EUPTYCHIA AREOLATA: DISTRIBUTION AND VARIATION, WITH SPECIAL REFERENCE TO MISSISSIPPI (SATYRIDAE)

BRYANT MATHER
Jackson, Mississippi

Euptychia areolata (J. E. Smith) apparently was first collected in Mississippi at Biloxi, Harrison County, on April 10, 1921 by the late Dr. F. M. Jones (*in litt.*, 1953). The first records were published by Brown (1949, 1950a), who referred to its occurrence at Gulfport, Harrison County, based on reports by Harold I. O'Byrne (Sept. 1–4) and F. M. Jones (Apr. 28–May 18). Brown's map (1950a) indicated occurrence only in the extreme southeastern portion of the state. Mather and Mather (1958) knew of 18 specimens and regarded theirs from Burnsville, Tishomingo County, within 12 miles of the Tennessee line, a significant extension of the known range. Sixty-five specimens are now known. The 12 localities in Mississippi from which *E. areolata* is known to have been taken are shown in Fig. 1; they are situated in eight of the 82 Mississippi counties. The 65 Mississippi specimens, classified by locality, date, and sex (were known), are indicated in Table 1. Forty-eight of these specimens were examined at the U. S. National Museum through the courtesy of Mr. William D. Field on January 5, 1959 and checked particularly as to their assignment to sex; three had previously been determined by Mr. C. F. dos Passos.

Specimens are at hand representing 56 of the 65 recorded; these include 29 ♂ ♂ and 27 ♀ ♀. The other nine specimens known are: the one collected by F. M. Jones which is presumably at the USNM; four collected by H. I. O'Byrne, which were examined in the collection at the University of Missouri in 1953 by K. Mather; three collected by Mather and Mather, two of which are in the collection of C. F. dos Passos and one of which is in the collection at Mississippi State University; and one, or more, collected in May, 1961 by W. J. Reinthal (1962) and presumably in his collection.

VARIATION IN MISSISSIPPI

The 56 available specimens have been examined particularly with regard to the development and shape of spots on the undersurfaces of the wings. The variation in development of spots on the underside of the forewings, based on the examination of the undersurface of the left forewing, ranged from no spots to four. Ten conditions were distinguished and the specimens examined were distributed among them as follows:

	♂♂	♀♀	Total
Spots absent	4	5	9
Trace of one spot	5	3	8
One spot	7	4	11
Traces of two spots	3	6	9
One spot and trace of second	4	1	5
Two spots	4	3	7
Traces of three spots	0	1	1
Three spots	0	4	4
Traces of four spots	1	0	1
Four spots (specimen #14) (see Plate I)	1	0	1
	29	27	56

The development of spots on the undersurface of the left hindwing was studied both with regard to number present and degree of elongation. Figure 2 is a diagram showing the designations used in this study and the dimensions that were measured at length (L) and width (W). The number of spots found ranged from four to six. One specimen (a ♀,

TABLE 1. MISSISSIPPI RECORDS OF *Euptychia areolata*

Locality and County	Month							Total	Collector
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.		
Burnsville, Tishomingo	–	–	–	–	1 ♀	–	–	1	B & K Mather
Barnett, Clarke	–	–	–	–	–	2 ♂♂	–	2	M & E Roshore
Waynseboro, Wayne	–	–	–	–	–	1 ♂	–	1	B & K Mather
Goss, Marion	–	–	1 ♀	–	–	–	–	1	B & K Mather
Rawl's Springs, Forrest	–	–	–	–	–	1 ♀	–	1	M & E Roshore
Hattiesburg, Forrest	–	1 ♀	–	–	–	–	–	1	B. J. Miller[1]
Shelby State Park, Forrest	–	–	–	–	5 ♂♂ 3 ♀♀	16 ♂♂ 15 ♀♀	–	39	M & E Roshore (38) B & K Mather (1)
Whites Crossing, Stone	–	1o	–	–	–	–	–	1	W. J. Reinthal
Biloxi, Harrison	1o	–	–	–	–	–	–	1	F. M. Jones
Gulfport, Harrison	–	–	–	–	–	4 ♂♂ 1 ♀	–	5	B & K Mather (1)
Ocean Springs, Jackson	–	–	2 ♂♂ 2 ♀♀ 3 o o	–	2 ♂♂ 1 ♀	–	1 ♀	11	H. I. O'Byrne (4) B & K Mather (9) M & E Roshore (2)
Fontainbleau, Jackson	–	–	–	1 ♂	–	–	–	1	B & K Mather
	1	2	8	1	12	40	1	65	

[1] *Ex* coll. B. D. Valentine.

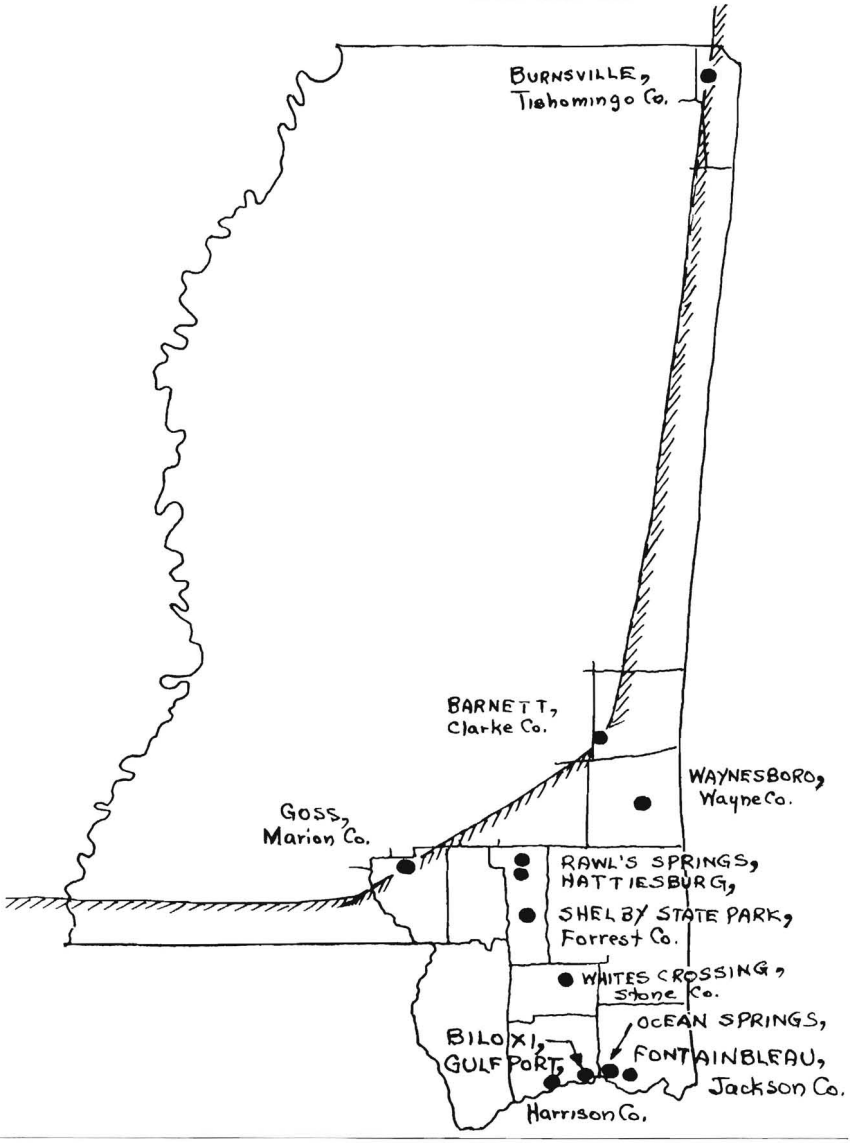

Fig. 1. Known distribution of *Euptychia areolata areolata* (Smith) in Mississippi.

