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## Variations in the Maculation of *Olla abdominalis* Say (Coleop., Coccinellidae).

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(Plate XIII.)

The present paper is based on a study of the variations in the maculation found to be present in a series of 200 specimens of *Olla abdominalis*, collected on November 26, 1910, at Vine Hill, Contra Costa County, California.

At Vine Hill the meteorological conditions are moderate and "tully-fogs" are frequent.

The large series was collected from beneath the bark on eucalyptus trees. These coccinellids were there to hibernate through the winter, and the individuals were congregated in groups of from two to twelve. They never congregate in such immense masses as do the *Hippodamia*e. Usually there was one *Olla plagiata* Casey with each of the groups, irrespec-

tive of whether they were made up of two or more individuals. The latter species is the one formerly known as *Cycloneda oculata* Fab., a variety of *abdominalis* before Casey removed it from the genus *Cycloneda* and placed it in the genus *Olla*.

Colonel Casey, in his revision of the Coccinellidæ, states that the large series of *Olla abdominalis* studied by him exhibited an extremely small amount of variation, which, considering its geographical range, is very remarkable. The following descriptive notes are taken from his diagnosis of the species:

Upper surface pale brownish-yellow, head pale and immaculate. *Pronotum* with a basal black spot at two-fifths from the middle and a short transverse spot before the scutellum, also with two posteriorly converging black spots at the center and a narrow elongate spot on the median line joining the ante-scutellar spot and, at lateral eighth and basal third, a small rounded spot. *Scutellum* black in the male. *Elytra* each with a subbasal transverse series of four small black spots, a median series of three spots, the medial the largest and transversely crescentiform and, at apical fourth near the margin, another small rounded black spot. *Legs* and under surface pale.

After a careful study of the series under consideration, thirty-one specimens were selected out of the two hundred and arranged so that at one extreme they tended toward albinism and at the other toward melanism. By selecting and classifying the variations in elytral maculation, it was possible to arrange them in ten series, as follows:

*Series 1*, fig. 1.—Subbasal transverse series of elytral maculæ small and subequal; median\* macula of the median series obsolete, the medial and lateral maculæ larger than those of the subbasal series, the medial scarcely crescentiform; subapical macula very minute. Pronotal maculæ all rather widely separated, lateral macula minute. Scutellum and sutural margins of the elytra pale. Under surface and legs rufo-testaceous, except the metasternum, which is rufous, and the meso- and met-episterna which are distinctively whitish, the small epimera apparently concolorous.

A companion specimen to the one from which fig. 1 was drawn, is identical with the above, but the meso- and met-episterna are white, the mes-epimera apparently rufo-fuscous, and the met-epimera are white; the metasternum rufous, laterally rufo-piceous, the first two

\*Note.—The adjectival terms lateral, median and medial refer to the maculæ in a series on each elytron.

abdominal segments are rufous centrally and each has a piceous macula laterally.

*Series 2*, fig. 2.—In the subbasal transverse series of small spots the second from the suture is distinctly enlarged and slightly more extended posteriorly; median macula of the median series present and very small, medial macula distinctly crescentiform and narrower; subapical macula larger. Sutural margins of the elytra concolorous with the disc. Pronotal maculae slightly less widely separated and the lateral macula larger. Under surface paler, as in the type of *Series 1*, except that the general color is more rufous and the side pieces scarcely whitish. Two companion specimens to the type of *Series 2* are identical, except that the side pieces are more whitish.

*Series 3*, fig. 3.—Maculae of the subbasal series larger and subequal; maculae of the median series distinctly larger, the medial subcrescentiform, thicker and more irregular in outline, lateral macula slightly the largest. Pronotum with the posteriorly converging maculae nearer together and almost connected with the narrow elongated macula which is continuous with the ante-scutellar macula. Edge of the sutural margin of each elytron very narrowly nigrescent.

