

## CLIMATE AND COLORATION IN SOME WASPS.\*

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The following discussion has developed as the result of studies on the solitary wasps of the subfamily Sphecinae. The writer thinks it not unlikely that other groups of wasps would repay investigation along these lines, but he has not had an opportunity to study them in this way.

In the Sphecinae the insects have commonly been placed in two genera: *Sphex* (*Ammophila* auct.) and *Psammophila*. In the first named genus there is a long, slender petiole consisting of two segments: in the other the petiole has but one segment. The insects of the group as a whole are black, but with more or less of a color which, for convenience, may be called red, though in fact it is more nearly ferrugineous. This color, if present at all (there are some wholly black species), is found on the second petiolar segment in *Sphex* and on the abdominal segment next behind: in *Psammophila* it is on the first segment behind the petiole, which would correspond to the second petiolar segment in the other genus.

Study of long series of examples of species in both of these genera shows much variation in the amount of red present in the same species from different localities, and has resulted, after years of study, in the formulation of the following propositions:

I. In the Sphecinae the amount of red present is determined: (1) by sex; (2) by climate, particularly humidity.

II. (1) In the most humid climates there is the least red. (2) In the semi-arid regions the amount of red varies with the varying humidity of different seasons; hence material from these regions collected in different seasons, or even of different generations the same season, may vary considerably in the amount of red present. (3) This will hold for unusually dry seasons in regions which are generally humid, though perhaps less markedly than for the semi-arid regions.

III. The greatest amount of red found in specimens found from arid regions.

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\*Contribution from the Entomological Laboratory of the Massachusetts Agricultural College.

IV. It is at least probable that size in the adult Sphecinae is influenced by the amount of food available for the larva, and that occasional marked departures from average size may be accounted for in this way.

In support of these propositions a quantity of evidence has been accumulated in the Sphecinae, which cannot be presented in detail within the limits of this paper. An outline of it is possible, however.

The common insect *Sphex procerus* (Dahlb.) may be used as an example. This species is widely distributed over the United States, Canada, Mexico and Guatemala at least. From New Hampshire to well down the Florida peninsula close to the shore, these insects show a minimum of red. A little distance back from the shore the red becomes more prominent, except perhaps in Florida with its general humid climate everywhere. The type of *procerus* came from Dom. Zimmerman who appears to have collected mainly in the Carolinas. The specimen which meets type requirements is in the Berlin Museum; is a male; and is quite dark as compared with specimens from points farther inland. *Sphex gryphus* (Smith), the same species, was described from specimens of both sexes taken at Charleston, S. C., East Florida, and California. Here the female is of the darker type, though not extreme in this regard, while the male (from California), as Smith states, has more red on the abdomen.

*Sphex conditor* (Smith), also this species, from St. Johns Bluff, Fla., is a very dark example, as is to be expected from the locality where it was captured.

Going westward from the Atlantic Coast we find that the specimens of this insect show what may be termed the normal amount of red, though an occasional specimen taken near a large body of water, such as one of the Great Lakes, or a large river like the St. Lawrence, manifests something of a reduction of color. On approaching the 100th meridian, however, in the more northerly States, much variation among the specimens is noticeable, and in a few cases it has been possible to obtain information regarding the nature of the particular season in which these insects were taken, at their places of capture. This shows that the specimens having the largest areas of red were taken during or following unusually dry and hot periods, while the darker ones were taken in cooler, wetter seasons.

Passing west into the arid regions, the red areas on the insects become larger, and this condition remains until the humid conditions of the West Coast are reached, where darker forms reappear, and in British Columbia and Washington, quite typical forms again are met with.

Passing west in the Southern States, this same relation may be observed. As far west as Eastern or Central Texas the color is only normal in its extent, but in Western Texas, New Mexico and Arizona, it covers a greater area.

In western Nebraska, arid conditions appear to begin to make their influence felt on this insect, and in Southern and Western Colorado the red area is considerably enlarged. This condition appears to reach its maximum in Utah and Nevada, whence come some of the specimens which show the largest amount of red, with the exception of some from California.

Going south on the Pacific Coast, perplexing forms not lending themselves as readily to analysis are met with. The writer is not familiar with local climatic conditions in that region, and has been dependent upon others for information. From this, it would seem that rather humid areas locally, in Central California, occur not far from arid ones, and it is possible that this may explain the presence of considerable color variation of these insects in localities not very far apart. In general, passing south, rather typical forms are found in Washington, Oregon, and Northern California, but as the arid regions are approached, more red appears, and toward Southern California the red begins to occupy a larger area on the abdomen than the black, which may be reduced to separated spots or a black terminal dorsal plate and a spot or two, producing *Sphex sæva* as described by Smith. Farther south this form becomes more abundant and it is not unlikely that it is present in Western Arizona and Lower California. It is noticeable that in the reduction of the black on the abdomen the red encroaches from the sides of the segments first, and that in form *sæva* the black spots are at or near the dorsal median line.

