

A. Stupka

ARTHUR STUPKA

FRAGRANT BUTTERFLIES

BY

AUSTIN H. CLARK

FROM THE SMITHSONIAN REPORT FOR 1926, PAGES 421-446
(WITH 13 PLATES)



(PUBLICATION 2901)

UNITED STATES
GOVERNMENT PRINTING OFFICE
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PREFACE

Surprisingly few naturalists seem ever to have noticed that the males of many butterflies give off a pleasant fragrance similar to and rivaling in attractiveness that of the scented flowers. This is the more remarkable since some of the most fragrant sorts are among the commonest species almost everywhere.

There are two reasons why we know so little of the odors of our butterflies. In the first place, most people interested in the butterflies regard them more as natural works of art than as the insects that they are, and therefore pay but slight attention to anything further than the form and color and the seasonal occurrence and general habits of the adults.

In the second place the adult nose is a quite uncertain organ, especially in men, and the testing of a butterfly often results in nothing more than a fit of sneezing caused by the irritation of the loosened scales.

The sense of smell in children is much keener than in adults, and they easily detect faint odors that escape their elders. It is also

more exact, and if their previous experience with odors has been adequate their comparisons are likely to be closer.

The information on our native butterflies in the following pages was brought together with the assistance of my two young sons, Austin B. J. Clark and Hugh U. Clark, whose assistance in experimenting with some scores of captured butterflies was of the greatest value. On our various excursions in the field it fell to them first to investigate the butterflies we caught. In most cases I could myself confirm their observations, but in some I was quite unable to perceive an odor which both of them assured me was quite strong.

Ordinarily the testing of the butterflies for odors is an interesting and a pleasant task, but one must always be prepared for surprises sometimes most unwelcome as in the case of the females of the fritillaries.

SOURCES OF THE MALE FRAGRANCE

The flowerlike odors of male butterflies usually have their origin in hairs or scales of a peculiar type called androconia found only in the males, grouped in special "brands" or patches in various locations on the wings, distributed along the veins, or scattered widely on their upper surface. In the males of a species of *Melete* from Brazil, Fritz Müller found that a rather strong odor was emitted by a pencil of nonretractile hairs protruding from the ventral side of the abdomen. In the skippers the scent-emitting hairs are sometimes placed upon the tibiae of the hindmost legs.

In our common milkweed butterfly (*Danaus archippus*) the males possess, besides the scent scales in the little sack on the hind wings, an extensible brush of hairs on either side of the last segment of the body which when fully extended radiate in all directions. In various related species these hairs are borne upon the inner end of a more or less long tube extending into the body within which the hairs form a compact tuft ensheathed by the tube walls. This tube can be everted or pushed outward in such a way that the inner end now becomes the tip of a more or less elongate fingerlike process bearing a tuft of radiating hairs.

Similar organs are found in the *Euplaeas* (fig. 44, pl. 9; fig. 55, pl. 12) of the Old World regarding some species of which de Nicéville says: "The males may often be observed patrolling a small aerial space, with the end of the abdomen curled under the body toward the thorax, and with the two beautiful yellow anal tufts of long hair distended to their fullest extent at right angles to the body." The males of the related *Itunas* and *Lycoreas*, and the gorgeous males of *Morphos* and of their more somber eastern representatives, all have similar extensible appendages. In some forms it has been determined that a strong odor is given off by these.

DELAYED APPEARANCE OF THE PERFUME

Various observations giving negative results have been recorded on butterflies remarkable for their strong fragrance. In some cases it is stated that the examination was made on males recently emerged from the chrysalis. Very fresh butterflies appear always to be nearly, often indeed quite, odorless, while very ragged individuals sometimes are very fragrant. It appears to take some time after the wings are fully formed and functional for the odoriferous secretion to become diffused sufficiently to give the characteristic perfume.

OTHER ODORS EXHALED BY BUTTERFLIES

Besides these pleasant odors arising from the hairs and scent scales and confined, or almost entirely confined, to males, there are also other sorts of odors possessed by butterflies.

If you take a living female of any of our common fritillaries (*Argynnis cybele*, *A. aphrodite*, *A. atlantis* [figs. 57, 58, pl. 13] or *Brenthis myrina*) and gently squeeze the abdomen there will appear from between the last two segments on the upper side a double patch of soft dull light orange tissue. On further pressure there suddenly pops out just in front of this a pair of thick blunt processes like short thick horns which give off a strong and nauseating smell resembling that of the forked red or orange organ which the caterpillars of all of our swallowtails protrude from the first thoracic segment when they are disturbed.

Among the heliconians of the American tropics, close relatives of the fritillaries, the females have similar organs, though not quite so large, which also give off a disgusting smell.

The males in both these groups have a single unpaired organ of the same nature which is very small and situated between the upper ends of the terminal valves where in our fritillaries it is very noticeable because of its bright orange color.

In the females of some pierids, as *Catopsilia* (fig. 14, pl. 2) and *Melete*, there are organs like those of female fritillaries which give off a peculiar odor.

In one of the nymphaline butterflies (*Didonis*) both sexes from the upper side of the abdomen between segments four and five extrude hemispherical protuberances which have a strong and rather disagreeable smell. The male has in addition a pair of similar protuberances, white in color, which are extruded between segments five and six and give off an agreeable odor comparable to that of heliotrope.

In various forms the insects of both sexes give off a rank, mouldy, cockroachlike, or similarly disagreeable, in rare cases pleasant, odor,

which is usually stronger in the females, and in the males often is combined with a wholly different sweetish scent. An example is our common milkweed butterfly.

A rank and disagreeable odor is in certain species common to both sexes when freshly dead, though not in life.

Some butterflies, like the Old World purple emperors, the various species of *Charaxes*, and certain swallowtails, which are immoderately fond of excrement or of rotting flesh, occasionally proclaim their preferences in the odors they exhale, though these do not properly arise from them themselves.

APPARENTLY SCENTLESS BUTTERFLIES

There are certain of our common butterflies with a great development of scent scales in which as yet no odor has been found. One of the most conspicuous of these is *Cercyonis alope* (fig. 35, pl. 6). This at any rate must have an odor, though I have been quite unable to find any in either sex. Mr. Scudder also was unable to find any odor in the three species of *Eneis*, of the same family, examined alive by him. So far I have found no odor in our common orange-tip (*Anthocharis genutia*, figs. 10, 11, pl. 2), though it probably has one.

THE ODORS OF BUTTERFLIES BY GROUPS

Pierids.—Of all the larger groups of butterflies the pierids are the most remarkable for the very general occurrence and the strength and uniformity of scent in males. Its presence has now been well established in about 80 different species. Furthermore it has been found among these butterflies that closely allied forms may have quite different scents. One of the best examples of this is found in our common whites.

Mr. Scudder wrote that among our common whites the males of the common cabbage butterfly (*Pieris rapæ*, fig. 1, pl. 1) "have a very faint but pleasant odor, difficult to detect. I have sometimes done so, but at other times have been unable to perceive it, on rubbing the scales of the upper surface of the wings and immediately smelling the fingers." More recently Doctor Dixey, Mr. Longstaff, and others have determined from studies made in England that the males of this butterfly have a scent, though it is neither so strong nor so distinctive as that of the green-veined white (*P. napi*, fig. 2, pl. 1). Originally Doctor Dixey compared the scent to that of mignonette (*Reseda odorata*), but Mr. Longstaff says that Prof. Selwyn Image's comparison to sweetbriar is better, though that is not exact.

Mr. Scudder found that the males of our native gray-veined white (*P. oleracea*) have a more distinct odor than those of the imported European white, though it is still faint. It is, too, quite a different odor, and he compared it to the fragrance of syringa blossoms. Mr. Longstaff, who examined this species at North Bend, B. C., compared the odor to that of lemon verbena.

Quite a fragrant little butterfly is our common sulphur (*Eurymus philodice*, fig. 7, pl. 1; figs. 20, 21, pl. 3), the males smelling like dried "sweet grass" or like sweet hay. This odor is fairly strong, and apparently it is constant and quite uniform, as I have noticed it in all examined both in Massachusetts and at Washington.