#38) (see Plate I) had only a trace of spot #1. One other specimen (a ♀, #42) (Plate I) had all six spots quite well developed. A third specimen, also a ♀, #36 had a trace of spot #6. The other 54 specimens had no trace of spot #6; but all except #38 had spots #1, 2, 3, and 4 well

EXPLANATION OF PLATE I

Undersides of eight Mississippi and two Florida specimens of *Euptychia a. areolata*; average length/width ratios of spots 1–4 as follows: (For complete data of Mississippi specimens see Table 2.) *Top row*: left, ♂ #14, Shelby St. Park, L/W = 2.5; middle, ♀ #42, Shelby St. Park, L/W = 2.7; right, ♀ #38, Shelby St. Park, L/W = 2.2. *Second row*: left, ♂ #49, Fountainbleau, L/W = 1.7; middle, ♀ #44, Shelby St. Park, L/W = 1.7; right, ♂ #11, Shelby St. Park, L/W = 3.0. *Third row*: left, ♀ #25, Goss, L/W = 2.4; right, ♀ #24, Burnsville, L/W = 2.2. *Bottom row*: left, ♀ #57, Orange Park, Fla., May 25, 1959, L/W = 3.1; right, ♀ #63, Jacksonville, Fla., May 30, 1959, L/W = 3.7.

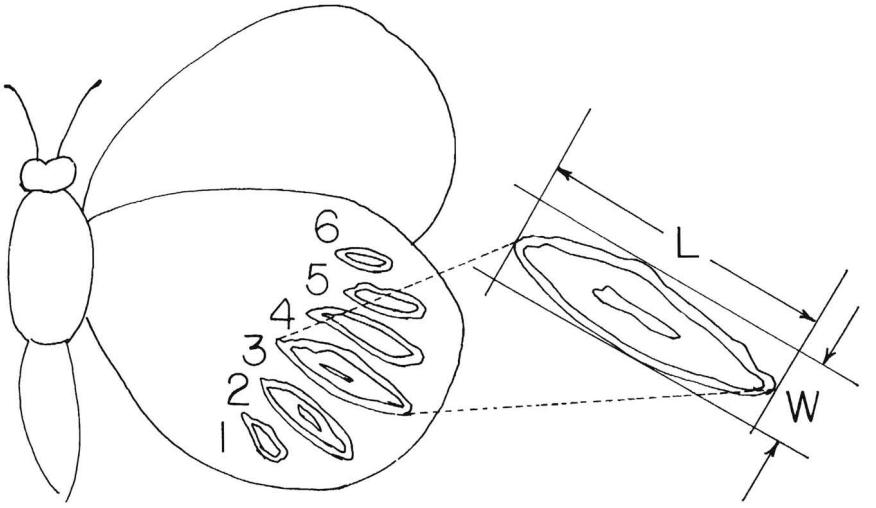

Fig. 2. Diagram showing the numbers assigned to the spots on the underside of the hindwing of *Euptychia areolata* and the dimensions measured as length (L) and width (W).

developed. The greatest variation in the series was with respect to spot #5; data on which are given below.

	♂♂	♀♀	Total
Spot absent	7	6	13
Absent on right, trace on left	2	1	3
Absent on left, measured on right	1	0	1
Trace on both wings	3	1	4
Present and measured on both wings	16	19	35
	29	27	56

The length (L) and width (W) of each spot on the left hindwing venter (in two cases, the right hindwing was used because of damage to the left wing) were measured at a magnification of 10× using an eyepiece micrometer having graduations such that at this magnification one division was equal to 0.1 mm. Using these measurements, the L/W ratio was computed for each spot. From the L/W ratios for spots #1, 2, 3, 4, an average L/W ratio was computed for each specimen. These data are given in Table 2. Figures 3 and 4 plot length and width of each measured hindwing spot identified as to spot number and sex of the specimen. The maximum, minimum, and average value of L/W for each spot and for the extreme specimens for average L/W were as follows:

TABLE 2

DIMENSIONAL DATA ON SPOTS ON HINDWING BELOW FOR MISSISSIPPI *AREOLATA* *

Length (L) and Width (W) given in 0.1-mm. units

SPECIMEN NUMBER AND LOCALITY	DATE	#1 L	#1 W	#1 L/W	#2 L	#2 W	#2 L/W	#3 L	#3 W	#3 L/W	#4 L	#4 W	#4 L/W	#5 L	#5 W	#5 L/W	#6 L	#6 W	#6 L/W	Av. 1-4 L/W	Spots on forewing
								♂	♂												
49 FONTAINBLEAU	31 JUL 60	11	7	1.6	22	12	1.8	21	11	1.9	15	9	1.7	Trace			Absent			1.7	Absent
21 SHELBY ST. PK.	6 SEP 58	20	10	2.0	29	15	1.9	26	14	1.8	27	13	2.1	10	6	1.7	Absent			1.9	One + Trace
13 "	"	15	7	2.1	27	15	1.8	25	14	1.8	27	11	2.5	Tr. - Abs.			Absent			2.0	Two
9 "	"	13	8	1.6	28	11	2.5	25	11	2.3	18	9	2.0	5	4	1.2	Absent			2.1	Two
10 "	"	18	6	3.0	27	14	1.9	22	13	1.7	21	12	1.7	9	4	2.2	Absent			2.1	One
52 "	13 AUG 60	20	10	2.0	32	15	2.1	26	12	2.2	26	12	2.2	8	7	1.1	Absent			2.1	Four
55 "	"	20	8	2.5	28	14	2.0	24	12	2.0	26	14	1.8	Absent			Absent			2.1	One + Trace
1 WAYNESBORO	20 SEP 53	16	8	2.0	27	14	1.9	29	10	2.9	21	10	2.1	Absent			Absent			2.2	Trace
4 OCEAN SPRINGS	2 AUG 58	16	6	2.7	22	12	1.8	19	10	1.9	21	8	2.6	Absent			Absent			2.2	Trace
16 SHELBY ST. PK.	6 SEP 58	8	4	2.0	29	13	2.2	26	13	2.0	25	10	2.5	Absent			Absent			2.2	Two
18 "	"	19	8	2.0	31	13	2.4	25	12	2.1	29	13	2.2	Trace			Absent			2.2	One
19 "	"	14	5	2.8	23	11	2.1	25	11	2.3	15	9	1.7	Absent			Absent			2.2	Absent
20 "	"	10	6	1.7	26	10	2.6	21	10	2.1	22	9	2.4	9	5	1.8	Absent			2.2	Trace-Two
51 "	13 AUG 60	21	8	2.6	32	14	2.3	25	12	2.1	20	11	1.8	10	6	1.6	Absent			2.2	Trace-Two
53 "	"	9	5	1.8	28	15	1.9	26	11	2.4	26	10	2.6	11	4	2.7	Absent			2.2	Trace-One
6 BARNETT	7 SEP 58	20	9	2.2	30	15	2.0	28	12	2.3	31	11	2.8	11	6	1.8	Absent			2.3	One
7 SHELBY ST. PK.	6 SEP 58	10	6	1.6	24	11	2.2	24	10	2.4	20	7	2.9	Absent			Absent			2.3	Trace
22 "	"	18	7	2.6	31	13	2.4	30	12	2.5	28	12	2.3	18	7	2.6	Absent			2.4	One
3 OCEAN SPRINGS	13 JUN 52	12	5	2.4	26	11	2.4	24	10	2.4	26	9	2.9	4	4	1.0	Absent			2.5	Absent
12 SHELBY ST. PK.	6 SEP 58	15	7	2.1	33	11	3.0	26	11	2.4	27	10	2.7	4	4	1.0	Absent			2.5	One

