Pittsburgh) was observed from three to four o'clock in the afternoon of March 8, 1964, in a large grassy swamp. The flight was heavy, calculated at about 500 individuals crossing per 100 feet of highway per minute. These expert fliers were wary and hard to catch, as in half an hour I managed to collect only five specimens, besides another I picked up that was hit by a car. At first they flew directly from north to south, but curiously and slowly changed from west to east, finally changing to southwest to northeast. This changing of direction on the vast, open, flat, swampy lowland in only an hour's time doesn't make much sense. It might be surmized that they were only flying circles within the particular swamp where I observed them. It might be mentioned that the southern end of the swamp was south of the road and very close to the same, and was rounded as if the road were a line cut through the middle of a circle, being surrounded by swamp forest. However north of the road the swamps extended as far as the eye could see. Perhaps these creatures, on reaching the southern end of the swamp and encountering the forest, circled back to stay within the limits of the more open grassy areas. The winds on that afternoon were mild and hot from the southeast.

Lee D. Miller calls my attention to an article published by C. B. Williams (Records of Insect Migration in Tropical America, 1920, *Trans. Ent. Soc.* LONDON, 68:154-159), in which excellent detail is given on migratory habits of *Calpodes ethlius* in Panama. In this article it will be noticed that this species in migration does not adhere to one single direction, mention being made of it "passing in almost every direction" in the course of a single afternoon and evening.

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HUMIDITY, DARKNESS, AND GOLD SPOTS AS POSSIBLE FACTORS IN PUPAL DURATION OF MONARCH BUTTERFLIES

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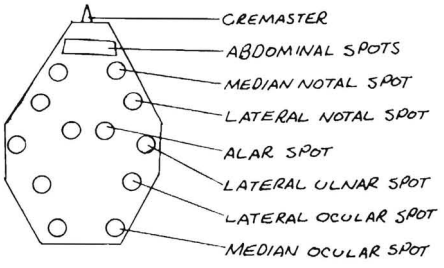
In his recent book on the monarch butterfly, *Danaus plexippus* (L.), Dr. F. A. Urquhart (1961: 38-39) encouraged work on the pupal stage with these statements: "I am of the opinion that these spots are not purely ornamental, but that they perform a definite function. They may act as light receptors that delay emergence of the adult butterfly during periods of adverse weather conditions.", and "Presumably some light perception mechanism controls the rate of development, allowing more rapid development on bright, sunny days, and virtually no development during periods of darkness." Accordingly, the following two experiments were conducted.

The effect of painting the gold spots of the monarch butterfly chrysalis on the emergence time of the adult was tested. Twenty-seven monarch butterfly chrysalids were put in nine groups of three each on the day after pupation. All of the gold spots on the chrysalids in group 1 were painted over with red fingernail polish. Groups 2 through 7 had various combinations of spots painted. Group 8 was daubed with polish, but care was taken not to cover any of the spots. Group 9 was not painted (figure 1).

One pupa in group 7 died. Butterflies emerged from the remaining chrysalids in eleven to fifteen days. The time prior to emergence seemed unaltered by the red fingernail polish. The butterflies emerged at varying intervals in all groups. Two possible conclusions come to mind: fingernail polish is not an effective means of keeping out light, or the gold spots on monarch butterfly chrysalids do not function as photoreceptors that effect the emergence period. The latter explanation seems more likely.

FIGURE 1



DIAGRAMATIC REPRESENTATION OF SPOTS ON A MONARCH BUTTERFLY CHRYSALIS

● SPOT PAINTED

O SPOT LEFT UNPAINTED

THERE APPEARS TO BE AS MUCH VARIATION IN PUPAL TIME AMONG SIMILARLY PAINTED PUPAE AS THERE IS BETWEEN PAINTED PUPAE AND UNPAINTED ONES. THE SPOTS DO NOT APPEAR TO AFFECT EMERGENCE DATES.

GROUP		DAYS SPENT IN PUPA		
1		11	13	14
2		14	11	11
3		11	11	12
4		12	11	13
5		12	13	14
6		15	14	12
7		12	X	13
8		12	15	12
9		12	12	13

An experiment was performed to test effects of humidity and darkness on pupal maturation of monarch butterflies. Ten chrysalids were suspended by a thread tied to their cremasters from the lids of each of five transparent plastic containers on the day after pupation. The cylindrical containers were 10 cm deep, and 25 cm in diameter. One container of chrysalids was set aside as a control. The second container was placed 25 cm under a 60 watt desk lamp that shone continuously. The third was placed in a dark cupboard. Containers 4 and 5 were loosely lined with cheesecloth. Three cm of water was added to both. Container 4 was placed under the desk lamp, while 5 was put in the cupboard.

A graph showing the number of days required until emergence of the butterflies in each group is given (figure 2). The butterflies in the dry light container emerged, along with those of the control group, over a five day period, requiring less than thirteen days to mature. The butterflies in the light and humid container all emerged by the thirteenth day, also, but almost all came out on the thirteenth day. The emergence of the butterflies kept in the dark was delayed several days. The first ones did not complete their metamorphosis until the twelfth day. The ones in the humid dark chamber emerged about a day behind those in the dry dark container.

One can conclude that both humidity and darkness retard development of monarch pupae and that darkness is a more significant factor than humidity. A combination of total darkness and a saturated atmosphere cannot delay the monarch butterfly's emergence from his chrysalis more than about five days.

Literature Cited

Urquhart, F. A., 1961, *The Monarch Butterfly*, University of Toronto Press.

FIGURE 2