In the little sulphur (*Eurema euterpe*, fig. 13, pl. 2) the males have a pronounced fragrance which is somewhat similar to that of the males of the preceding, but is sweeter and more flowery, and is very easy to perceive in spite of their small size. My observations were all made in the vicinity of Washington. All but 8 out of 39 males of *E. euterpe* taken by Mr. Longstaff in Jamaica had an odor varying from very slight in some to strong in 17. Mrs. Longstaff described it on various occasions as "a slight pleasant smell," "strong, like syringa," "a very soft gentle smell, might be jasmine," and "very slight, sweet, jasmine or syringa." Mr. A. P. Ponsonby suggested gorse. In Mr. Longstaff's judgment the scent resembled rather the clove pink, but was still more like pink bindweed. There was no scent in the 21 females studied.

Among the southern relatives of this little butterfly *Eurema delia*, which is common in the Gulf States, was examined by Mr. Longstaff in Jamaica, Panama, Colombia and Venezuela in 1907. The results were conflicting, but in the large majority of cases negative. Of *E. westwoodii*, which is found sparingly in Texas and Arizona, three males taken in Jamaica all had a scent, described in one as a "spice odor, not quite the same as in *E. euterpe*."

The large clear yellow butterfly so common in the Southern States (*Catopsilia eubule*, fig. 14, pl. 2) according to Miss Murtfeldt has a slight violet odor in the male. From observations in Brazil, Fritz Müller described the perfume of this same butterfly as faint and musklike. In no less than 32 out of the 33 males tested by Mr. Longstaff in the West Indies and on the northern coast of South America in 1907 "a distinct scent was readily perceived, indeed in the great majority of cases it is noted as strong, twice as very strong. In quality the scent was agreeable and was compared by me to *Stephanotis*, or *Freesia*."

Mr. Longstaff records that two large males of the form *sennæ* taken at Savanilla, Colombia, had a strong scent, like that of *Freesia*. Of one of each sex taken at Cartagena the male had the usual strong *Freesia* scent, the female a disagreeable, but somewhat sweet, odor.

Of 22 females examined by Mr. Longstaff 9 proved negative, but in the remaining 13 a scent was detected which, though usually described as very slight, or slight, and never as strong, was often distinct enough. In quality the scent of the female *eubule* was disagreeable; somewhat sweet, but recalling bad pomade, or rancid butter, or butyric acid. In the female of this species Fritz Müller found a very strong peculiar odor in which some volatile acid seemed to predominate.

In a related species (*C. agarithe*) which occurs in the Gulf States and is common throughout tropical America, Mr. Longstaff found that of three males examined in Tobago two yielded a scent noted as being "sweet, neither strong nor pleasant."

In Brazilian specimens of another form (*C. argante*) which is found in Florida and Texas, Fritz Müller detected a very distinct musklike odor. In the females of this species he found an odor resembling that of female *eubule*.

In *Appias ilaire*, which ranges southward from southern Florida and Texas, Müller observed an odor in the male which he recorded both as faint and rather strong.

In *Dismorphia melite* (fig. 23, pl. 3), which occurs in New Mexico, Müller found in the male a faint disagreeable odor; but a single male taken by Mr. Longstaff in Venezuela had a scent like mignonette.

This is all we know about the odor of our native pierids. Let us now review the information on the foreign species.

The scent found in the European cabbage butterfly (*Pieris rapæ*, fig 1, pl. 1) was also found by Mr. Longstaff in the related *P. canidia* in China and in India.

The European species corresponding to our gray-veined white (*P. oleracea*), the green-veined white (*P. napi*, fig. 2, pl. 1), has long been known to be a fragrant butterfly. The odor of its wings has been compared to thyme, to lemon verbena, to orange and to balsam, and apparently is always present in the males, or rather can always be detected. Mr. Longstaff says that out of 46 examined all had the scent, and that many times he has known by the scent alone the moment he had it in his net that a small white was a male green-veined. This is no exaggeration, as I can testify from my experience with this form in Europe. Mr. Longstaff says that besides the green-veined white there are but two other butterflies known to him with the lemon verbena fragrance, our gray-veined white, and the related *P. melete* of Japan.

It is curious that the scent of the large white of Europe (*P. brassicæ*, fig. 6, pl. 1) is more difficult to detect than that of either the common cabbage (*P. rapæ*) or the green-veined white (*P. napi*), but neither Doctor Dixey nor Mr. Longstaff have the slightest doubt of its existence. Doctor Dixey compared it to that of scarlet geranium

petals, and Mr. Longstaff to the flowers of rape. But the latter thinks that orris root is the best comparison.

Among the close relatives of our common sulphur the following observations are recorded. In *Eurymus hyale* (figs. 3, 4, pl. 1) var. *marnoana*, Mr. Longstaff found in the Sudan a very slight odor in both sexes which he doubtfully compared to chocolate candy or to cloves. In *Eurymus edusa* (figs. 17–19, pl. 3) caught in England, Doctor Dixey determined the existence in the male of an odor which he compared to heliotrope. Mr. Longstaff failed to detect any odor in this species in Algeria. Doctor Dixey found in a male of *Eurymus electra* in South Africa a scent like that which previously he had found in *E. edusa*; Mr. Longstaff found a somewhat less agreeable odor. The latter suspected a slight scent in two males of *E. nilgiriensis*.

Observations by Mr. Longstaff on *Eurema phiale*, like those on *E. delia*, gave results which were conflicting, but in the large majority of cases negative. The results were uniformly negative in the case of *E. albula*. Five out of eight males of *Eurema nise* had a scent varying from very slight to very strong, which was compared to that of the pink bindweed (*Convolvulus arvensis*); a slight scent, confirmed by Mrs. Longstaff, was detected in a female.

In *Eurema messalina* a scent was noted in 6 males out of 10. Mr. Longstaff described it as distinct or strong, and compared it to pink bindweed and to spice. It is also noted as distinct from that of *E. euterpe*, more dusty and less specific, and in another specimen as more spicy than bindweed. The bindweed odor was detected by Mr. Longstaff in several males of *E. libythea* in Ceylon. He failed to detect any scent in *E. hecabe* or in any of the allied forms.

Among the relatives of our *Catopsilia eubule*, Mr. Wood-Mason noticed in Assam that the tufts of hair on the wings of the males of *Catopsilia pyranthe* smell like jasmine. When in India Mr. Longstaff confirmed this observation, but thought a closer comparison was with the tuberose (*Polianthes tuberosa*). After his second visit to Ceylon in 1908 he wrote "The number of specimens taken was very much smaller than of *pomona*, but the scent was more easily detected in the male, and more decided in the female, than in that species. In both sexes the scent was compared to *Stephanotis*, but in one male to *Freesia*, and in one female Mrs. Longstaff thought the odor was 'a little bit hair-oily.'"

On stroking the scent tufts on the hind wings of the male of *Catopsilia pomona* Mr. Longstaff detected a slight jasminelike scent; later he compared this to *Freesia* or to *Stephanotis*. Out of 27 females examined the result was negative in 18; but in the other 9 a slight, usually very slight, sweet scent without other special character was noted.

On exposure of the tufts of hairlike scales on the hind wings of males of *Catopsilia florella* in South Africa a very strong scent was found to be emitted. This Doctor Dixey compared to jasmine, and Mr. Longstaff to tuberose or to *Freesia*. Mr. Longstaff confirmed this later in the Sudan, and also there suspected a faint odor in the female.

In Brazil, Fritz Müller found a musklike odor in the males of *Metura cypria* (fig. 12, pl. 2) and of *Rhabdodryas trite* (fig. 15, pl. 2); it was unusually strong in the former but faint in the latter.

Müller observed that during courting the female of *Appias lycimnia* in Brazil emitted from the genitalia an odor which he described as rather faint, though quite distinct, and very different from that emitted by the male's wings. This last he found to be very delicious, but rather faint and often hardly distinguishable. Mr. Longstaff records that the three males caught by him all had a strong sweet flowery scent suggesting *Freesia*. Of three females one had a rich, sweet scent.

The male of *Dismorphia thermesia* was found by Müller in Brazil to emit a very strong odor disagreeable to human noses. In the male of *D. astyonome* there is a similar, but much fainter odor.

No examination has been made of either of our dog-face butterflies (*Zerene casonia* and *Z. eurydice*), but one out of three females of *Z. cerbera* (fig. 26, pl. 4) examined by Mr. Longstaff was found to have a slight very sweet scent like (?) clover.

