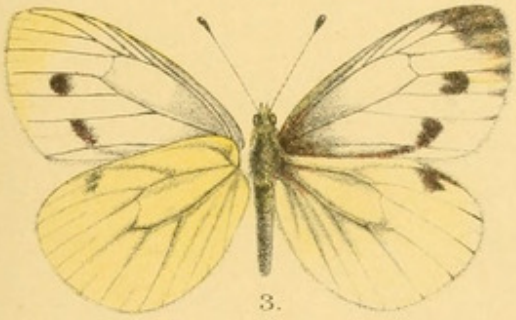

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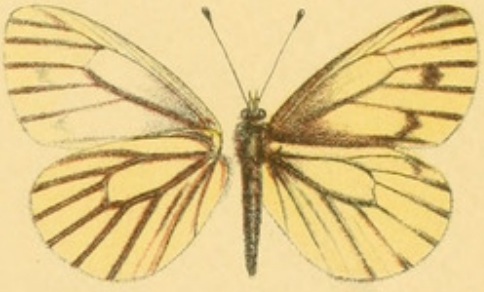

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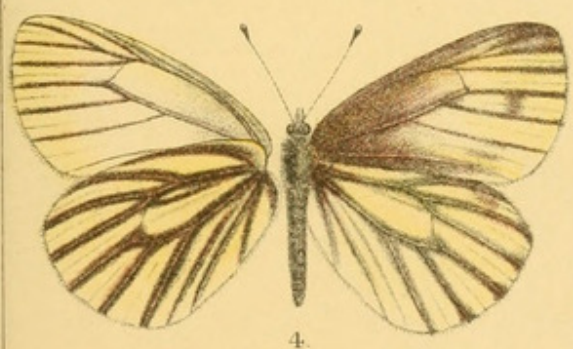

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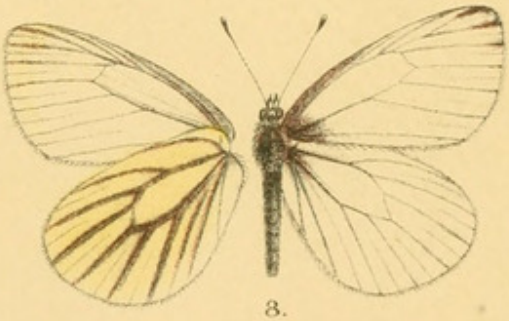

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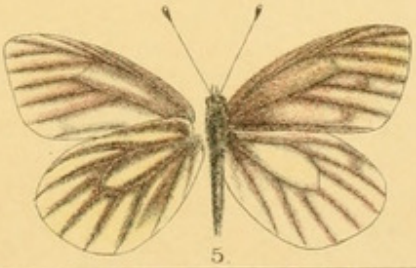

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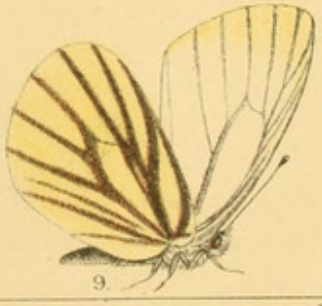

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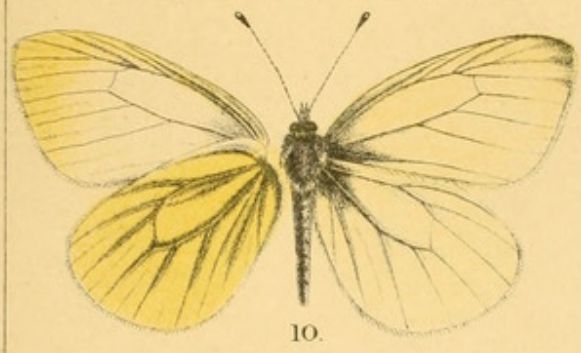