TABLE 2 continued

14 SHELBY ST. PK.	6 SEP 58	18 8 2.2	29 13 2.2	28 11 2.5	31 10 3.1	10 5 2.0	Absent	2.5	Four
15 "	"	18 7 2.6	31 12 2.6	22 10 2.2	26 10 2.6	7 6 1.2	Absent	2.5	One
23 BARNETT	7 SEP 58	25 7 3.6	28 14 2.0	27 12 2.1	29 10 2.9	Tr.- Abs.	Absent	2.6	Absent
54 SHELBY ST. PK.	13 AUG 60	19 9 2.1	29 12 2.4	26 10 2.6	28 8 3.5	9 6 1.5	Absent	2.6	Two
2 OCEAN SPRINGS	13 JUN 52	15 4 3.7	26 10 2.6	23 10 2.3	21 10 2.1	Absent	Absent	2.7	Trace
5 "	2 AUG 58	14 5 2.8	27 11 2.5	25 10 2.5	26 8 3.2	5 4 1.2	Absent	2.7	One
8 SHELBY ST. PK.	6 SEP 58	15 6 2.5	27 11 2.5	21 10 2.1	25 7 3.6	4 4 1.0	Absent	2.7	One
17 "	"	22 6 3.7	35 12 2.9	26 12 2.2	26 12 2.2	Trace	Absent	2.7	Trace-Two
11 "	"	17 6 2.8	31 10 3.1	26 8 3.2	27 9 3.0	4 3 1.3	Absent	3.0	One + Trace
			♀♀						
44 SHELBY ST. PK.	6 SEP 58	12 9 1.3	31 17 1.8	29 16 1.8	24 13 1.8	Absent	Absent	1.7	Absent
35 "	"	23 13 1.8	36 19 1.9	32 18 1.8	35 13 2.7	17 9 1.9	Absent	2.0	Three
37 "	"	18 9 2.0	31 16 1.9	28 13 2.1	28 13 2.1	13 5 2.6	Absent	2.0	Absent
50 "	13 AUG 60	15 9 1.7	39 19 2.0	35 16 2.2	33 15 2.2	14 5 2.8	Absent	2.0	Trace-Two
48 "	6 SEP 58	15 9 1.7	32 16 2.0	30 13 2.3	28 14 2.0	18 6 3.0	Absent	2.0	Absent
27 OCEAN SPRINGS	13 JUN 52	7 5 1.4	29 12 2.4	24 10 2.4	24 10 2.4	Absent	Absent	2.1	One
32 RAWL'S SPRINGS	6 SEP 58	12 8 1.5	38 16 2.4	31 15 2.1	27 11 2.5	Absent	Absent	2.1	One
39 SHELBY ST. PK.	"	19 9 2.1	31 14 2.2	27 12 2.1	27 12 2.1	7 5 1.4	Absent	2.1	Two
47 "	"	18 9 2.0	32 16 2.0	29 15 1.9	30 13 2.3	16 8 2.0	Absent	2.1	Three
24 BURNSVILLE	28 AUG 55	24 11 2.2	40 16 2.5	38 17 2.2	33 16 2.1	16 10 1.6	Absent	2.2	Trace-Two
26 HATTIESBURG	28 MAY 55	15 7 2.1	34 14 2.4	30 18 1.7	31 12 2.6	16 6 2.7	Absent	2.2	One
36 SHELBY ST. PK.	6 SEP 58	18 7 2.6	29 15 1.9	29 14 2.1	29 12 2.4	13 8 1.6	Trace	2.2	Three
38 "	"	Trace	29 12 2.4	30 12 2.5	19 11 1.7	12 7 1.7	Absent	2.2	Absent
45 "	"	17 8 2.1	32 14 2.3	25 12 2.1	23 11 2.1	Absent	Absent	2.2	Absent
33 "	3 AUG 58	17 9 1.9	33 13 2.5	31 15 2.1	29 11 2.6	13 6 2.2	Absent	2.3	Three
34 "	6 SEP 58	20 9 2.2	34 16 2.1	31 13 2.4	30 12 2.5	14 7 2.0	Absent	2.3	One
25 GOSS	15 JUN 52	17 7 2.4	38 15 2.5	42 17 2.5	37 16 2.3	12 5 2.4	Absent	2.4	Trace
31 GULFPORT	23 SEP 51	15 6 2.7	30 13 2.3	22 9 2.4	22 11 2.0	9 5 1.8	Absent	2.4	Trace-Two

TABLE 2 concluded

40 SHELBY ST. PK.	6 SEP 58	14 6 2.3	33 13 2.5	27 13 2.1	27 10 2.7	Tr. – Abs.	Absent	2.4	Trace-Two
56 "	13 AUG 60	22 9 2.4	35 16 2.2	35 15 2.3	36 13 2.7	22 10 2.2	Absent	2.4	Trace
28 OCEAN SPRINGS	13 JUN 52	13 6 2.2	32 11 2.9	24 10 2.4	26 11 2.4	Absent	Absent	2.5	Trace-Two
43 SHELBY ST. PK.	6 SEP 58	16 6 2.7	31 15 2.1	32 13 2.5	32 10 3.2	14 6 2.3	Absent	2.6	Trace-Three
46 "	"	25 8 3.1	38 16 2.4	34 15 2.3	33 13 2.5	13 6 2.2	Absent	2.6	Two
29 OCEAN SPRINGS	3 OCT 53	12 5 2.4	32 11 2.9	30 10 3.0	23 9 2.5	8 5 1.6	Absent	2.7	Trace-Two
30 "	2 AUG 58	15 6 2.7	37 12 3.1	27 10 2.7	25 10 2.5	Absent	Absent	2.7	Trace
41 SHELBY ST. PK.	6 SEP 58	21 6 3.5	36 12 3.0	27 12 2.1	26 12 2.2	Trace	Absent	2.7	Two
42 "	"	20 9 2.2	39 13 3.0	31 12 2.6	29 9 3.2	14 6 2.3	6 4 1.5	2.7	One + Trace

* Tabulated in order of increasing average h/w for spots 1-4 in each group : ♂♂ and ♀♀.