I have found no odor in our native eastern orange-tip (*Anthocharis genutia* [figs. 10, 11, pl. 2]), but I have had little opportunity for testing it. In England, out of many tested of the European orange-tip (*A. cardamines*), Mr. Longstaff found a fairly distinct, though faint, scent, sometimes described as musky, once as "very sweet."

A very interesting case of two different odors occurring in two closely related butterflies is afforded by the European brimstones (*Gonepteryx rhamni* [fig. 32, pl. 5] and *G. cleopatra*). While a slight scent has occasionally been detected in the males of the common brimstone butterfly (*G. rhamni*), though most of the trials have given negative results, the males of the allied southern form (*G. cleopatra*) have a scent uniformly distinct and often strong which Mr. Longstaff, who discovered it, described as "sweet, rich, thick—suggesting *Freesia*," later hesitating between *Freesia* and *syringa*.

Of other pierids, seven males of *Leptophobia aripa* out of eight examined by Mr. Longstaff in Venezuela had a distinct or even strong scent which he compared on various occasions to orange, *Freesia*, and mignonette.

Three males of *Itaballia calydonia* from Venezuela, all that he captured, were found by Mr. Longstaff to have a distinct flowery scent, in one described as like that of *P. brassicæ*, in another as somewhat sickly. In another undetermined species, near *P. sevata*, the only male examined had a faint, sweet, flowery scent.

In Assam Mr. Wood-Mason noted that both sexes of *Delias hierte* var. *indica* have a strong and grateful smell of musk. Of 18 males of *Delias eucharis* examined by Mr. Longstaff a scent was detected in 17. In 4 of these the scent was very slight or indefinable, but in 12 it was strong, or very strong, and compared by him to that of sweetbrier. In 6 females out of 9 there was more or less scent, but in no case was it strong; it was described as sweet, dusty or musky, and faint sweetbrier. In *D. nigrina* a male was thought by Mr. Longstaff to have a very slight scent.

The males of *Catophaga paulina* in Ceylon were found by Mr. Longstaff to have a scent which was variously described as "like sweetbrier, but sweeter and more luscious," "sweet," "very sweet (?)" *Freesia*," "flowery," "decided meadowsweet," "decided *Stephanotis*," and "extremely sweet."

In *Huphina nerissa* Mr. Longstaff found that the males have a distinct sweetbrier scent.

Nine males of *Ixias cengalensis* (fig. 36, pl. 6) examined by Mr. Longstaff all had a sweet, but only moderately strong, scent, which reminded him of meadowsweet (*Spiræa ulmaria*). Four females were scentless.

Ten African species of *Teracolus* have been examined, with the following results. In *T. achine* Doctor Dixey found in the males an odor like that of honeysuckle. In *T. ione* he found the scent not always easy to detect, but sweet and flowery. In *T. annæ* he sometimes found the scent of the male strong, like syringa; Mr. Longstaff found it faint and like that of *Pieris brassicæ*. A dead male of *T. phisadia* had a sweet luscious scent, but another of *T. halimede* a somewhat disagreeable odor.

Mr. Longstaff says that the male of *T. protomedia* has a distinct scarcely agreeable scent hard to describe, while a female of *T. दौरα* had a scent like clove pink, both in the field and in the house. In *T. omphale* both Doctor Dixey and Mr. Longstaff found in the males a "white flour perfume," but the former usually found a musky constituent in addition. In *T. auxo* they both found a scent in the males, and in *T. eris* a sweet flowery scent.

All of the nine males of the giant orange-tip (*Hebomoia australis*) examined in Ceylon by Mr. Longstaff had a heavy sweet scent which was strong in most, and in all decided. It was compared to that of

the flowers of the mango or to cinnamon. In three females out of four there was a similar scent.

In *Belenois gidica* (cf. fig. 27, pl. 4) from South Africa, Doctor Dixey and Mr. Longstaff found in some of the males a flowery scent which the former compared to that of roses. In *B. mesentina* in India Mr. Longstaff found the male to have a faint sweet flowery scent which did not appear to him to be quite like that of any other insect. In South Africa Doctor Dixey found in a male a scent much like that of *B. gidica*. In the Sudan Mr. Longstaff found the males to have a slight scent, sometimes described as musky, but once as luscious. In *B. severina* in South Africa both Doctor Dixey and Mr. Longstaff found much individual variation in the males. The former compared their scent to sweetbrier, the latter thought it like that of *Pieris brassicae*, but stronger and more luscious. In *B. thysa* they agreed that the males have a strong distinct odor which Doctor Dixey compared to that of roses, Mr. Longstaff rather to the bluebell (*Scilla nutans*), but sometimes to *Freesia*. In *B. teutonia*, examined in Australia, Mr. Longstaff suspected a slight scent in sundry males, but nothing at all definite.

Mr. Longstaff found in the male of *Nepheronia ceylanica* in Ceylon a more or less distinct scent which he compared to *Freesia*. A female had a similar scent which Mrs. Longstaff compared to frangipani (*Plumeria rubra*). A male of *N. hippia* from India had a very slight burnt-sugar scent.

Both Doctor Dixey and Mr. Longstaff found a flowery scent in the males of the South African *Eronia cleodora*.

In *Pinacopteryx charina* from South Africa Doctor Dixey and Mr. Longstaff occasionally found in the male a flowery scent which the former compared to mignonette. In *P. pigea* they both found a distinct, sometimes strong, scent like honeysuckle in the male.

Three species of *Mylothris* (cf. fig. 30, pl. 4) have been examined in South Africa. The males of *M. agathina* and of *M. rüppellii* have a strong, pleasant scent exactly like that of sweetbrier. The scent of *M. trimenia* is of quite a different nature; it reminded Doctor Dixey of sweet peas and Mr. Longstaff of clover.

Doctor Dixey compared the scent of the males of *Synchlœ hellica* to that of gorse. Mr. Longstaff recorded a male as having a very slight heavy and flowery odor. Later at Cape Town he caught a single male with a sweet odor which seemed to him to have a resinous element.

Swallowtails.—Among the swallowtails (Papilionidæ) apparently the males always have an odor, but the information concerning these is often more or less indefinite, sometimes conflicting. The females commonly, always perhaps, have a musty or acid odor, and the males frequently a similar odor, though much less strong, which

sometimes makes the detection of the true male fragrance difficult and apparently explains much of the confusion in the records.

Our spicebush swallowtail (*Papilio troilus*) is our most fragrant species. In this the males have a distinct and rather strong aroma difficult to describe, but exactly resembling that of Nabisco or Huntley & Palmer's honey biscuits. The odor of the female is not known.

In the black swallowtail (*P. polyxenes*, fig. 34, pl. 6) the males have a rather strong, sweet odor like that of carrot flowers, quite the same, apparently, as that of the males of its close relative in Europe (*P. machaon*, fig. 37, pl. 6). No one has investigated the odor of the females.

In our common yellow swallowtail (*P. glaucus*, fig. 45, pl. 9; figs. 46, 47, pl. 10) the males, at least in Massachusetts, all have a sweet, flowery odor, varying from faint to fairly strong, which resembles that of the males of the spicebush swallowtail, though it is never so pronounced. The yellow females (fig. 46, pl. 10) have a strong and disagreeable odor, pungent or acid in quality, resembling rubber cement or creosote, which is very strong in some, especially in the South. The odor of the black females (fig. 47, pl. 10) has not been recorded.

The males of the blue swallowtail (*P. philenor*) have a sweet flowery odor somewhat similar to that of the males of *P. polyxenes*, though not so strong. The females have a strong and disagreeable scent, pungent and penetrating, with a suggestion of acetic acid.

Mr. William Schaus informs me that the most fragrant butterfly in his experience is *P. devilliersi* (fig. 40, pl. 8) which has been found in Florida, though properly confined to Cuba, a relative of our blue swallowtail. The odor is very strong and of a most pleasing nature, resembling that of the fragrant orchids.

The male of the black and white swallowtail (*P. marcellus*, fig. 52, pl. 11) has a very faint odor resembling that of the males of our other swallowtails, but with a spicy flavor not discernible in them.

Fritz Müller examined in Brazil the males of a swallowtail (*P. polydamus*) which ranges north to southern Florida and Texas. In these the odor was very strong. In this form there appear to be, indeed, two sets of males emitting equally strong but quite different odors, a condition aptly called by Mr. Scudder diosmism. In this same species (var. *polycrates*) Mr. Longstaff found an odor resembling that of musty hay in two examples of each sex; Mrs. Longstaff compared the scent to rue (*Ruta graveolens*).

