

We were especially impressed by the precise intermediacy of the individual. Generally speaking hybrid butterflies show such intermediacy, but in some cases they may resemble one parent more than the other. In the genus *Limenitis*, F<sub>1</sub> hybrids of *L. archippus* Cramer and *L. astyanax* (Fabricius) are intermediate, but backcrosses yield both hybrid-like and parent-like morphs (Platt 1975, *Evolution* 29: 120-141). In swallowtails at least, even F<sub>1</sub> hybrids may sometimes show one-sided intermediacy. For example, Clarke and Sheppard (1957, *Lepid. News* 11: 201-205) bred female *P. glaucus* L., the eastern North American counterpart of *P. rutulus*, with male *P. eurymedon*, and found that the *glaucus* wing pattern seemed generally dominant to that of *P. eurymedon* (cf. their Fig. 2 with Fig. 1 of the present paper). The F<sub>1</sub> progeny of laboratory crosses of *P. polyxenes* and *P. xuthus* were like the former parent in 11 out of 14 characters (Remington 1959, *J. Lepid. Soc.* 13: 151-164). Thus it is possible that all individuals of *P. eurymedon* × *rutulus* found in nature in the future will not be so conspicuously and precisely intermediate as the one figured here.

WARREN HERB WAGNER, JR., *Department of Botany, University of Michigan, Ann Arbor, Michigan 48109.*

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#### NOTES ON SOME MOSAIC *PIERIS* (PIERIDAE)

Mosaic specimens occur in many if not all species of butterflies and moths, and are of scientific interest in that they can provide clues to the sequence of events occurring in embryonic or post-embryonic development. The origins of several types of mosaics are discussed by Ford (1945, *Butterflies*, Collins, London, Ch. 9). The mosaic nature may be sexual (various kinds of gynandromorphs) or homeotic (involving the production of a normal feature or pattern in an inappropriate location) or neither.

The checkered white, *Pieris protodice* Bdv. & LeC., is one of the most abundant and widespread North American butterflies and shows a conspicuous sexual dimorphism. There are apparently no published reports of gynandromorphs or other sexual mosaics although a bilateral non-sexual aberration inherited in a Mendelian manner has been reported (Shapiro 1970, *Wasmann J. Biol.* 28: 245-257). I have never seen a mosaic in any institutional or private collection. Figure 1 shows the first such specimen I have turned up in thirteen years of research on this species, including mass laboratory culture through over 30 generations and repeated field sampling in several states. It was collected in a sample of 10 taken 16 October 1977 at Rancho Cordova, Sacramento Co., California. It is a very unusual gynandromorph for a number of reasons. The entire body and three wings are apparently male. The right forewing appears about 40% female, with the inner margin, discal cell and apex mostly female. There are three black spots near the margin in the interspaces where no black normally occurs in either sex. The female characters are confined to the upper surface. Ventrally the forewings are symmetrical and both male. Thus the assumed chromosomal accident must have occurred in a cell all of whose progeny were fated to positions on the surface giving rise to the dorsal lamina and its scales.

I have on hand a similar mosaic gynandromorph of *Colias eurhythme* Bdv. (figured by Shapiro 1973, *J. Res. Lepid.* 12: 94) in which the apex of the left forewing is female above, and the rest of the animal male. In this case the sexes do not differ ventrally in the forewing apical area, and it cannot be said with certainty whether