Under surface as in the type of *Series 2*. Four companion specimens to the type of the present series, vary as follows:—One has the under surface the same, but the side pieces of the sterna are whitish; the second has the metasternum and first two abdominal segments slightly piceous; the third has the metasternum nigro-piceous; the fourth is rufous beneath with the abdominal segments piceous centrally.

*Series 4*, fig. 4.—Medial and umbonal maculae larger than in the type of *Series 3*; median series with the lateral and median maculae slightly smaller, the medial thicker and more crescentiform; subapical macula distinctly larger and irregular. Pronotum with the maculae narrowly connected, forming an irregular M-shaped figure; lateral maculae larger and rounded. The mes- and met-episterna are whitish; metasternum and first two abdominal segments are rufopiceous, remaining segments gradually becoming rufous to the fifth.

Seven companion specimens to the present type are variable in the color of the under surface, metasternum nigro-piceous, or metasternum and first three abdominal segments nigro-piceous to rufopiceous, to entirely rufous; one specimen has the metasternum and four abdominal segments nigro-piceous, and the fifth segment rufopiceous; another specimen has the mes-epimera nigro-piceous.

*Series 5*, fig. 5.—Maculae of all the series larger and more subequal, the medial of the median series distinctly thicker and less evenly crescentiform. Pronotal M-shaped maculation larger and heavier, connectants thicker. Lateral macula no larger than in the type of *Series*

4, and the limit in size. The metasternum and abdominal segments piceous, the latter moderately narrowly rufo-piceous at the sides.

Three companion specimens have the under surface about as in the type of the present series, but the pronotal maculæ are more or less separated as in fig. 9.

*Series 6*, fig. 6.—Maculæ of the subbasal series distinctly heavier and more irregular, the medial two of each side coalescing; median series of maculæ slightly smaller than in the type of the preceding series and subequal, medial maculæ less crescentiform; subapical macula slightly smaller than in fig. 5. Pronotal M-shaped maculation slightly less heavy. Under surface pale rufous, with the sides of the metasternum rufo-piceous.

*Series 7*, fig. 7.—Maculæ of the subbasal series smaller, except the medial two; median series larger and more irregular, the medial and median of each side coalescing, the medial macula largest and more obtusangular; subapical macula large. Pronotal M-shaped maculation as in the type of Series 6, lateral macula smaller. Under surface pale as usual, with the sides of the metasternum slightly piceous. A companion specimen has the elytral subbasal series of maculæ distinctly larger and subequal, the sub-apical macula rounded and subequal to the largest.

*Series 8*, fig. 8.—The second macula on each side of the suture in the subbasal series is distinctly extended posteriorly, and the sutural macula slightly produced anteriorly, both subequal, similar in form and larger than the lateral two; median series of maculæ subequal in size and smaller than in type 7; subapical maculæ as in Series 7. Pronotal M-shaped maculation a little heavier than in Series 7, lateral macula as in Series 6. The metasternum is rufo-piceous, the abdominal segments slightly paler rufo-piceous, laterally and apically more or less rufous. A companion specimen is similarly colored.

General color of the elytra within an area as shaded in fig. 8, distinctly pale scarlet, enclosed maculæ are surrounded by a halo of the usual color. Several specimens in the original series had the entire elytra tinged with pale or obscure scarlet, the maculæ with or without a halo.

*Series 9*, fig. 9.—The medial macula of the subbasal series is slightly produced posteriorly, the series as a whole apparently straighter, size of the maculæ as in figs. 7 and 8; maculæ of the median series larger than in Series 8 and very narrowly separated from each other, the medial macula being as distant from the suture as in all the preceding series; subapical macula as in fig. 4. The pronotal M-shaped maculation dissolved, the medial maculæ very narrowly separated; lateral macula as in Series 7. Under surface of the type and two companion specimens dark, metasternum and abdomen nigro-piceous, terminal segment more or less rufous.

*Series 10, fig. 10.*—Maculae of the subbasal series nearly as in Series 8; maculae of the median series enlarged, the medial crescentiform, the lateral and median nearly coalescent, the median macula produced posteriorly and confluent with the subapical macula, the three forming an irregular figure-7 pattern. Pronotal M-shaped maculation again reconstructed as in Series 7 and 8. Under surface dark, as in Series 9.