Several South American swallowtails were studied by Fritz Müller. He found that the males of *Papilio hyperion* have a very strong odor; the males of *P. scamander* (?*grayi*) have a strong and most agreeable odor; the males of *P. protesilaus* (fig. 41, pl. 8) have a very strong rather disagreeable odor; and the males of *P. nephalion* have

a faint agreeable odor. Mr. Longstaff found that a male of *P. euri-medes* had a strong odor of musty straw, and a living female of *P. æneides* a similar odor which persisted after death.

In *Troides darsius* of Ceylon (fig. 28, pl. 4) the males have a scent, sometimes a strong scent, like sassafras; the females smell like musty straw.

Mr. H. Pryer said that the male of *Papilio alcinoüs* (fig. 39, pl. 7) of Japan has a peculiarly sweet musky odor when alive, and that the female also emits a faint odor which to him is as unpleasant as that of the male is pleasant.

In Assam Mr. Wood-Mason noted in the male of *Papilio aristolochiæ* a strong and slightly pungent odor resembling that of (?) bachelors' buttons, or of the rose with a trace of acetic acid. Mr. Longstaff in Ceylon found that both sexes have an odor like musty hay. Of *P. doubledayi* (fig. 56, pl. 13) Mr. Wood-Mason said that the male has a musk-scented body, while the female of *P. dasarada* has the strong scent of caged porcupines with a touch of musk, and the female of *P. astorion* has a strong and disgustingly rank musky odor.

Mr. Longstaff has studied some additional Indian species. He found that the male of *Papilio hector* has a musty odor. Two males of *P. demoleus* (fig. 31, pl. 5), one in Ceylon and one in India, had an odor like fresh straw; a female had "a slight peculiar scent in the field, stronger in the house." A specimen of *P. telephus*, sex not given, had a slight sweet scent at home. A male of *P. parinda* was noted as having a scent like tea, but nothing of the kind was found in any of the other individuals examined. A male of *P. polymnestor* (fig. 38, pl. 7) had a somewhat musty odor.

Among the South African swallowtails both Doctor Dixey and Mr. Longstaff found an odor of fusty packing straw in both sexes of *Papilio demodocus* which according to the latter was stronger in the female. Doctor Dixey sometimes found an element in the odor suggestive of cabbage water or a kitchen sink. Mr. Longstaff says that the male of *Papilio dardannus* (fig. 33, pl. 5) has an odor of the musty-straw type, and that some of the males of *P. lyæus* examined had a scent which he at the time described as "sweet, luscious, flowery." In the males of *P. leonidas* Doctor Dixey thought the scent to be like that of *Danaus chrysippus*; but Mr. Longstaff found in several males what he described as a "strong sweet 'white flour' scent, followed by something more spicy."

Lelièvre found that *Thaïs polyxena*, which feeds on *Aristolochia*, has on emergence when handled an odor like that of its food plant, which arises from a fluid left upon the hand that has seized the insect.

Nymphalids.—About 30 years ago I was much surprised to find that a strong and pleasant fragrance comparable to that of sweet flag or of sandalwood combined with Spanish cedar and with a "dusty" element was given off from the wings of a male example of one of our common fritillaries (*Argynnis aphrodite*). More recently I have examined this peculiarity more closely. Of the males of both of our common species in New England (*A. aphrodite* and *A. cybele*) some dozens were examined. All had the odor, and on the average about one in four or five was found to possess a very strong aroma. In several cases so fragrant was the butterfly that the odor could plainly be detected as the insect fluttered in the net. Some of the most fragrant of the butterflies were badly rubbed and torn, while some freshly emerged were almost scentless.

Mr. Scudder remarked that *Argynnis atlantis* (figs. 57, 58, pl. 13) has a distinct odor of sandalwood so strong that it is hardly possible to handle living specimens without recognizing it, which he has known to be retained for many weeks after death when the insect had been inclosed at capture in a paper envelope.

In the regal fritillary (*Argynnis idalia*, fig. 59, pl. 13) the odor of the male is uniformly strong, resembling that of the other species but sweeter and more flowery. It was compared to musk by Mr. Scudder.

Prof. John H. Gerould writes me that he has noticed the same odor as that in *A. atlantis* in another species (*Brenthis montinus*) which I have not examined.

Of a curious fritillary common in the Southern States (*Dione vanillæ*) Mr. Longstaff says that 13 out of 17 males examined possessed an odor varying from very faint to very strong which in character was distinctly disagreeable—like a stable.

The majority of observations made by Mr. Longstaff on our southern heliconian (*Heliconius charithonia*) in 1907 in Jamaica gave negative results, but in three males and two females a slight pleasant flowery scent was detected which Mrs. Longstaff described as "sweet."

The large and handsome *Victorina stelenes*, occasional in Florida and in southern Texas, was studied by Mr. Longstaff in Jamaica. Five males appeared to have a slight flowery scent; in one it suggested chrysanthemum.

The handsome male of *Hypolimnas misippus*, abundant in the eastern tropics and in Africa, and occurring sparingly in Florida and southward where long ago it was introduced from Africa, was found by Doctor Dixey from observations in South Africa to have a smell like coffee, though not very strong.

In our common viceroy (*Basilarchia archippus*) there is a pronounced and disagreeable odor comparable to that of the females of

Danaus archippus. It is rather curious that this butterfly should resemble the milkweed butterfly not only in its color but also in its odor.

The males of our common peacock butterfly (*Junonia cænia*, fig. 25, pl. 3; fig. 43, pl. 9) have a rather strong sweet sugary odor which sometimes quickly disappears. The variety examined was the one with the under surface of the wings deep dull pinkish red, the commonest in the fields in the vicinity of Washington.

Mr. Scudder noticed that in the males of the milkweed butterfly (*Danaus archippus*) the scales found in the little pouch upon the upper surface of the hind wings next the lower median nervule emit a slightly honeyed odor over and above the caroty smell which all the scales possess. This odor was detected in nearly all the males which I examined. It may be described as like the faint sweet fragrance of red clover blossoms, or of the flowers of the common milkweed. With this is a fainter cockroachlike or caroty odor which is found alone, and much stronger, in the females. Mr. Longstaff's notes on the odor of this species which was studied by him in Jamaica, Tobago, Panama, and Venezuela in 1907, and in Australia in 1910, and Fritz Müller's observations in Brazil, evidently refer to the disagreeable odor, and not to the true male odor which escaped both observers.

In the group of which the milkweed butterfly is a member (*Euploinae*) the evidence seems to show the common or even general occurrence of two quite different scents, a flowerlike scent peculiar to the males and a more or less disagreeable mouldy or acid odor common to both sexes, often stronger in the females, as in our milkweed butterfly.

Mr. Longstaff says regarding *Danaus jamaicensis* that of two males one had a strong smell of rabbit hutches, the other a decided odor as of (?) cockroaches, scarcely disagreeable. Of two females both had a strong cockroach smell, perceptible next day. Two males of *D. eresimus* had a "(?) very slight pleasant scent," and a female a "strong (?) muskrat [? *Desmana moschata*] odor when alive."

In the common and widespread *Danaus chrysippus* (fig. 24, pl. 3) of the eastern tropics Doctor Dixey found that the scent in both sexes is of a strong and disagreeable nature like that of cockroaches, often stronger in the female. In *D. genutia* (fig. 53, pl. 12) Mr. Longstaff sometimes detected an unpleasant scent, but did not record the sex of the individuals examined. Later he found a male to have a slight muskrat odor in the field, but none at home, though still alive.

In *Danaus limniace* Mr. Longstaff found in a male a very faint scent suggesting old cigar boxes; but observations made on other occasions were doubtful or negative. Of 11 males of *D. septentrio-*

nalis (fig. 54, pl. 12) 9 yielded a scent noted as slight, moderate, or decided, and described as pleasant or sweet, and in 2 cases compared (with, however, some hesitation) to clover. In a single female out of seven a slight scent was found and compared to *Stephanotis*; but Mrs. Longstaff in the house said "(?) ginger."