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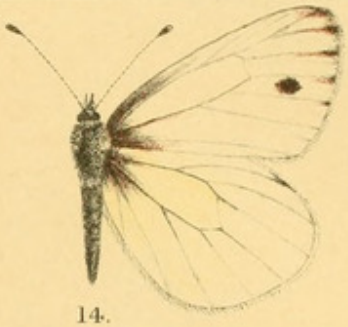

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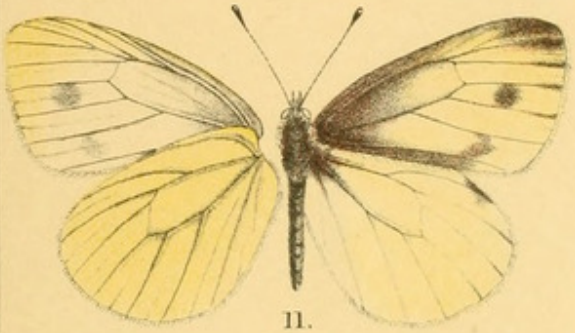

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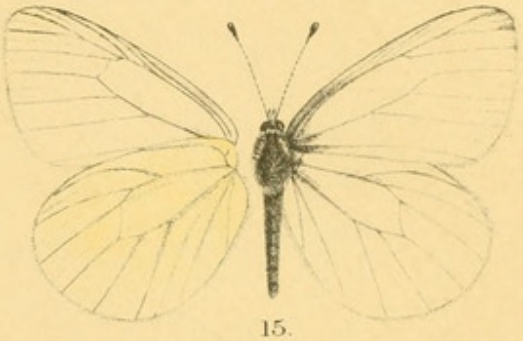

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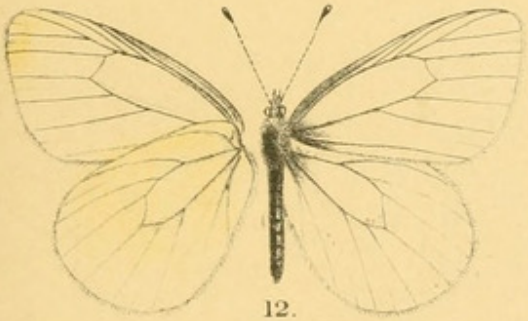

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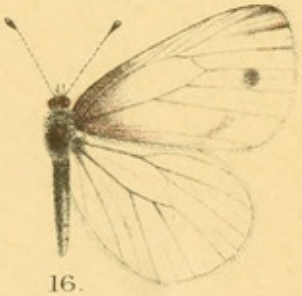

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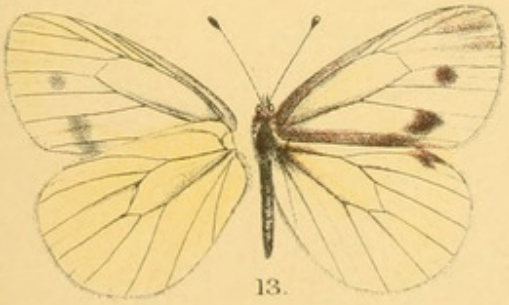

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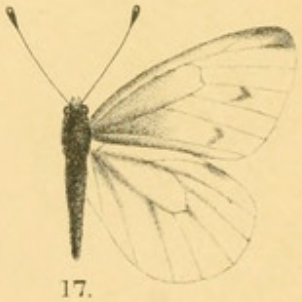

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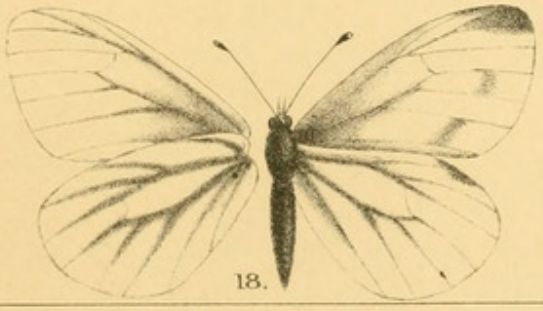

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