A small series of my reared adults has been placed in the collection of the United States National Museum. A few preserved larvae are in the Yale University collection.

LITERATURE CITED

SALA, F. P., 1964. The *Annaphila astrologa* Complex. Jour. Res. Lepid., 2 (4): 289–301 ["1963"].

THE BEGINNING OF THE BUTTERFLY SEASON

HARRY K. CLENCH
Carnegie Museum, Pittsburgh, Pennsylvania

Work on another problem has yielded a by-product that may have some interest for collectors, particularly those who may be planning trips to areas with which they are not familiar. This by-product is a rough means of estimating the beginning of the "butterfly season" in any given place.

The estimate depends heavily on two hypotheses. The first is that the yearly course of the mean temperature in a locality can be approximated closely by a simple sine function:

$$T_d = T_C + \frac{R}{2}(1 - \cos A)$$

T_d = mean temperature for day d, counted from January 1; T_C = mean temperature of coldest month (usually January in the northern hemisphere); T_H = mean temperature of hottest month (usually July in the northern hemisphere); $R = T_H - T_C$; and $A = (72/73)\ (d - b)$. In the last, b is the seasonal lag and normally is around 13.5.

The second hypothesis is less well documented: that there exists a temperature threshold above which butterflies fly, below which they do not; and which also functions as a limiting value for geographical occurrence. As applied here, the threshold refers to mean temperatures and its value has been determined to be about 43° F. (6.1° C.). In confirmation of the hypothesis it can be observed that in localities where T_H is below this value, virtually no butterflies occur; and in areas where T_C is above this value, at least some butterflies fly through the winter. Furthermore, in several places where accurate data on butterflies are available the time of the year when the mean temperature, on the average, reaches this value about marks the average time of appearance of the first butterflies (overwintering hibernators).

TABLE I. APPROXIMATE AVERAGE STARTING DATES FOR THE BUTTERFLY SEASON. IN EACH BOX THE *UPPER DATE* IS FOR APPEARANCE OF OF HIBERNATORS; THE *LOWER DATE* IS FOR THOSE EMERGING FROM OVERWINTERING PUPAE

Merriam life zone	T_H R	80° F. (44.4° C.)	70° (38.9°)	60° (33.3°)	50° (27.8°)	40° (22.2°)	30° (16.7°)	20° (11.1°)	10° (5.6°)	0° (0°)
	43° F.	–	–	–	–	–	–	–	–	–
Arctic–Alpine	(6.1° C.)	–	–	–	–	–	–	–	–	–
	50°	11 June	9 June	5 June	1 June	26 May	18 May	4 May	21 Mar.	–
Hudsonian	(10°)	–	–	–	–	–	–	–	–	–
	57°	26 May	24 May	18 May	12 May	4 May	19 Apr.	21 Mar.	–	–
Canadian	(13.9°)	9 June	8 June	5 June	1 June	26 May	18 May	2 May	22 Mar.	–
	64°	14 May	10 May	4 May	25 Apr.	13 Apr.	21 Mar.	–	–	–
Transition	(17.8°)	26 May	22 May	18 May	12 May	2 May	19 Apr.	22 Mar.	–	–
	72°	2 May	25 Apr.	17 Apr.	4 Apr.	19 Mar.	5 Feb.	–	–	–
Upper Sonoran (U. Austral.)	(22.2°)	12 May	7 May	30 Apr.	22 Apr.	9 Apr.	18 Mar.	–	–	–
	79°	21 Apr.	13 Apr.	2 Apr.	19 Mar.	19 Feb.	–	–	–	–
Lower Sonoran (L. Austral.)	(26.1°)	2 May	25 Apr.	17 Apr.	5 Apr.	19 Mar.	4 Feb.	–	–	–

From the above formula it is not difficult to obtain the following relation, substituting X (the threshold value, unspecified) for T_d and solving for d:

$$\text{starting date} = 13.5 + \frac{73}{36} \sin^{-1} \sqrt{\frac{X + R - T_H}{R}}$$

which gives the starting date (the date that the mean temperature reaches the threshold value X) as the number of days from the first of January.

Using a value of 43° F. for the threshold gives a date rather ahead of the time most collectors would consider significant since it indicates the time when the first hibernators appear. By taking a higher threshold value, 50° F. (10° C.), one obtains a date more nearly that when the first butterflies appear that have emerged from overwintered pupae. In the table both of these dates are given.

In order to use the table, one needs only the values of T_C and T_H for the locality in question (usually respectively mean January and mean July values). From them obtain R and enter the table with R and T_H, interpolating as necessary. The values of T_H given in the table are the defining boundary values of the Merriam Life Zones, which are added along the side. If the area for which one seeks information has no temperature data directly available for it, obtain the data for the nearest station in about the same latitude, get the difference in elevation between that station and the area of interest and adjust the values of that station by a lapse rate of 1° F. per 300 feet (1° C. per 166 meters) of elevation difference. Since both T_C and T_H lapse at about the same rate, no change in R is needed. Instead of the table, of course, the formula may be used for a direct computation.

These points should be kept in mind in using either table or formula: (1) the premise is solely for a thermally controlled flight season. Where the flight season is more under control of pluvial conditions, it does not pretend to apply. (2) The premise is solely for average conditions. In putting it to practical use, any information available on the advancement or retardation of the particular season should be taken into account. (3) Error in the dates given in the table or calculated directly is likely to be most extreme in areas approaching the threshold values for either T_H or T_C. (4) For areas where the seasonal lag is markedly more or less than 13.5, the difference should be added to or subtracted from the date obtained. Seasonal lag is a very difficult datum to get, but departure from the given lag value is rarely significantly great except (so far as I know) in the immediate vicinity of the Pacific Coast of North America. (5) Presumably, d should be counted from July 1 in the southern hemisphere.