Of four males and four females of *Danaus taprobana* Mr. Longstaff found an odor in two females only. In the field he called it "a slight musty scent," but on reëxamination he compared it to stale tobacco smoke. In a previous investigation he reached more positive conclusions, saying that "it has the acetylene odor of *Euplœa core* (fig. 44, pl. 9), but not so strong and with a difference."

In *Danaus aglea* Mr. Longstaff detected a distinct scent "in 15 males out of 17 and in 11 females out of 14. In the male the scent varied from very slight to strong; twice, indeed, it was so strong as to be clearly perceptible when the insect was fluttering in the net." In 13 examples he compared it to acetylene; in the other 2 it was described as acetylene plus cockroach; but these, when re-examined in the house, were described as cockroach only and slightly musty, respectively. In six individuals in which there was a decided, or even strong scent in the field, none was detected in the house; in others the scent at home was slight, or described as musty; but in one it was compared to sweet hay. In all the 11 females the scent was compared to acetylene. Two other females were said to have a musty odor. Mr. Longstaff was satisfied that in *D. aglea* the scent is more transitory, possibly more volatile, than in the majority of scent-producing butterflies.

Doctor Dixey and Mr. Longstaff both agree that the two sexes of *Amauris albimaculata* yield a similar smell of musty straw, accompanied by an evanescent sharp or pungent scent like that of vinegar. In *A. echedna* Mr. G. A. K. Marshall found a strong smell, which reminded him somewhat of that emitted by many ladybirds.

In four males and two females of *Euplœa core* (fig. 44, pl. 9) Mr. Longstaff found a scent that to him suggested rancid oil or old lamps, but which he later called acetylene. In one female he described it as muskrat plus acetylene. But in two specimens he described the scent when examined in the house as like that of acetic acid, although in the same specimens he had noted in the field the odor of acetylene. He suggests that the scent has two elements, one more persistent than the other.

In *Euplœa asela* a scent was noted in the field in 32 out of 38 males and in 17 out of 19 females. In four males and one female no scent was detected; there is no record of the others. On reexamination in the hotel in 13 males and 5 females no scent could be detected; when a scent was noted in the house it was in the large majority of specimens, especially among males, much fainter than

it had been in the field. Mr. Longstaff noted that in both sexes the scent varied considerably in strength; it seemed to him to be quite as strong in the females as in the males, though all three specimens in which the scent was strong enough to be obvious through the net were males. In one male Mr. Longstaff described the scent as not unpleasant. In five examples, four females and one male, it was described as pungent and compared to acetic acid. One female was noted as having a strong pungent odor of acetic acid, still pungent and distinct at home. The scent adhered to the fingers after pinching. Mr. Longstaff remarked that the scent in *Euplœa* would appear to be more volatile than in the pierids or the danaiids. From a series of observations he concluded that in *Euplœa* and in *Danaus* the scent which is common to both sexes whatever its source may be is independent of the genital tufts.

In *Euplœa anymone* var. *kinbergi* Mr. Longstaff noted the acetylene scent in several males; once it was so strong as to be obvious as soon as the insect was in the net.

In *Euplœa midamus* the acetylene odor of a female was perceptible when it was in the net. Mr. R. Shelford wrote in a letter to Mr. Longstaff that he found the terminal tufts of a male of *E. mulciber* to be sweetly scented.

A male of *Euplœa kollari* examined by Mr. Longstaff had a slight peculiar and rather disagreeable scent. Of two males of the form *sinhala* from Ceylon (fig. 55, pl. 12) one had an acetylene odor, moderate in the field but slight at home, while the other had a moderate acetylene scent in the field, none in the house; but on pinching it again while it was still alive the terminal tufts were protruded, and there was a momentary strong acetylene scent. As Mr. Longstaff says, it does not follow necessarily that the scent emanated from the tufts.

Five males of *Euplœa montana* all had a strong, or at any rate decided, acetylene odor in the field, at home either no scent at all, or at most a faint musty odor. "In one case the strong acetylene odor seemed to come from the upper surface of the body or wings, while there was a suspicion of a sweet scent (compared with some hesitation to sassafras) which seemed to come from the tufts." Two living females yielded an odor of acetic acid, which in one persisted slightly after death.

Mr. Wood-Mason said that in *Euplœa rhadamanthus* the eversible caudal tufts of the males are finely vanilla scented.

Fritz Müller found a rather disagreeable odor to be extremely strong in *Lycorea*, sp., and in *Ituna ilione*.

Among the southern relatives of our fritillaries a single male of *Dione juno* taken in Venezuela was found by Mr. Longstaff to have a slight stablelike odor, like that of our *D. vanillæ*.

Neither of our two species of *Colænis* has ever been examined. In *C. cillene* in Jamaica Mr. Longstaff found, in eight out of 11 males, a decided scent, though never strong. Its character was noted as peculiar, sweetish, pleasant, distinctly aromatic, resinous, druglike or medicinal; it suggested to him at one time or another tea, Canada balsam, and pure carbolic acid, but his wife compared it to ginger, or a mixture of ginger with jasmine. Later he thought that sassafras would probably be the best comparison.

Müller says that the heliconians possess a disgusting odor which is generally stronger in the females. Of 11 males of *Heliconius hydarus* examined by Mr. Longstaff in Trinidad, Tobago, and Venezuela, 3 gave a negative result and 1 was doubtful; but the remaining 7 had a scent which varied from slight to very strong and was described as musty, like acetylene, or like hazeline (a preparation of witch-hazel). Eight females were examined, only one with negative results; in the other seven the scent varied from slight to strong, and was described as disagreeable, or like acetylene, or like hazeline. In one male and one female the scent was so strong as to be easily discerned when the butterfly was fluttering in the net. Two males of *H. euryades* were examined by Mr. Longstaff; one had a peculiar, rather pleasant, smell, the other none. Two females also were examined; in one the result was doubtful, but the other had a slight odor like that of the preceding.

Three males of *Eueides aliphera* were examined by Mr. Longstaff in Trinidad, two with negative results; the third had a stablelike odor. Two females both had decided odors, described as a peculiar scent, (?) acetylene, strong when alive, and as a strong *Dione* (that is, stablelike) scent when living.

Among the close relatives of our peacock butterfly (*Junonia cænia*, fig. 25, pl. 3; fig. 43, pl. 9), a male of the Indian *Junonia almana* had a slight sugary scent, and two males of *Precis iphita* out of several yielded a slight odor of molasses.

Quite a number of additional nymphalids have been studied. The European species of *Charaxes* is said by Girard to have a strong odor of musk, especially just after its emergence; but he does not state in which sex this is found, nor its point of origin. Of *C. varanes* of South Africa Doctor Dixey says that a male on being squeezed emitted an odorless juice. Another was noted by Mr. Longstaff as having an odor resembling molasses. A female was thought by him to have a smell like cow dung, but to Doctor Dixey the scent of the same specimen recalled that of *Danaus chrysippus*.

In Brazil an unusually strong odor was detected by Fritz Müller in the males of *Myscelia orsis*, *Epicalia acontius* and *Ageronia arethusa*. In *Prepona laërtes* he noted a distinct odor in the male, not

strong, but unmistakable, like a bat. In *Didonis biblis* he found a strong disagreeable odor common to both sexes. The males have in addition two other scents comparable to heliotrope and musk respectively, the latter faint.

Five males of *Cynthia asela* out of eight taken in Ceylon were found by Mr. Longstaff to have a peculiar slight sweet scent, at the time compared by him to sassafras or to French polish.

In *Neptis jumba* from Ceylon a faint sweet chocolate scent was detected in a male in the house by Mr. Longstaff. A somewhat similar scent was suspected in another male and in a female. But no scent was recognized in the much commoner *N. varmona*. In *N. agatha* (fig. 51, pl. 11) from South Africa Doctor Dixey noted in three males from Natal a strong and very disagreeable scent, like that of *Danaus chrysippus*, but more intense. Three males taken by Mr. Longstaff on the Zambesi had a slight scent which he described as sweet. Doctor Dixey notes that there is a difference in the aspect of the insects from the two localities.

Doctor Dixey and Mr. Longstaff are agreed that the male of *Hamanumida dædalus* of South Africa has a smell of the burnt sugar type.

In the males of *Byblia goetzius* in South Africa Doctor Dixey found a very distinct and agreeable odor of sweet chocolate, with a suggestion of vanilla. Mr. Longstaff found a similar scent in the only specimen he examined, which was a female.