*Sphex striolatus* (Cam.) from Ventanas, Durango, Mexico, closely resembles *sæva*. The type is in poor condition but structurally it agrees with *procerus*. Coming from an arid region, 2,000 feet high, conditions there would be such as to lead one to expect specimens to have a large amount of red.

Other specimens of *procerus* from various parts of Mexico support the general propositions, individuals from close to the Gulf of Mexico being darker while those from higher and dry regions show more red, *striolatus* marking about the extreme in this regard.

*Sphex ceres* (Cam.) and *Sphex championi* (Cam.) from San Geronimo, Guatemala are described from a male and a female. The types, in the British Museum, are undoubtedly specimens of *procerus*, the male (*ceres*) being rather dark and the female (*championi*) a little darker than the typical form. Cameron is incorrect in placing *ceres* in the group having no red on the abdomen, for a faint red shade is present on the type.

These specimens in the British Museum have been placed (probably by Mr. R. E. Turner) in connection with the name *barbata* Smith. Unfortunately, the type of *barbata* appears to have been lost, and the description is not sufficient to accurately determine its identity. It is perhaps a dark *procerus*, though its size—"13-13½ lines"—is small for *procerus* and it may prove to be a different species.

In *Psammophila violaceipennis* Lep. and *Psammophila valida* Cress., the same feature of color area as related to humidity, holds. The distribution of *P. violaceipennis* and its changes in the red area in different localities might almost be described in the same words as those already used for *Sphex procerus*. Other species having a more restricted distribution, also support the propositions formulated, as far as the localities where they occur, permit.

Finally, a study of size distribution shows a few specimens of each species much smaller than the rest, and in this way *Sphex macrus* (Cress.) is found to be only a small male specimen of *S. procerus*, and darker than is perhaps usual.

Variation in color area, due to differences in sex and in humidity, have therefore, resulted in the production of seven and perhaps eight synonyms for the single species *Sphex procerus* (Dahlb.), and only a geographical study of the species with reference to climate has made recognition of this fact possible.

Knight (Ann. Ent. Soc. Am., XVII, 258-272, 1924) considers the relation of temperature and humidity to color forms in the Hemipteran *Perillus bioculatus* (Fab.) and comes to the conclusion that "variations in the black color pattern of Hemip-

tera, and doubtless other insects, are produced by changes in physiological activity of the insect; and this rate of physiological activity, or metabolism, is governed chiefly by the temperature to which the individual insect is subjected." How far the active life of an Hemipteran nymph can be compared with that of a parasitic larva living in a hole in the ground, on food provided for it, is difficult to determine. As there is no evidence of any change in area of color pattern during adult life, in the Sphecinæ, however, the factors causing this must presumably act on the larva, or pupa, or both, and the condition of the soil at the nests, as regards both heat and dampness, is of importance. As black covers larger areas in these insects in the hot but humid areas of the South while an increase of the red is met with even in parts of Canada, where the maximum temperatures are presumably lower than in Eastern Texas for example, but where there is much dryness, it would seem that Knight's view that humidity in the case of *Perillus* is of less importance than temperature, may not entirely hold for all insects.

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### SYNONYMIC NOTE.

#### *Notonecta bergrothi* Esaki.

In 1925 there appeared two descriptions of a new *Notonecta* species from China. I described some specimens from Shanghai, China, in the Annals of the Entomological Society of America, Vol. XVIII, p. 417, under the name *N. suenisoni*. Before the appearance of this description in print, but too late to withdraw it, I received a reprint from my friend, Tieso Esaki, describing *Notonecta bergrothi* from material in the Helsingfors Museum. These insects were from Chanka, Amur River region and the description was in *Notulæ Entomologicæ* V, p. 14. I surmised from the description of *Notonecta bergrothi* Esaki that my *N. suenisoni* was the same thing. In the *Entomologische Mitteilungen* Band XIV, Nr. 5-6, p. 313, 10 Oct. 1925, Mr. Esaki gives a figure of his *N. bergrothi*. Through the kindness of Dr. Lindberg I have received a paratype of *N. bergrothi*. The specimen is a female, but I feel quite sure my species is a synonym.

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