Figure 11 is drawn from a specimen collected in Southern California, and kindly loaned to me by Dr. E. C. Van Dyke. The elytral maculation is self-explanatory after what has been said in the consideration of the preceding series. In the specimen the metasternum and abdomen are dark rufous, the central area of the abdomen is clear rufous. The mes- and met-episterna are distinctly whitish. The lateral macula of the median series nearly meets the marginal bead, the latter and sutural edge of the elytra are very narrowly piceous. The scutellum is fuscous. Two companion specimens collected at Old Fort Brown, Brownsville, Texas, on August 3d, 1906, by A. B. Wolcott and loaned to me by Mr. F. W. Nunenmacher, are quite identical in elytral maculation. In one specimen the under surface is rufous and the metasternum is rufo-piceous. In the other one the metasternum is nigro-piceous and the general color darker rufous. In both the mes- and met-episterna and met-epimera are distinctly whitish, the white extending caudad along the sides of the first two abdominal segments, and more dilated on the first segment in one specimen than in the other.

The coxal lines in both are black and the enclosed coxal plate is rufo-piceous. In one specimen the front of the head is fuscous; in both the marginal and sutural edges of the elytra are dark as in Series 10. The scutellum is fuscous.

A careful re-examination of Type 10 clearly determines that the white of the sternal side pieces extends backward on the first two abdominal segments.

Mr. Nunenmacher informs me that these extreme dark forms are more common in Mexico. They are rare north of the Mexican boundary, at least as far as we know here on the Pacific coast.

Figure 12 illustrates an extreme pale form taken in Arizona, and it appears to be rare. The white of the sternal side pieces is distinct and its extension backward upon the abdomen is also evident.

The extension of the white upon the sides of the abdomen occurs sporadically in specimens collected at Mokelumne Hill,

Calaveras County, California, elevation 2,300 feet. A series of four specimens collected by Mr. G. R. Pilate, at El Centro, Imperial County, California, is to be referred to Series 1 and 2 of the present paper.

The material just discussed does not in any way elucidate the relation between *Olla abdominalis* and *Olla plagiata* Casey.

The above interesting series has caused considerable speculation as to the factors which act to bring about this variation in pigmentation. The normal tendency in *Olla abdominalis* is toward albinism.

I desire to mention the conclusions or theoretical suggestions of W. L. Tower, who made his studies on *Leptinotarsa 10-lineata*. His experiments extended over a period of eleven years, and his results have been published by the Carnegie Institution at Washington.

Tower believes that color production in insects is dependent on the action of a group of closely related enzymes, of which chitase, the agent which produces hardening of chitin, is the most important. He demonstrates by a series of well-planned experiments that colors are directly modified by the action of external agencies, namely: temperature, humidity, food, altitude and light. Food chiefly affects the subhypodermal colors of the larvae, and does not enter much into account, the most important agents affecting the adult coloration being *temperature* and *humidity*. A *slight increase* or a *slight decrease* of *temperature* or *humidity* was found to stimulate the action of the color-producing enzymes, giving a tendency to *melanism*; but a *large increase* or *large decrease* of *temperature* or *humidity* was found to inhibit the action of the enzymes, producing a strong tendency to *albinism*.

There seems to be no logical reason why we should not reason from analogy. Let it be granted that there is such an enzyme as chitase or its analogues present during the earlier stages in the ontogenesis of insects and that temperature and humidity can produce the optimum state for the activity of such enzymes, just as they do for other ferments, notably those for the conversion of proteids into peptones,

or starch into sugar; or that a similar environment excites activity in organized ferments. Biologists contend that environment plays a very important part in the variation of organisms, not only in the modification of coloration, but also in sculpturing.