In *Salamis anacardii* of South Africa both sexes have an animal-like odor which to Mr. Longstaff suggested rabbit hutches; it appears to be stronger in the female.

Very pronounced odors are characteristic of the *Morphos* and their allies. Fritz Müller found that the males of *Morpho hercules*, *M. epistrophis*, *M. menelaus*, *M. achilles* and *M. adonis* give off a very distinct odor which in the last two is most agreeable, resembling vanilla.

In Assam Mr. Wood-Mason found that in *Stichophthalma camadeva* the gland covered by a patch of modified scales and by an erectile wisp of hairs on each hind wing occurring in the male secretes a fluid that gives out a pleasant odor distinct from, but so faint as barely to be perceptible in the presence of, a much stronger odor resembling that of a sable fresh from the furrier's shop which is common to the two sexes. Mr. Wood-Mason also noted that the scent fans of *Thaumantis diores* are vanilla scented.

Among the Brassolinæ Fritz Müller noted very distinct odors in the males of various species of *Caligo*, *Opsiphanes* and *Dasyophthalma*, the odor being particularly strong in the last named.

According to Müller all the Brazilian Ithomiinæ emit a more or less distinct odor from a tuft of long hairs near the fore margin

of the hind wings. In *Dircenna xantho* he says there is a rather strong and most agreeable fragrance of vanilla. In *Ceratinia eupompe*, *Mechanitis lysimnia* and *Ithomia sylvo* he records a faint scent in the males. In *Thyridia megisto* he found an odor in both sexes, but much fainter in the female.

In *Tithorea megara* Mr. Longstaff found a very distinct, or even strong, scent which he compared to *Stephanotis*, but he thought it had in addition a spicy or dusty element. In *Athesis clearista* he noted that a male had a slight sweet flowery scent, both alive and dead, which appeared to be associated with the brushes on the hind wings. A male of *Leucothyris victorina* and another of *L. phemone* had each an offensive odor which in the latter seemed to be associated with the tufts or brushes on the hind wings.

Both of the species of *Elymniinae* which have been examined are strongly fragrant. In Assam Mr. Wood-Mason noted that the males of *Elymnius undularis* emit a strong odor resembling vanilla, the females being scentless. In *E. fraterna*, which is probably an insular race of the preceding, Mr. Longstaff found in four males an odor like that of vanilla scented chocolate; once Mrs. Longstaff compared it to very strong honey or coarse brown sugar.

Among the *Acraeinae* (fig. 42, pl. 9) Fritz Müller noted a disgusting odor in both sexes of *Actinote thalia*. Mr. Longstaff failed to detect any odor in *A. antivas* at Caracas, Venezuela.

All of the other observations on members of this group are based on South African species. Doctor Dixey found that the green juice exuded from a male of *Planema aganice* had a by no means unpleasant odor, like that of a crushed cabbage leaf. Doctor Dixey and Mr. Longstaff concur in stating that both sexes of *Acraea alboradiata* have a distinct musty odor, like old hay or straw; they both are in substantial agreement regarding *A. anemosa* in which the males have a musty odor, which Doctor Dixey found also in a female. Mr. G. A. K. Marshall says that this is the only *Acraea* in which he has noticed a strong odor. In *A. encedon* Mr. Longstaff found a slight unpleasant odor in both sexes. In *A. doubledayi* Doctor Dixey and Mr. Longstaff concur as to a musty odor in the male, and the latter found it in the female also. Mr. Longstaff found a faint odor in both sexes of *A. atolmis*. In *A. caldarena* Doctor Dixey found a distinct smell of musty straw in the female, and Mr. Longstaff came across a similar but slighter odor in a male. Doctor Dixey found a similar musty odor in *A. atergatis*, accompanied by a strong ammoniacal scent, like that of stable litter; no sex was given.

Satyrids.—In many of the wood nymphs or *Satyridae* the males have numerous and well-developed scent scales, but in only a very

few of them has an odor been detected, and when found the fragrance has usually been faint. No odor has been found in any of our species.

Several European forms have been found to have a scent, though it is faint in all. Doctor Dixey and Mr. Longstaff are agreed that the males of *Satyrus semele* have a slight scent which the former compared to chocolate or to sandalwood, the latter to snuff or old cigar boxes. Both these gentlemen found that the males of *Epinephele janira* have a very slight odor; to Mr. Longstaff it appeared somewhat pungent and suggested old cigar boxes. Doctor Dixey found in the males of *Pararge magæra* a faint but heavy odor suggestive of chocolate cream which he connected with the brand on the forewings. In *P. schakra* of India Mr. Longstaff suspected the existence of a very slight sweet scent that appeared to be unlike that of any other species examined up to that time (1903). Mr. Longstaff found a slight but distinct musky scent in two males of *Melanargia galathea*. Aurivillius recorded that both sexes of the European *Eneis norna* have a musky odor.

In Jamaica Mr. Longstaff found in 10 males of *Calisto zangis*, nearly all those examined, a scent varying from faint to strong compared by him to molasses, chocolate, burnt sugar, or to caramel, but in one instance described simply as aromatic. Ten females were without scent. Fritz Müller says that the male of the Brazilian *Antirrhæa archæa* emits a strong odor, which he does not describe.

In Assam Mr. Wood-Mason found that the males of *Lethe rohria* emit a delicious vanillalike scent.

Mr. Longstaff detected in a few males of *Ypthima ceylonica*, which was flying abundantly when he was in Ceylon, a very slight scent of chocolate.

The males of the four species of *Mycalesis* which have been examined all possessed an unusually strong fragrance. Mr. Wood-Mason found in *M. suavis* in Assam that the scent glands and fans emit a powerful and delicious odor resembling that of vanilla which continues for some hours after death. In *M. mineus* var. *polydecta*, which he examined in Ceylon, Mr. Longstaff found in two male specimens that exposure of the pencils of hairs on the hind wings produced a strong scent which he compared to burnt sugar, and his wife to coarse brown sugar or molasses. In South Africa Doctor Dixey found in the tufts of the male of *M. safitza* a very strong odor of chocolate. In *M. perspicua*, examined also in South Africa, Doctor Dixey and Mr. Longstaff are agreed that there is a strong odor distinct from that of the preceding, but they were in only partial agreement as to its character.

The most interesting of the wood nymphs in regard to odors is *Heteronympha merope* of Australia and Tasmania, which is remarkable for the striking difference between the sexes, the males being

much the larger and handsomer insects. In four males Mr. Longstaff found a faint, but distinct, scent of a sweetish character, sometimes suggesting molasses, sometimes tobacco. In eight females he found a decided sweet and flowery scent. He once compared it to syringa, but in two other individuals it seemed to have rather a balsamic character. Mrs. Longstaff said that it was "sweetish, like some flower, not quite syringa—not so strong." In no other butterfly does the female have a sweet, flowery scent stronger than the male.

Lycænids.—The hair-streaks, blues and coppers, which together make up the family Lycænidæ, are all quite small, the largest only slightly over 3 inches in expanse. Most of them spread from 1 to 1½ inches, or in North America from 1 to 1¼ inches, while a few do not exceed half an inch. Considering their small size and delicate build it is remarkable that many of them have a scent sufficiently strong to be detected.

Our common little blue (*Cyaniris ladon*) as described by Mr. Scudder has an exceedingly delicate odor which he compared to that of newly stirred earth in the spring, or of crushed violet stems. He specifically stated that he could not discover any odor in the males of *Rusticus scudderi*.

Six out of eight males of a close relative of our little blue occurring in Ceylon (*Cyaniris singalensis*) were found by Mr. Longstaff to have a scent of varying intensity, described in all cases as sweet, once as luscious, and once as *Freesia*-like.

In the common blue in England (*Lycæna icarus*) both Doctor Dixey and Mr. Longstaff found in the males a decided scent suggestive of chocolate candy. In the English *Chrysophanus astrarche* Mr. Longstaff found in a male the odor of chocolate "not flavored with vanilla."

In tropical America Mr. Longstaff found in a male of the very small *Catachrysops hanno* a very strong *Freesia*-like scent; but most of his specimens appeared to be quite odorless.