		#1	#2	#3	#4	L/W Avg: 1–4
29 ♂ ♂	max	3.7	3.1	3.2	3.6	3.0 (#11)[1]
	min	1.6	1.8	1.7	1.7	1.7 (#49)[1]
	average	2.4	2.3	2.2	2.5	(2.3)
27 ♀ ♀	max	3.5	3.1	3.0	3.2	2.7 (#30, #42)[1]
	min	1.3	1.8	1.7	1.7	1.7 (#44)[1]
	average	2.2	2.4	2.2	2.4	(2.3)

[1] See Plate I.

Figure 5 indicates the frequency distribution of average L/W for spots 1–4 for the 56 Mississippi specimens and the approximately normal shape of the distribution curve suggested by this histogram. Measurements of length and width of spot #2 are plotted in Figure 6 together with lines representing L/W = 1.8 and 3.1, the minimum and maximum values for elongation found for this spot.

Geographical Distribution

Brown (1950a) indicated that *E. areolata* is distributed throughout Florida, Georgia, South Carolina, and North Carolina, and in southeastern Virginia, southern New Jersey, eastern Tennessee, southern Alabama, southeastern Mississippi, and southeastern Louisiana. Harris (1931) reported that it was found in the coastal region of Georgia; the same writer (1950) reported it throughout the state. Knudsen (1954) did not find it on the Oglethorpe University campus but regarded it as a species that might be tentatively added to his list based on its having been reported as distributed throughout the state of Georgia, but very local in occurrence. A. H. Clark (*in litt.* to Brown, 1950) mentioned the occurrence of *areolata* in West Virginia. Haydon (1934) listed the species as probable for Maryland, but based on recent reports, Simmons (1956, 1963), Simmons and Andersen (1961), it does not seem to have been recorded from that state. Davis (1924) mentioned a specimen from Harris County, Texas, and Texas specimens are figured by Clark (1932), Clark and Clark (1951), and Ehrlich and Ehrlich (1961). It was, however, not included in the tentative list of Texas butterflies compiled by Kendall (1963b) nor was it mentioned by Gooch and Strecker (1924). Forbes (1960) gave the range as "southern states north to New Jersey," Ehrlich and Ehrlich (1961) gave it as "southeastern United States north to Ocean County, New Jersey." Lambremont (1954) recorded it for the first time from Louisiana, based on 31 specimens (15 ♂ ♂, 16 ♀ ♀) from nine localities in Livingston, St. Tammany, Tangipahoa, and Washington parishes, all in the "longleaf pine flats north of Lake Ponchartrain." He observed: "Supposedly the species ranges as far west as Texas, but the

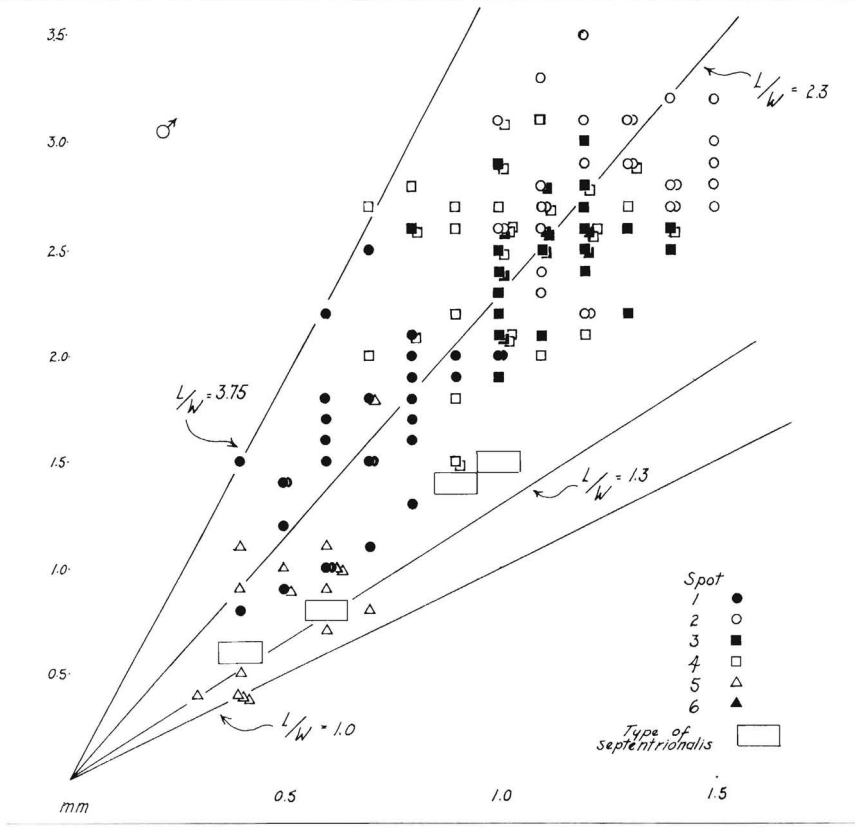

Fig. 3. Plot of length (vertical axis) and width (horizontal axis) of spots on 29 male specimens of *Euptychia a. areolata* from Mississippi, showing the relative positions of the measurements of spots on the figure of the type specimen of *E. areolata septentrionalis* (Davis).

results of this survey indicate it must be rare west of the Mississippi River, although it localizes and can be overlooked." Kendall (1963a) reported taking one male on June 30, 1957 at Leesville, Vernon Parish, which is less than 20 miles east of the Texas border and about 10 miles north of Latitude 31, the boundary between Louisiana and Mississippi east of the Mississippi River. If the closely related *E. mitchellii* (French), described from Cass County, Michigan, were to be considered a northern race of *E. areolata*, the distribution would form a pattern rather similar to that known for *Euphyes dukesi* (Lindsey) as was shown by Mather (1964). The known distribution of *E. areolata* (and of *E. mitchellii*) is shown by the stippled areas in Fig. 7.