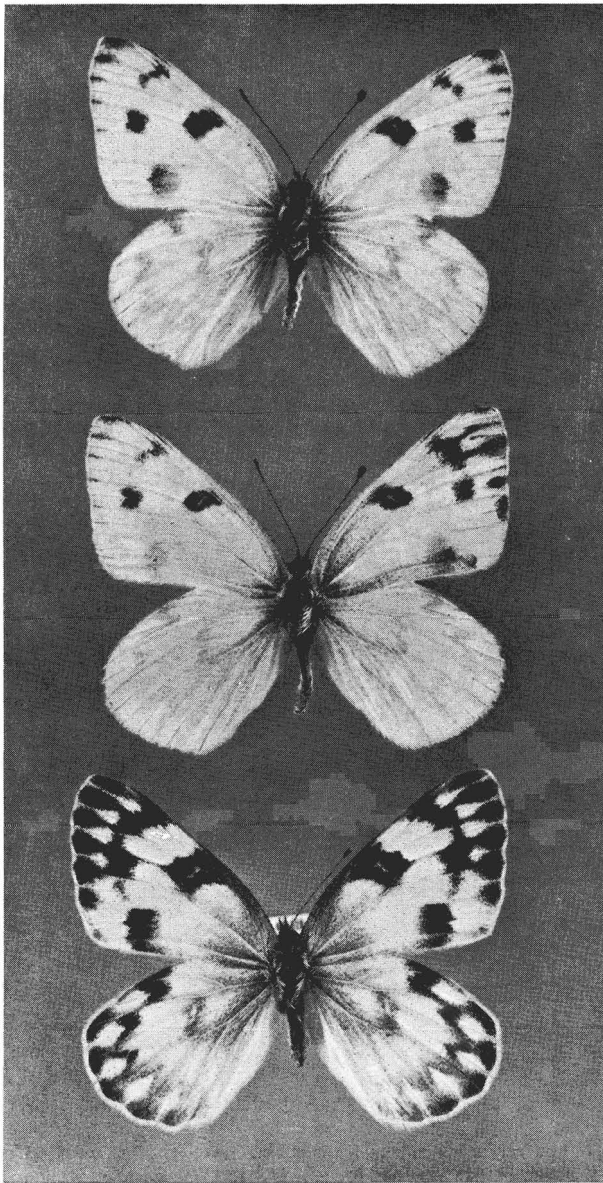


Fig. 1. Normal male (top) and female (bottom) *Pieris protodice* and mosaic gynandromorph (center). All from Rancho Cordova, California, 16 October 1977.

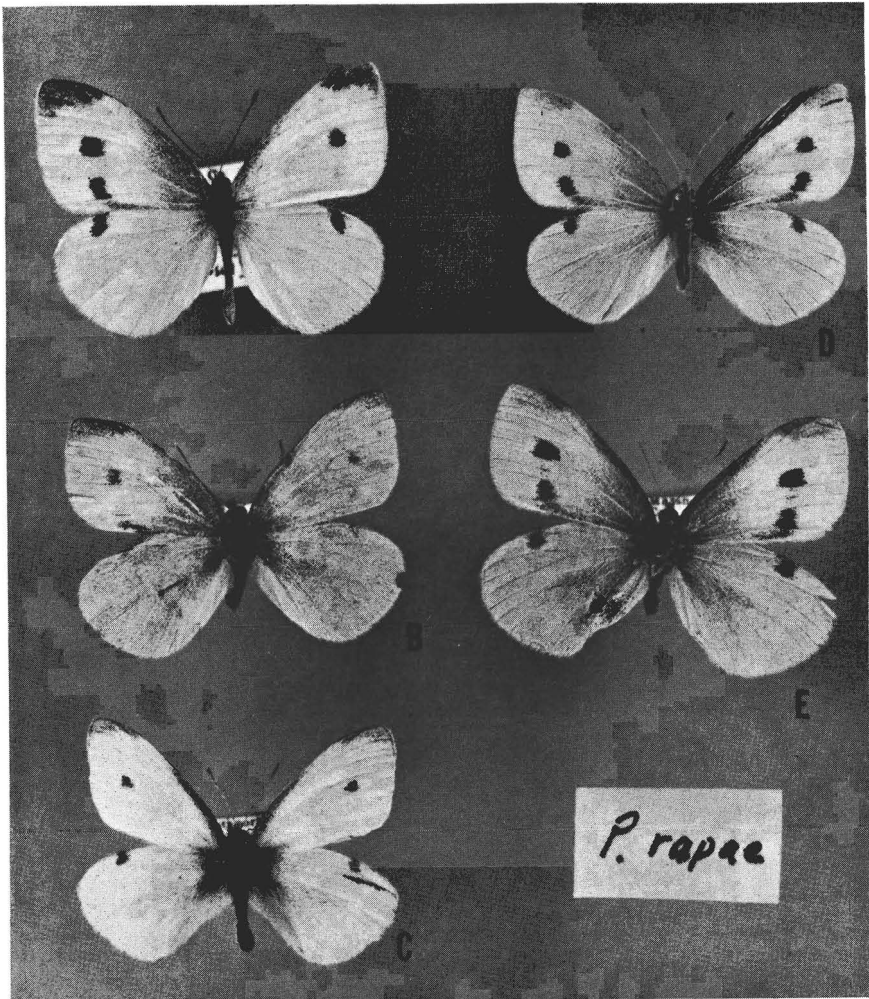


Fig. 2. Mosaic *Pieris rapae* from California. A: bred, Davis, Yolo Co., April 1972; B: wild, Davis, March 1972; C: Southport, Yolo Co., March 1973; D: Sacramento Co., April 1973; E: Suisun Marsh, Solano Co., March 1974.