Mr. Longstaff writes that 10 males of *Polyniphe dumenelii* gave positive results of a surprising character. In the majority of cases the odor was strong or even very strong; moreover, it was disagreeable. He compared it to pig sties, or perhaps more correctly to pigs. It seemed to him scarcely credible at first that so small a butterfly could smell so strongly. A female was odorless.

In a male of *Theclopsis tephreus* examined in Venezuela a strong peculiar rather disagreeable odor was detected. A male of *Tmolus cambes* yielded an odor of molasses; Mrs. Longstaff compared it to coarse brown sugar. A male of *Tmolus palegon* had an odor of chocolate. In *Thecla atys* in Brazil Fritz Müller found an unusually strong batlike odor in the male, and he also found more or less

distinct odors in various other types, the names of which he did not know.

In a male of *Tarucus theophrastus* from the Sudan Mr. Longstaff found a moderately strong, sweet, luscious scent.

All of the remaining records are from Ceylon, where they were gathered by Mr. Longstaff. Two males of *Nacaduba atrata* had a sweet, flowery scent, confirmed by Mrs. Longstaff and in one case compared by her to "very, very faint jasmine." Five males of *Lampides elpis*, all of those examined, had a sweet scent which in one was with some hesitation compared to clover. Nine males of *L. lacteata* all had a distinct odor which was compared to vanilla biscuits or to chocolate candy. These two closely allied species therefore have quite different scents. A minority of the numerous males of *L. celeno* which were examined had a faint, sweet scent. About half of the males of *Polyommatus bœticus* had a slight scent like that of meadow-sweet. Three males of *Rapala lazulina* yielded a scent like that of vanilla biscuits.

Skippers.—Among the skippers, or Hesperidæ, which are mostly very small, there are but few observations, though in very many scent scales are extraordinarily developed in various places on the wings and even on the tibiæ of the hindmost legs.

In *Plesioneura eligius* and in a species of *Achlyodes* from Brazil Fritz Müller noticed that the pencil of long hairs on the hindmost tibiæ of the males emitted a very faint odor. In the South African *Gegenes occulta* Doctor Dixey found a very distinct chocolate scent in a male.

FUNCTION OF THE ODORS

What is the purpose of the fragrance of the males of butterflies? Last summer I watched the courting process in *Argynnis cybele*. A female was seated on the upper surface of a horizontal leaf with the wings folded tight together and the fore wings drawn backward to the maximum, a somewhat unusual and strained position for this insect when sitting on a leaf, but one which was maintained unchanged throughout the whole performance. An inch or so behind the female on the same leaf was a male, his body just in line with hers and facing the same way. His wings were close together, but the fore wings were drawn far forward so that their hinder border approached the vertical, as that of hers did the horizontal. At intervals he would suddenly open and close his wings, these intervals, at first about a second, becoming less and less; and constantly, almost incessantly, he slightly shifted his position, in a series of little rapid jerks.

The same drawing forward of the fore wings of the male, the spasmodic opening and closing of the wings, and the constant

sudden shifting of position, is also characteristic of the courting of *Cercyonis alope* (fig. 35, pl. 6); but the performance usually takes place upon a tree trunk or some broad surface more or less near the vertical, and the male commonly moves up so that the two sit side by side.

In the common sulphur (*Eurymus philodice*) (fig. 7, pl. 1; figs. 20, 21, pl. 3), the courting of the male always is accompanied by a constant fluttering of the wings, with the fore wings drawn well forward; but in this butterfly the female usually sits with her wings widely spread, the fore wings drawn well back.

In all these cases it is evident that the male endeavors to envelop the female with his perfume, which in the first and last is wholly different from that of any flower upon which the insect feeds. Were the odor of the males really attractive to the females as has been assumed, and as the fragrance of the flowers is, there would surely be no need for such persistence as the males exhibit.

The natural conclusion therefore is that the odors of male butterflies are in reality sex stimulants, like the odors of the males in other creatures. Such odors, though all serving the same purpose, may or may not be agreeable to our senses, and this is probably the reason why in certain butterflies the males seem to us to have a most unpleasant smell.

Undoubtedly the nauseating odors of the subterminal organs of the female fritillaries are protective in their function. The chief enemies of these butterflies with us undoubtedly are mice. I have noticed that discarded individuals dropped into the meadow grass were by the next morning invariably eaten. But these butterflies always spend the night as near the ground as possible, crawling down the grass stems and often many feet along the ground, hiding away in the débris close to the soil, much as in the spring their caterpillars hide themselves away during the daytime. Here they are exposed especially to attacks by mice. The females of our fritillaries seem to be much longer lived than do the males, for by the end of August in New England all the still fairly numerous individuals remaining are females busily engaged in searching for their food plants and depositing their eggs.

Whether the much longer life of the female fritillaries results from superior vitality or from superior protection against mice is an interesting question.

The females of all our fritillaries are larger and more conspicuous than the males, and at the same time less shy with a less swift and less erratic flight. It may be that when on the wing the males are protected by the more conspicuous and more readily caught females with their powerful repellent organs.

Presumably in the other butterflies in which the females have a disagreeable odor absent from or weaker in the males that odor is more or less protective. But it is by no means a complete protection, for certain mice commit great havoc in the wintering swarms of our milkweed butterfly (*Danaus archippus*), while in Africa and Asia certain of its relatives are freely preyed upon by other creatures, especially by certain kinds of mantises.

EXPLANATION OF PLATES

PLATE 1

- FIG. 1.—The common cabbage butterfly (*Pieris rapæ*); the specimen is from Newtonville, Mass.
- FIG. 2.—The green-veined white (*Pieris napi*); the specimen was caught by the author at Interlaken, Switzerland.
- FIG. 3.—The clouded sulphur (*Eurymus hyale*), male, from Interlaken, Switzerland.
- FIG. 4.—The clouded sulphur (*Eurymus hyale*), female, from Interlaken, Switzerland.
- FIG. 5.—*Eurymus eurytheme*, male from Ipswich, Mass., August 25, 1925.
- FIG. 6.—The large white (*Pieris brassicæ*), Interlaken, Switzerland.
- FIG. 7.—The common sulphur (*Eurymus philodice*), male, Newtonville, Mass.
- FIG. 8.—*Eurymus eurytheme*, female, Washington, D. C., September 19, 1925.
- FIG. 9.—*Eurymus eurytheme*, white female, Washington, D. C., September 19, 1925.

PLATE 2

- FIG. 10.—The falcate orange tip (*Anthocharis genutia*), male, from Washington, D. C., April 13, 1925.
- FIG. 11.—The falcate orange tip (*Anthocharis genutia*), female, from Washington, D. C., April 19, 1925.
- FIG. 12.—*Metura cypriis*, male, Brazil.
- FIG. 13.—The lesser sulphur (*Eurema euterpe*), male.
- FIG. 14.—*Catopsilia eubule*, male.
- FIG. 15.—*Rhabdodryas trite*, male, Brazil.
- FIG. 16.—*Eurymus phicomone*, female; the specimen was caught by the author at Chamonix, France.

PLATE 3

- FIG. 17.—The clouded yellow (*Eurymus edusa*), male, from Interlaken, Switzerland.
- FIG. 18.—The clouded yellow (*Eurymus edusa*), female, from Interlaken Switzerland.
- FIG. 19.—The clouded yellow (*Eurymus edusa*), white female, from Interlaken, Switzerland.
- FIG. 20.—The common sulphur (*Eurymus philodice*), white female, Newtonville, Mass.
- FIG. 21.—The common sulphur (*Eurymus philodice*), white female, Newtonville, Mass.
- FIG. 22.—*Dismorphia nemesis*, male, South America.
- FIG. 23.—*Dismorphia melite*, male, South America.
- FIG. 24.—*Danaus chrysippus*, male, from Kilossa, Tanganyika Territory; caught by Arthur J. Loveridge, January 15, 1921.
- FIG. 25.—The American peacock butterfly (*Junonia cania*), female, Washington, D. C., September 19, 1925.

PLATE 4

- FIG. 26.—*Zerene cerbera*, male, Venezuela.
 FIG. 27.—*Belenois zochalia*, Kilossa, Tanganyika Territory, December 4, 1920.
 FIG. 28.—*Troides darsius*, male, Colombo, Ceylon.
 FIG. 29.—The western checkered white (*Pieris occidentalis*).
 FIG. 30.—*Mylothris rubricostata*, Nairobi, Kenya Colony, August 31, 1920.