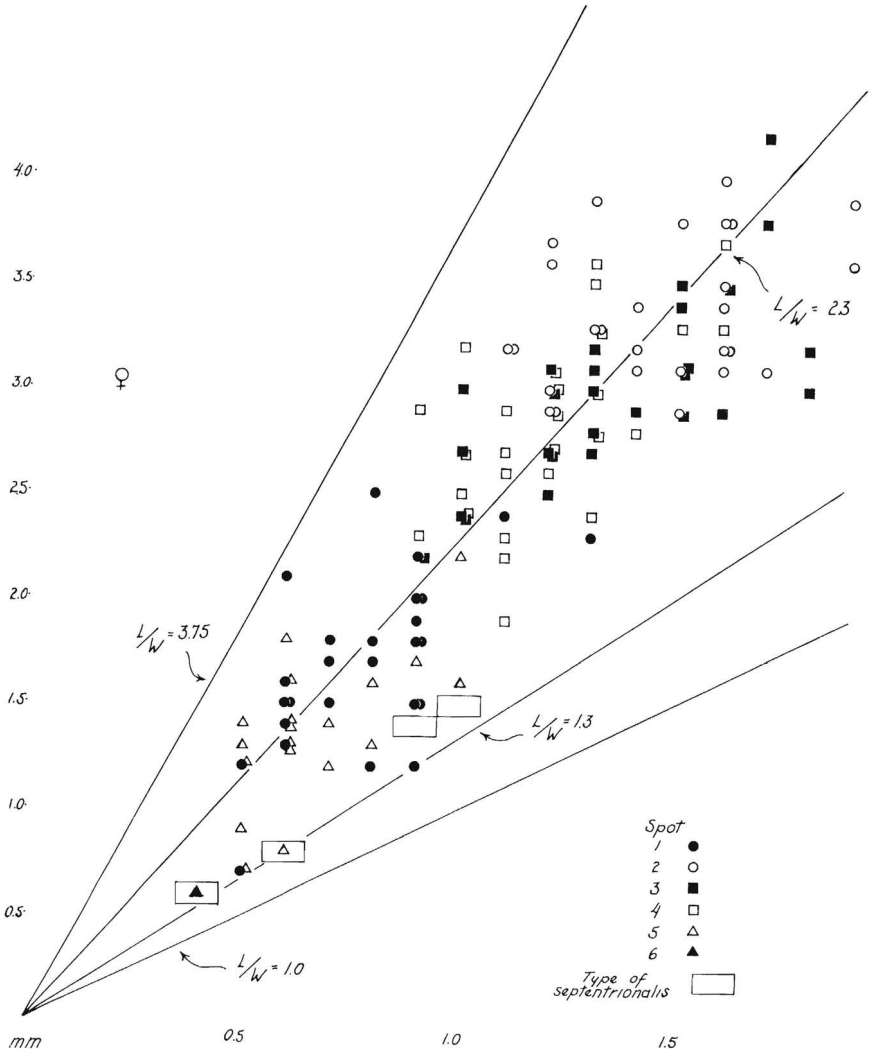

Fig. 4. Plot of length (vertical axis) and width (horizontal axis) of spots on 27 female specimens of *Euptychia a. areolata* from Mississippi, showing the relative positions of measurements of spots on the figure of the type specimen of *E. areolata septentrionalis* (Davis).

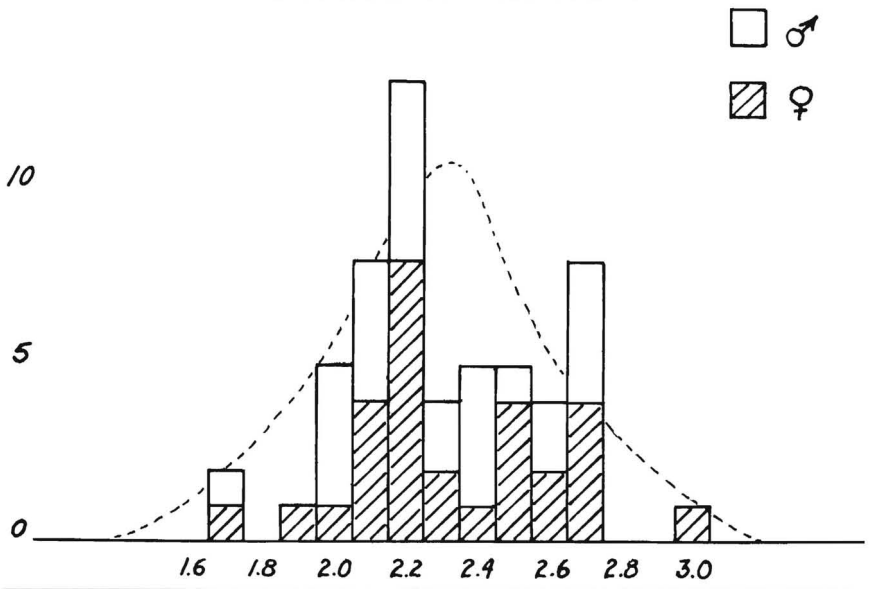

Fig. 5. Average of length/width ratios of spots 1–4 on 56 Mississippi specimens of *Euptychia a. areolata* and the apparently normal distribution curve suggested by these data.

SEASONAL DISTRIBUTION

The Mississippi records are all from localities that have been visited by collectors only relatively infrequently; thus while it is regarded as probable that the occurrence of *E. areolata* in Mississippi is generally limited to the period April through October, it is not believed that the relative abundance within this period can be judged from the number of specimens recorded per month. These figures probably tell more about the mobility of the collectors than about the abundance of the butterflies. Lambremont (1954) took his 31 Louisiana specimens in May, June, and September. Clark and Clark (1951) report two broods in Virginia, April–May and August–September. Harris (1950) reported it in Georgia "April–October." Grossbeck (1917) gave dates of occurrence in Florida in March through June and September and October. The available data are given below.

	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Ref
Mississippi		×	×	×	×	×	×	×	This report
Louisiana			×	×			×		Lambremont (1954), Kendall (1963)
Florida	×	×	×	×			×	×	Grossbeck (1917)

	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Ref
Georgia	×	×	×	×	×	×	×		Harris (1950)
Tennessee						×			Martin and Truxal (1955)
Virginia	×	×				×	×		Clark and Clark (1951)
New Jersey					×				Davis (1924)
North Carolina				×					Davis (1924)
Michigan[1]				×	×				Martin and Truxal (1955)
Indiana[1]					×				Martin and Truxal (1955)

[1] *E. mitchellii.*

Seasonal Variation

The sample available for study included only seven specimens taken on dates in May, June, and July, but 49 taken on dates in August, September, and October. The single available specimens representing May and October are both females (#26 and #29, see Table 2). The data on these specimens do not indicate significant differences; nor are such differences clearly shown by other comparisons within the series. Badger (1958) figured specimens of *E. mitchellii* showing maximum and minimum development of spots on the wings beneath, that were taken within a single four-day period.

Sexual Variation

The ground color of the upper surfaces of the wings is darker in males and lighter in females. Previous writers do not present a consistent discussion of what these colors are. French (1889), describing *E. mitchellii*, referred to the color of the upper surfaces of the male as "gray wood-brown, rather dark" and stated that the female "differs from the male in being paler both above and below." He did not indicate that *mitchellii* differed from *areolata* in this respect. Clark and Clark (1951) refer to *E. a. areolata* as "dark mouse gray" and to *E. a. septentrionalis* (Davis) as "dark warm brown" and did not indicate that the different sexes of either race varied in color. Forbes (1960) said "plain fuscous above" for *areolata*. From an examination of specimens at hand, it is concluded that Mississippi populations meet the description given by French (1889) for *E. mitchellii*; that the males meet the description given by Clark & Clark (1951) for *E. a. areolata*; and the females meet the description given by them for *E. a. septentrionalis*. There appears to be no significant variation between the sexes with regard to elongation of the spots on the hindwings below. It is not regarded as significant that both specimens showing four spots on the underside of the forewing were males and all five of those that showed three were females. The ratio in which the sexes are represented among the material collected is remarkable close to 1 : 1 in those cases where all specimens were taken that were available.