the specimen is aberrant on both surfaces. The same applies to the *Colias philodice* Latr. figured by Emmel (1964, J. Res. Lepid. 3: 63) as a mosaic gynandromorph. In this case, however, it is unlikely that the specimen is gynandrous at all. The "female" pattern is chaotic and more likely represents patches of male ground color within the black border, a not uncommon occurrence.

Figure 2 illustrates some mosaics of *Pieris rapae* L. from northern and central California. Two of these are clearly sexual. Specimen A is a bilateral gynandromorph bred *ex ovo* at Davis. Specimen B is a rather worn, field-collected specimen. These are the only California gynandromorphs I have seen in this species, and it is of more

than passing interest that B was collected in the same field in the same week as the mother of A. Both specimens show some streaky mosaicism, with patches of male scales on the female side and conversely.

Specimens C through E have abnormal, asymmetrical black markings which are confined to the upper surface. (Mosaics of this sort are very rare on the ventral surface. I have only one *rapae*, a female, with an abnormal black marking confined to the ventral surface and this is a "ray" similar to and perhaps homologous with the Mendelian character found in the *protodice* group (Shapiro 1973, Wasmann J. Biol. 31: 301-311).) In specimen E the shape of the spot suggests homeosis, but it is located in an inappropriate interspace; moreover its position corresponds to an obvious crimp in the dorsal lamina, of the sort to be expected from a deformation of the pupal wing-case. Such injuries may occur when an unhardened pupa slips in its silken girdle. In *Colias* they routinely result in melanization of the area around the injury; if the adult is able to eclose, the resulting pattern is grossly abnormal (compare female figured by Shapiro 1970, Entomol. News 81:50/data document p. 5).

Braun (1939, Biol. Bull. 76: 226-240) showed that as pigment precursor spread outward across the wing from the body, deposition took place in those scales which were sufficiently chitinized at that time. Control of pattern thus depends on the rate of scale maturation, which may be accelerated around injuries—contributing to mosaics such as these. Since injuries are most likely on the dorsal surfaces, especially of the forewings, it is not surprising that mosaicism is commonest there. The black streaking near the costa of specimen D could have arisen in several ways, but that near the hindwing apex of C suggests an injury resulting in pigment deposition in the corresponding scales as a wave of melanin precursor moved across the wing.

All of the specimens figured are in the collection of the University of California at Davis.

ARTHUR M. SHAPIRO, *Department of Zoology, University of California, Davis, California 95616.*

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#### A MALE-LETHAL GENETIC FACTOR IN *PHYCIODES THAROS* (NYMPHALIDAE)

During the course of four years of rearing studies using *Phyciodes tharos* Drury, a total of 17 broods was reared of stock from Upper Tyrone Township, Fayette Co., Pennsylvania. Of these, 15 were derived from wild-collected females and the remaining 2 from wild-laid egg patches found on leaves of the foodplant, *Aster simplex*. Exact egg-hatch data were kept on 16 of the broods, viability and sex ratio data on 13. Of the 17 broods, 3 showed almost total male inviability. In 2 of these 3, most mortality appeared to be during embryonic development, whereas in the third there was normal embryonic viability but about 50% mortality between the first and fourth larval instars. An additional brood (77-63) reared from a wild female collected in Rochester Mills, Indiana Co., Pennsylvania, showed greatly reduced embryonic viability and an almost total absence of male adults (Table 1).

Female progeny from two of the abnormal Fayette Co. broods (74-4, 76-2) were mated to males from normal broods of the same population. Each of these isofemale lines (A and B) showed a tendency toward lowered egg fertility ( $P < .001$ , Wilcoxon on