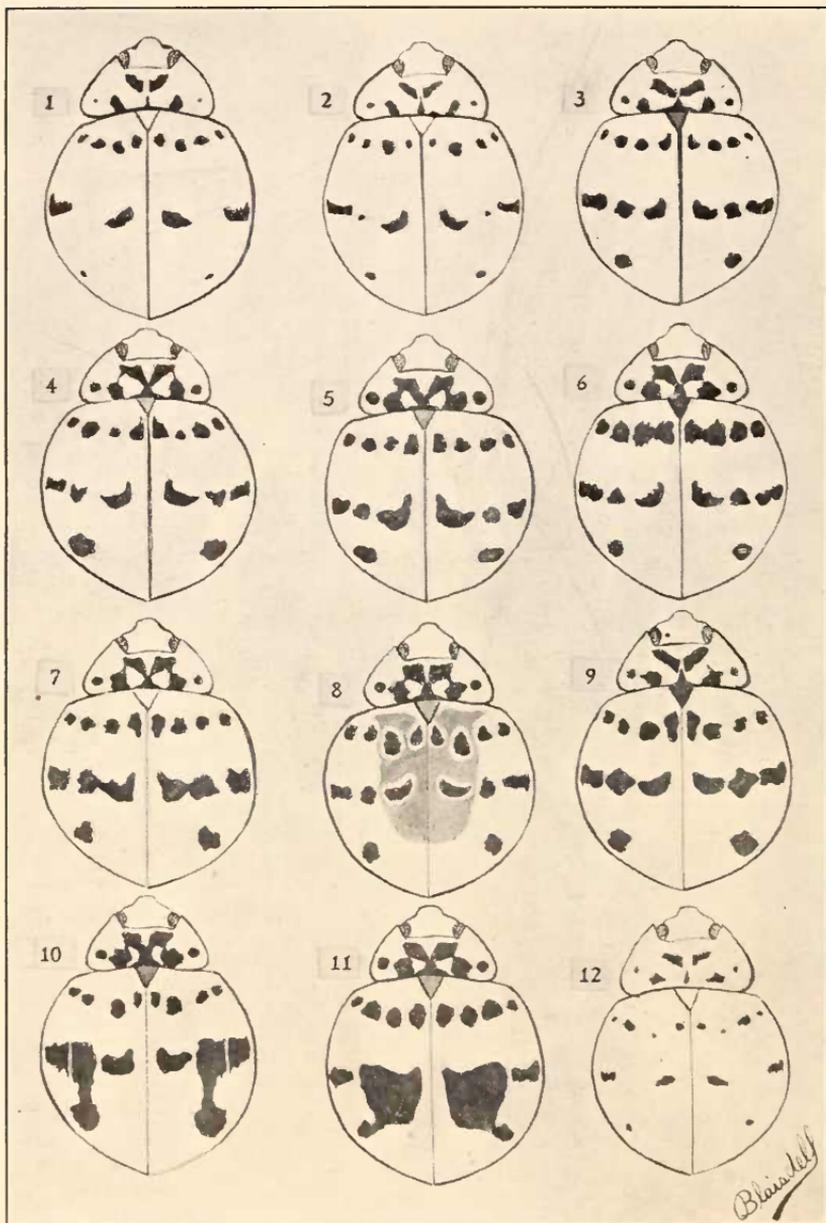
It is important to emphasize the necessity of observing large series of insects and of keeping very careful and detailed records of the meteorological conditions attending their ontogenesis under natural conditions, in order to correlate the observed facts with analogous data obtained through experimentation in the laboratory.

The collecting of large numbers of coccinellids necessitates some rapid and effective way of cleansing them after removal from the cyanide bottle. It is well known that these beetles throw out secretions from glands situated in the sides of their bodies and from articulations, besides regurgitating the ingesta.

It is recommended that the entire catch of the specimens, few or many in number, be placed in a vial and that they be covered with chloroform and gently shaken for about one-half of a minute. That the chloroform be then poured off into another vial and the insects shaken out upon a sheet of blotting paper to permit of the evaporation of the chloroform. They will then be perfectly clean, bright and shining with colors and sculpturing fully cleared for study.

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OLLA ABDOMINALIS—BLAISDELL.