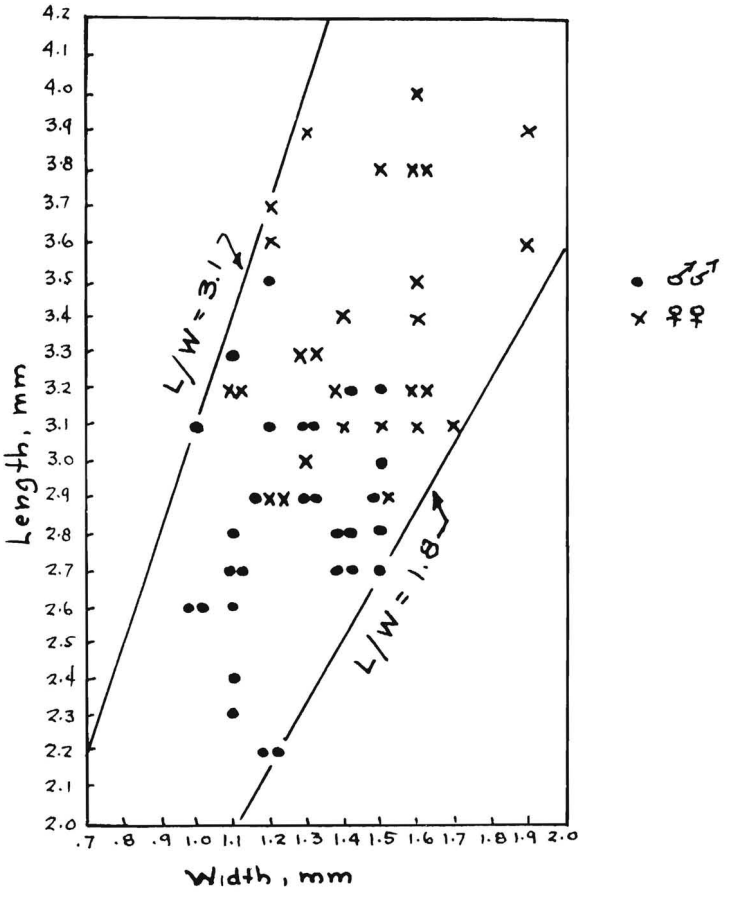

Fig. 6. Length and width for spot #2 on 56 Mississippi specimens of *Euptychia a. areolata*, indicating a L/W range from 1.8 to 3.1.

GEOGRAPHICAL VARIATION

E. areolata was described by J. E. Smith from Georgia. Davis (1924) noted that in the figure accompanying the original description, in which the underside is shown, there are four round blackish spots encircled by yellow on each forewing and six elongate spots encircled by yellowish on each hindwing. He also noted that Boisduval and Le Conte figured a specimen with elongate spots on the hindwing venter, that Scudder figured one from Georgia with five elongate spots on the hindwing underside, and that Edwards figured three specimens, one with long

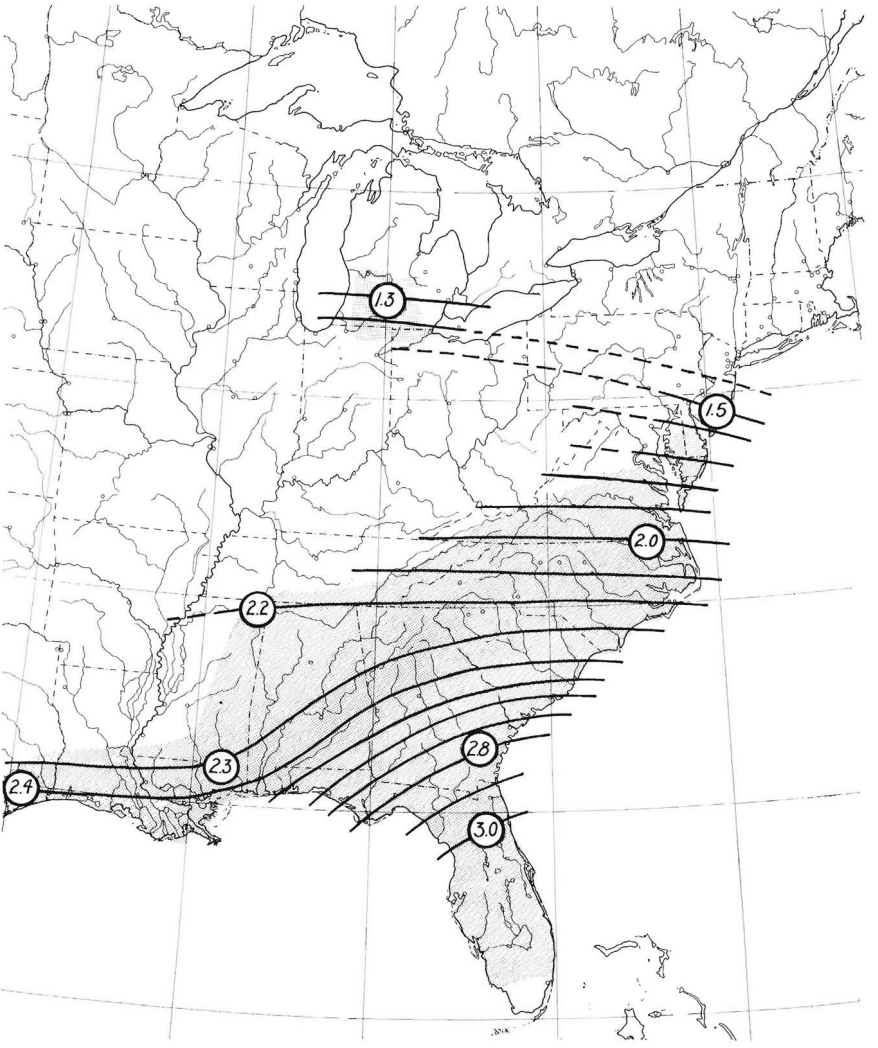

Fig. 7. Known geographical distributions of *Euptychia areolata* (Smith) and *E. mitchellii* (French) showing change in average of length/width ratios of spots 1–4 from north (1.3) to south (3.0).

spots, one with more rounded spots, and one with a reddish line surrounding the spots.

French (1889) described *E. mitchellii* as having four small spots on the forewing underside (circular in four examples, a little oval in two)

TABLE 3

DIMENSIONAL DATA ON FIGURED SPECIMENS OF *E. AREOLATA* AND *E. MITCHELLII* (a)