PLATE 5

- FIG. 31.—*Papilio demoleus*, east Africa.
 FIG. 32.—The Brimstone (*Gonepteryx rhamni*), female, from Interlaken, Switzerland.
 FIG. 33.—*Papilio dardanus*, male, Kilossa, Tanganyika Territory, July 6, 1921.

PLATE 6

- FIG. 34.—The black swallow-tail (*Papilio polyxenes*), male, Long Island.
 FIG. 35.—*Cercyonis alope*, male, Newtonville, Mass.
 FIG. 36.—*Ixias cengalensis*, Ceylon.
 FIG. 37.—The European swallow-tail (*Papilio machaon*), France.

PLATE 7

- FIG. 38.—*Papilio polymnestor*, Malabar coast, India.
 FIG. 39.—*Papilio alcinoüs*, Japan.

PLATE 8

- FIG. 40.—*Papilio devilliersi*, Cuba.
 FIG. 41.—*Papilio protesilaus*, South America.

PLATE 9

- FIG. 42.—*Acræa natalica*, Kilossa, Tanganyika Territory, January 29, 1921.
 FIG. 43.—The American peacock butterfly (*Junonia cænia*), female, migrant form, Washington, D. C., September 27, 1925.
 FIG. 44.—*Euplæa core*, India.
 FIG. 45.—The common yellow swallow-tail (*Papilio glaucus*), male, raised in Washington from a caterpillar from Cambridge, Mass.

PLATE 10

- FIG. 46.—The common yellow swallow-tail (*Papilio glaucus*), female, southern form.
 FIG. 47.—The common yellow swallow-tail (*Papilio glaucus*), female, black form.

PLATE 11

- FIG. 48.—*Papilio antheus*, Kibwezi, Tanganyika Territory, April 29, 1921.
 FIG. 49.—The European wood white (*Leucophasia sinapis*), Interlaken, Switzerland.
 FIG. 50.—*Amauris ochlea*, Frere Town, Kenya Colony, August 2, 1920.
 FIG. 51.—*Neptis agatha*, Kilossa, Tanganyika Territory, January 22, 1921.
 FIG. 52.—The black and white swallow-tail (*Papilio marcellus*), Washington, D. C., April 26, 1925.

PLATE 12

FIG. 53.—*Danaus genutia*, male, India.

FIG. 54.—*Danaus septentrionalis*, India.

FIG. 55.—*Euplœa sinhala*, Ceylon.

PLATE 13

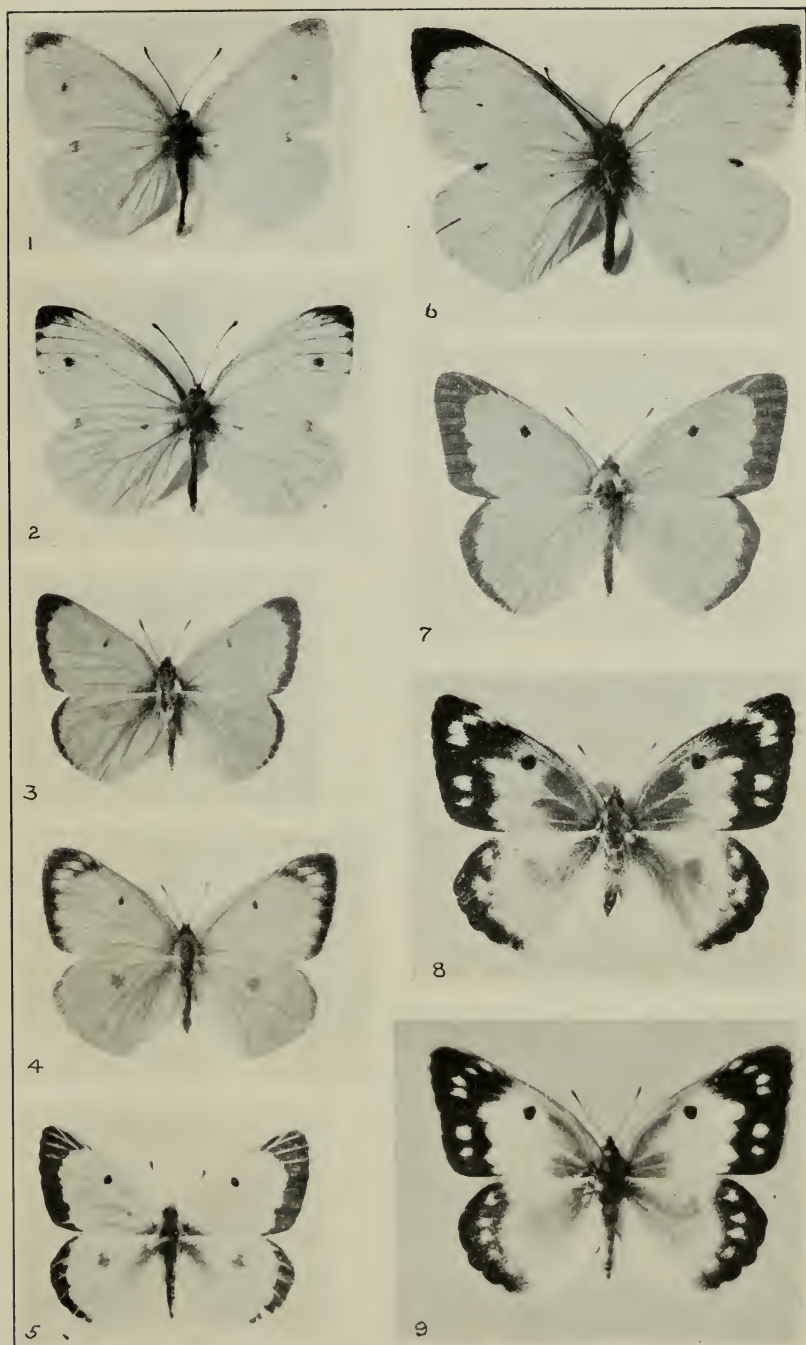
FIG. 56.—*Papilio doubledayi*; the specimen is from Trong, Lower Siam.

FIG. 57.—*Argynnis atlantis*, male, lower side, Essex, Mass.

FIG. 58.—*Argynnis atlantis*, male, upper side, Essex, Mass.

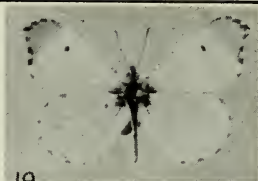
FIG. 59.—*Argynnis idalia*, male, Essex, Mass.







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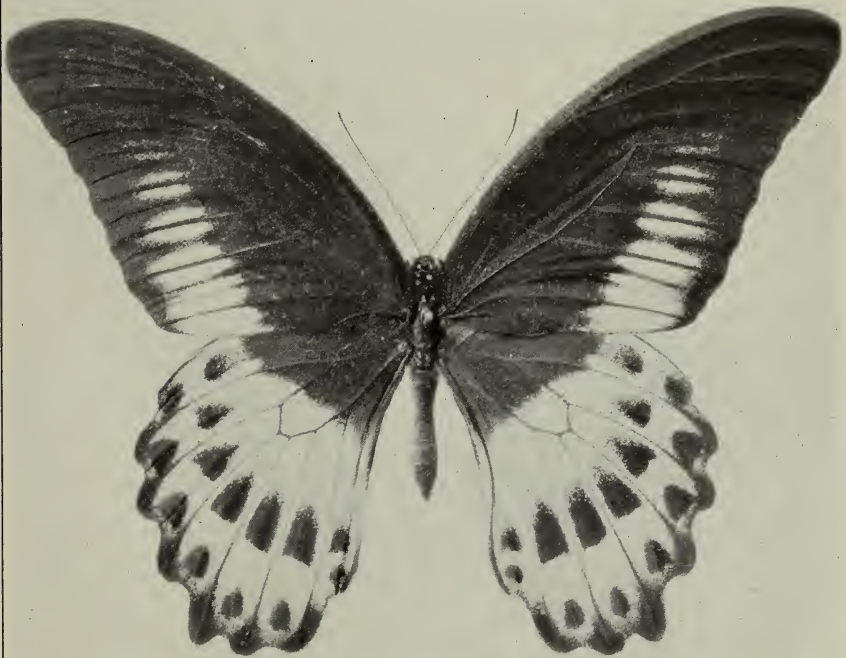
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