A MIGRATORY FLIGHT OF *CATOPSILIA EUBULE*
(LEPID.: PIERIDÆ).

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The butterflies belonging to the genus *Catopsilia* are frequent migrants, and many records of their migratory flights have been published. But these records are often vague as to the identity of the species, or they lack the precise data necessary to explain the problems that arise in connection with migratory behavior.

During September and early October of 1932, the writer has had an opportunity to witness a migratory flight of *Catopsilia eubule* L. which was in progress over a large part of St. Louis County, Missouri. Most of the observations were made at Webster Groves, but the flight was also seen in various other places. It was first noticed on September 3rd, and had probably already been going on for some time. The butterflies were flying almost due south (their direction being only a few degrees to the east) during the hours when butterflies are usually active, and on days when weather conditions were favorable to butterfly activity. On cool or cloudy days, as well as during the early morning hours, few or none were to be seen. They were most numerous between 10 A. M. and 3 P. M. The direction of the wind did not influence their flight. This was always in a southward direction although the prevailing winds were from the west and northwest. They flew from two to ten feet from the ground with an average of about five or six feet. Both sexes were observed in the movement.

Mr. Stuart L. O'Byrne, brother of the writer, made counts to determine the frequency with which the butterflies passed between him and a point approximately 100 feet east of his position, and the results are shown in the accompanying table. As already stated, all the butterflies

flew southward, with only one lone individual flying in any other direction; this one changed its course from south to west, and disappeared in that direction.

FREQUENCY ON 100-FOOT FRONT

Date 1932	Time (Central Standard)	Elapsed time	No.	Average rate per hour	Wind	Weather
Sept. 3	1:08-1:20 P. M.	12 min.	21	105	Northwest	Part cloudy
Sept. 3	1:20-1:30 P. M.	10 min.	20	120	Northwest	Part cloudy
Sept. 3	3:24-3:36 P. M.	12 min.	18	90	West	Clear
Sept. 4	11:17-11:32 A. M.	15 min.	62	248	Variable; light breeze	Clear
Sept. 4	1:19-1:30 P. M.	11 min.	32	176	None	Part cloudy
Sept. 4	1:30-1:39 P. M.	9 min.	29	194	None	Part cloudy
Sept. 4	2:39-3:00 P. M.	21 min.	25	72	Variable; light	Part cloudy
Sept. 13	12:59-1:15 P. M.	16 min.	53	199	East-north- east	Part cloudy

Total time, 106 minutes; 260 butterflies counted; average rate, 147 per hour. All observations made at Webster Groves, Missouri.

It is interesting to note that the butterflies kept at a uniform height above ground, adapting their up and down flight to the knolls and depressions of the ground. The direction was not altered by encountering obstacles such as knolls or buildings; but the butterflies flew over them instead of around them. Upon reaching a railroad embankment, they flew downward, maintaining their usual distance from the ground, until they were just above the tracks; then, as they approached the shadow of a nearby viaduct, they turned upward and flew over the bridge, when they could have flown under it much more easily.

Their flight differed from the usual mode of this species in being a little less rapid, and not so erratic. They frequently stopped at flowers, sipping the nectar from one or more of the blossoms. Their stops were short; they seemed impatient to resume their march, and showed a restlessness that indicated a desire to press onward. There was no pairing, and they showed no flocking tendency; each individual was flying independently. Other species common

hereabouts during this migration included *Colias eurytheme* Bdv., *Zerene caesonia* Stoll, and *Junonia coenia* Hbn., but they showed no disposition to join *eubule* in its southward flight.

Discussing the migration of butterflies, Clark ('32) suggests that the aggregation of male pierids about puddles of water is evidence of overcrowding, such assemblages being composed of the weaker individuals that have been unable to secure food because of competition and persecution by their more vigorous fellows; they therefore gather on muddy areas to obtain water. They subsequently begin to wander, and this leads to the formation of large migrating swarms which are almost wholly composed of males. They usually fly against the wind. He considers the migrations of *C. eubule* to be of this type, and that they therefore represent the end of the natural process of the elimination of surplus males. This explanation does not fit the facts in the present instance. During 1932 very few assemblages of pierids in muddy spots were seen in the region where the flight took place, although they were exceedingly numerous in 1931. This suggests that the heat and drought of 1931 brought them together at wet places, and that overcrowding had little to do with this phenomenon. Furthermore, these aggregations consisted mostly of *Eurema lisa* Bdv. & LeC., with some *Colias*, but only one or two *eubule* were ever seen in any one such group. In the migration observed in 1932, many females were seen. There was no tendency to fly against the wind; on the contrary, their flight was independent of wind direction.