REFERENCE	SEX	STATE	#1 L W L/W	#2 L W L/W	#3 L W L/W	#4 L W L/W	#5 L W L/W	Av. 1–4 L/W	Spots on Forewing
			E. AREOLATA AREOLATA						
HOLLAND, 1931	♂	NOT STATED	16 5 3.2	29 11 2.6	27 12 2.1	30 13 2.3	Trace	2.5	Absent
DAVIS, 1924	–	FLORIDA	25 9 2.8	35 12 2.9	30 10 3.0	25 11 2.3	Trace	2.7	Absent
DAVIS, 1924	–	"	25 11 2.3	44 14 3.1	38 14 2.7	36 15 2.3	Trace	2.6	Absent
DAVIS, 1924	–	NO. CAROLINA	16 7 2.1	28 14 2.0	26 14 1.8	22 12 1.7	Trace	1.9	One
CLARK, 1932	–	FLORIDA	12 8 1.5	30 15 2.0	30 13 2.3	25 11 2.3	Trace	2.0	Absent
CLARK, 1932	–	TEXAS	30 11 2.7	50 21 2.4	40 22 1.8	41 17 2.4	21 12 1.7	2.3	One
KLOTS, 1951	♂	GEORGIA	25 9 2.8	35 12 2.9	27 9 3.0	33 12 2.7	13 7 1.8	2.8	Trace
EHRLICH + EHRLICH, 61	♂	TEXAS	20 9 2.3	44 16 2.6	40 16 2.5	37 14 2.6	24 7 3.6	2.5	Absent (b)
CLARKE, 1963	♂	NOT STATED	20 8 2.5	31 12 2.6	30 11 2.7	29 11 2.6	12 8 1.5	2.6	Absent
			E. AREOLATA SEPTENTRIONALIS						
DAVIS, 1924 (TYPE)	–	NEW JERSEY	6 4 1.5	14 9 1.6	15 10 1.5	8 6 1.3	Trace	1.5	Trace
CLARK + CLARK, 1951	–	VIRGINIA	20 9 2.2	31 15 2.1	30 14 2.1	22 12 1.8	Trace	2.0	Absent
CLARK + CLARK, 1951	–	VIRGINIA	12 6 2.0	25 12 2.1	22 12 1.8	23 10 2.3	Trace	2.0	Absent
			E. MITCHELLII						
BADGER, 1958 (c)	♂	INDIANA	17 12 1.4	21 21 1.0	22 20 1.1	22 19 1.2	15 11 1.3	1.2	Two
BADGER, 1958 (c)	♀	MICHIGAN	20 15 1.3	28 24 1.2	26 23 1.1	28 21 1.3	20 15 1.3	1.2	Four
BADGER, 1958 (d)	♂	INDIANA	20 15 1.3	30 21 1.4	30 19 1.6	32 19 1.7	20 12 1.7	1.5	Four (e)
BADGER, 1958 (d)	♀	MICHIGAN	21 14 1.5	31 26 1.2	32 23 1.4	31 21 1.5	24 15 1.6	1.4	Four (e)

(a) Length (L) and Width (W) given in 0.1-mm units.

(b) Figure as published is magnified x 1.6, measurements reduced proportionately

(c) "minimum development of ocelli."

(d) "maximum development of ocelli"

(e) Spot #6 for last two specimens: 14 9 1.6; 15 12 1.3, respectively.

and six on the hindwing underside (circular to slightly bulging), differing from *areolata* which may have from three to many elongate spots on the forewing and has five on the hindwing.

Davis (1924) described *E. areolata septentrionalis* from New Jersey as having the eyespots on the underside of the hindwing rounder (less elongate) than in those from Florida and the south in general, based on a comparison of 22 specimens from New Jersey with 28 from the south (7 North Carolina, 3 South Carolina, 17 Florida, 1 Texas). Davis added "The writer does not mean to imply that specimens from New Jersey may not occasionally show spots resembling those from Florida and Georgia."

Clark and Clark (1951) reported that both *E. a. areolata* and *E. a. septentrionalis* occurred in Virginia and that, at a locality about eight miles south of Suffolk, specimens of both races were taken. They wrote: "Most of the individuals were intergrades between the two, but some were typical *areolatus*, agreeing with specimens from South Carolina and Georgia, while others were equally typical *septentrionalis*, agreeing with specimens from New Jersey." They also stated that, in *E. a. areolata* the spots on the hindwing underside are "usually at least twice as long as broad, often much longer" while, in *E. a. septentrionalis*, these spots are "short and broad, from scarcely longer than broad to about twice as long as broad." Forbes (1960) referred to the spots on the underside of the hindwing in *a. areolata* as "elongate" and in *a. septentrionalis* as "shorter and more regular, perhaps half longer than wide." Davis (1924) in describing *septentrionalis*, said, simply "rounder," but illustrated specimens. There are at hand 12 published figures showing the underside of *E. areolata* and four of *E. mitchellii*. These were examined by the procedures used for the specimens; the results are given in Table 3; the length and width values are plotted in Fig. 8.

Through the courtesy of Mr. Charles F. Zeiger, I have a series of nine specimens (6 ♂ ♂, 3 ♀ ♀) taken by him at Orange Park and Jacksonville, Florida in May, 1959. The distribution of these with regard to spots on the forewing underside is: males, four with both spots absent, two with traces of the two spots; females, three with both spots absent.

The distribution of these nine individuals with regard to spot #5 on the hindwing underside is: absent in two males, a trace in one male and one female, large enough to measure in the remainder.

The dimensions and L/W ratios of measured hindwing spots 1–4 were found to be as follows:

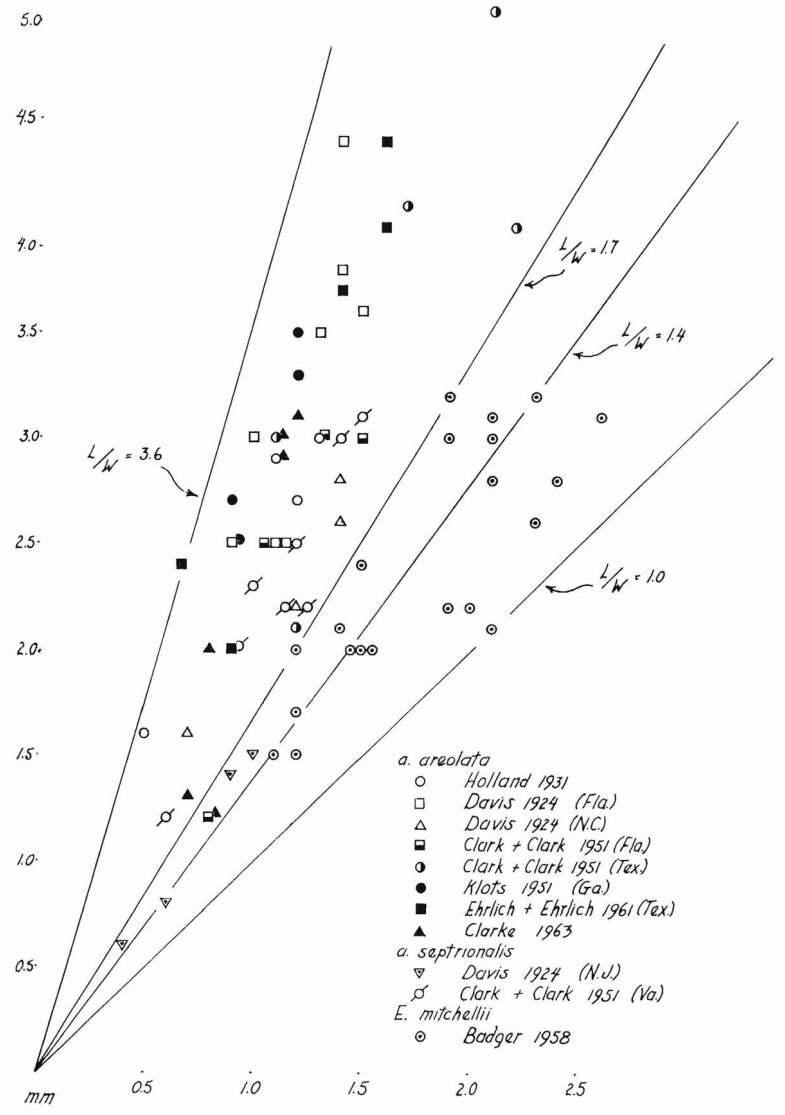

Fig. 8. Plot of length (vertical axis) and width (horizontal axis) of hindwing spots of 16 figured specimens of *Euptychia areolata* and *E. mitchellii* (French), showing range of L/W from 1.0 to 3.6.