There is good reason to believe that migration southward is an annual event in the life of this species in many parts of the United States. Scudder ('99) refers to it as a frequent migrant in the eastern states, and Brower ('30) says that in the neighborhood of Willard, Missouri, it "migrates through August, September, and October, coming from the northwest." Williams ('30-a) has collected many records of migration in the genus *Catopsilia*; many of these refer to *C. florella* Fab. in South Africa, and *C. eubule* and *C. statira* Cram. in tropical America. Most of the published records of "*Catopsilia* sp." or of "yellow butterflies" probably belong to these three species. In another paper Wil-

liams ('30-b) gives the results of counts made to determine the frequency with which butterflies in migration passed a given point. Observations of this kind on *C. florella* show that its migrations are indeed similar to the one observed by the writer in *C. eubule*. The large number of migration records in this genus are evidence of the frequency of its occurrence, and indicate that such behavior is no small factor in the biology of its species.

There is no evidence that a return flight takes place in *eubule*. The repopulating of the northern part of its range may be accomplished by a gradual dispersal northward during the summer, or through the increase in numbers of the few that manage to survive the winter. Of interest in this connection are the many records of individual northern occurrences of various southern species of this genus; for some recent records, reference is made to Calkins ('32), on *C. philea* L., *agarithe* Bdv. and *statira* in western Kansas, and citations by O'Byrne ('32) of some northern occurrences of *C. philea*. Such records refer to them as "strays," and indicate a possible way in which a northward spread of *eubule* could take place without attracting attention.

The foregoing data on *C. eubule* have important bearing on the nature of migration in insects. The question, whether insect migration is purposive, or is merely the result of their being blown about by the wind, is answered by the fact that the butterflies continued their flight day after day in the same direction, despite changes in the direction of the wind, and regardless of the contour of the ground and presence of obstacles. This has been fully discussed by Williams ('26), but the question still keeps bobbing up. The fact that the manner and speed of flight differed somewhat from the usual behavior indicates that the butterflies were in an abnormal physiological or mental state. The results of dissections of migrating females of *C. florella* by Williams ('30-a) give further weight to this suggestion, for they indicate that flight starts during a condition of sexual immaturity, and ceases when oviposition is ready to begin. It may be that the climatic changes of a temperate autumn are accompanied by internal changes in the butterflies. This is reasonable in view of the fact that the genus *Catopsilia* is almost exclusively tropical; *eubule* itself is most

abundant in tropical America, where it probably originated. It may never have become completely adjusted to the seasons of a temperate zone. If this is true, then the southward migration can be regarded as an adaptation to avoid the necessity for overwintering. Some individuals do survive the winter, however, either as pupae or as imagines, but the scarcity of the species in early summer makes it probable that most of them either migrate or perish. This suggestion does not explain the frequent migrations observed in the tropics.¹

Whatever the cause or purpose of migrating flights in *Catopsilia* may be, the notes confirm the conclusions of Williams ('26), that uni-directional flight is the active expression of an internal physiological or psychological state in the butterflies. This impels them to undertake self-contributory flight in a particular direction, which neither obstacles nor wind can prevent or even modify. This state may be produced by external conditions, but the flight itself is the result of volition or effort on the part of the butterflies. In this respect it is essentially similar to the migrating flight of birds, differing chiefly in its greater irregularity and in not being repeated by the same individuals. In its seasonal relations, the flight of *C. eubule* is similar to that of *Danais plexippus* L. (which likewise is a species of tropical origin), but differs in not being preceded by any concentration into large aggregations.

Anyone who observes this species in migration in the future can aid materially in solving its problems by making records of the pertinent facts in as great detail as possible. Such observations ought to be made in many localities and over a period of years. It is only through the co-operation of many observers that the mystery of the

¹The late Walter Heape, in an exhaustive work on animal migration and related phenomena ('31), distinguishes between emigration, in which no return flight is made, and true migration, in which a return flight is always made and which recurs periodically. He would therefore class the present flight of *eubule* as an instance of emigration. Heape believes that overcrowding and shortage of food is the chief cause of emigration in butterflies, but it is not clear whether he refers to shortage of food plants for the larvae or of flowers for the adults. He recognizes sexual condition as a contributing factor, which weakens somewhat the distinction he makes between the two kinds of behavior.

movements of countless butterflies can be explained, and it is to be hoped that intelligent efforts will be made to solve the problem of butterfly migration.

SUMMARY

1. A southward migratory flight of *Catopsilia eubule* Linn. was observed in St. Louis County, Missouri, during September and early October, 1932.

2. Wind and obstacles did not change the direction of the movement. There was no mating, or formation of aggregations, and no other species accompanied them.

3. It is shown that although migration in this species may be related to environmental factors, or to internal and possible sexual conditions, yet the actual flight is due to voluntary efforts on the part of the butterflies.

4. No return flight has been observed; repopulation is effected by means of the gradual northward spread of stray individuals, or through the increase in numbers of the few that survive the winter in the north.

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