	1			2			3			4			1–4
	L	W	L/W	L	W	L/W	L	W	L/W	L	W	L/W	L/W
♂♂	15	6	2.5	32	10	3.2	25	7	3.6	22	8	2.7	3.0
	14	7	2.0	32	12	2.7	30	12	2.5	35	11	3.2	2.6
	21	5	4.2	39	13	3.0	32	12	2.7	33	11	3.3	3.3
	23	8	2.9	39	12	3.3	30	10	3.0	34	10	3.4	3.1
	13	5	2.6	30	9	3.3	21	8	2.6	20	9	2.2	2.7
	20	5	4.0	29	10	2.9	22	10	2.2	24	10	2.4	2.9
													2.9
♀♀	12	6	2.0	40	11	3.6	35	10	3.5	33	10	3.3	3.1
	17	7	2.4	40	15	2.7	41	15	2.7	39	12	3.3	2.8
	25	6	4.2	40	11	3.6	33	9	3.7	32	10	3.2	3.7
													3.2

It will be noted that the spots range in elongation from L/W = 2.0 to 4.2, and the overall average is 3.0; these relations are shown in Fig. 9.

On the basis of the foregoing information, it would appear that the degree of elongation of the hindwing spots below undergoes clinal geographical variation somewhat as follows:

State	No.	L/W Min	L/W Max	L/W Avg	Specimens from
Florida	9	2.6	3.7	3.0	*ex* coll. Zeiger
Florida	3	2.0	2.7	2.5	figured by Clark, Davis
Georgia	1	2.8	2.8	2.8	figured by Klots
Texas	2	2.3	2.5	2.4	figured by Clark, Ehrlich and Ehrlich
Mississippi	56	1.7	3.0	2.3	in collection Mather
North Carolina	1	1.9	1.9	1.9	figured by Davis
Virginia	2	2.0	2.0	2.0	figured by Clark and Clark
New Jersey	1	1.5	1.5	1.5	figured by Davis
Michigan–Indiana[1]	4	1.2	1.5	1.3	figured by Badger

[1] *E. mitchellii.*

This geographical variation is represented as L/W contours in the map (Fig. 7).

It appears that those previous writers who assumed that any of the populations under discussion were composed of individuals having a constant number of spots on the underside of either the forewing or hindwing were in error. French (1889) believed that *E. mitchellii* always had six spots on the hindwing below and *areolata* always had five. Two of the four *mitchellii* figured by Badger (1958) have five spots on the hindwing underside and two have six. The Mississippi sample of *areolata* includes specimens having four, five, and six spots on the hindwing below. The figure of *areolata* accompanying the original description is

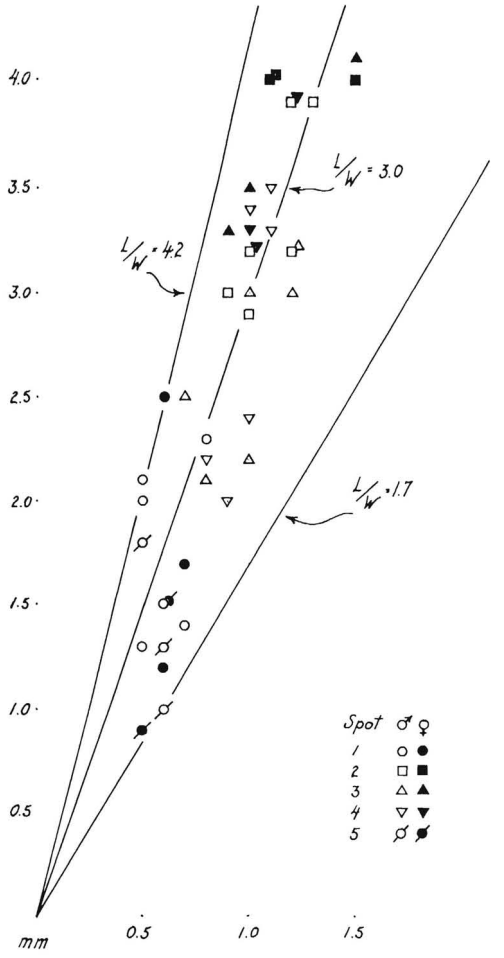

Fig. 9. Plot showing length (vertical axis) and width (horizontal axis) of hindwing spots of nine Florida specimens of *Euptychia a. areolata,* showing range of L/W from 1.7 to 4.2.

reported to be of a specimen having six spots. It is therefore suggested that, while there may be statistically significant differences in the frequency with which specimens occur having different numbers of hindwing spots in several populations, it is likely that any large sample will include specimens with four, five, and six spots on the hindwing undersurface.

The number of spots on the underside of the forewing in the Mississippi

sample ranges from none to four. The data suggest that the likelihood of fewer spots on the forewing increases southward. It would appear unlikely that specimens of the *mitchellii* population will be found with no traces of spots on the forewing underside although, as shown by Badger's (1958) male from Indiana, these spots may be greatly reduced.

The elongation of the spots on the hindwing venter clearly increases southward. It would appear that such spots in the *mitchellii* population in Michigan and Indiana would rarely have a L/W as great as 2.0 while those in the Florida–Georgia population would rarely have a L/W as small as 1.5. It would also appear, however, that specimens with hindwing spots having L/W in the range 1.5 to 2.0 could be taken anywhere within the entire range of all the populations under discussion. Davis (1924) seems to have had a more realistic view of these factors of geographical variation than was indicated by the comments of French (1889), Clark and Clark (1951), or most others who have written on the matter, since Davis did not contend that *all* individuals in the population he described were distinguishable from all of those making up the population with which it was being compared, nor did he endeavor to suggest, as did the Clarks, that those individuals occurring at a given locality resembling the average aspect of a population to which a name has been applied should be designated by that name, while others occurring at the same time at the same locality resembling another named population should bear its name.

Neither references to genetic studies nor speculations which may have been made to elucidate the factors involved in observed variation within and between the populations discussed above have been found. Ford (1945) discussed genetic and geographical variation with respect to size, number, and elongation of ventral hindwing spots in two satyrid species occurring in Great Britain. He noted (pp. 206–207) that in *Aphantopus hyperanthus*, the variety "*lanceolata*," characterized by an enlargement and distortion into ovals of the rings surrounding such spots, had been shown to be a simple recessive character, while variation manifested as reduction of size and number of ventral hindwing spots, found to be commoner in some districts than in others, was controlled on a multifactorial basis (pp. 222–223). He noted that in *Coenonympha tullia*, there is geographic, clinal variation from an almost unspotted race in the north (Scotland) to a race with well-developed spots southward (pp. 292–293). It would appear that the *areolata–mitchellii* complex could provide an excellent basis for studies of factors influencing variation.

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