Lepidoptera of North America
9. Butterfly Distribution and Dispersion across the Montane Islands and Drainages of the Chihuahuan Desert

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BUTTERFLY DISTRIBUTION AND DISPERSION ACROSS THE MONTANE ISLANDS AND DRAINAGES OF THE CHIHUAHUAN DESERT

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ABSTRACT. This paper tabulates the butterfly fauna of 36 montane and five canyon land refugia in the Chihuahuan desert, primarily in New Mexico and Trans-Pecos Texas, but to some extent also in Arizona, Colorado, Sonora, Chihuahua, and Coahuila. Theories for butterfly dispersal between ranges are evaluated by examining the fauna! correlation between refugia. Refuge diversity is highest in the Gila Mts. complex (ca. 175 sp.) and lowest in the canyon lands of northeastern New Mexico (ca. 70 sp.). As a general rule, population diversity decreases as one retreats farther from the main backbone of the Rocky Mts. to the north or from the main branches of the Sierra Madre to the south. The 41 refugia are divided into eight groups, each consisting of three to eight members. About 27 additional refugia are not discussed, either because data is lacking (eight cases) or because the computer analysis began to become unstable, and the sheer
data volume unmanageable.

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Additional key words: desert antiquity, New Mexico, Trans-Pecos Texas, population dynamics, range capacity for species, gene leakage, correlation evaluation and interpretation, insular biology.

Introductory Comments

This is the 18th in a series of papers treating the butterfly faunas of the mountain range and watercourse refugia in New Mexico and West Texas which are isolated from the main backbone of the Rocky Mountains to the north or the Sierra Madre Occidental and Oriental to the south. The objectives are to study these different refugia separately and comparatively, and to work out dispersion patterns across the underlying desert, using the refugia as stepping stones. At present, this work, begun in May 1966, has explored 36 of these montane refugia and five canyon complexes. Perhaps 27 other refugia have been sampled to the point where partially complete documentation would be useful. The question arises as to how much more information is carried by 68 studies, however. Generally, effectiveness depends on the square root of the sample size. Thus only about 32% more knowledge would be purveyed by augmenting the refugium count 65%.

Due to failed health, this will almost certainly be the final article to which I actively contribute. Now in its 44th year, I believe this is possibly the oldest systematic survey currently ongoing, with objectives unmodified from inception; Mike Toliver and I formally started on Mt. Taylor, near Grants, NM, on 7 May 66. It actually antedates MONA by a year (Hodges 1971) and is now older than the Jasper Ridge *Euphydryas* Watch was when the colony lost its survival battle in 1998 after 38 years of study (Eliperin 2006)). The Biologia Centrali-Americana, for comparison, was published from 1879 to 1915 (36 years), and the Macrolepidoptera of the World from 1906 to 1954 (48 years, under conditions which must have been incomprehensibly agonizing (Sebald

2002)). The annual butterfly count, now sponsored by the Xerces Society, was first conceived by Ray Stanford and Mike Fisher on 19 June 1969 (Stanford 1970 and Stanford 2001). The county dot-map distribution presentations was first applied to the state of Colorado, apparently in 1967 (Stanford 1991), but later as an adjunct to the Ferris & Brown Rocky Mountain Butterflies book (Ferris & Brown 1981).

Killian Roever has actively pursued the skippers of Arizona, especially Megathymidae, since 1958. Hugh Avery Freeman watched, described, and published on skippers from 1936 until at least 1995–a rather humbling 59 years (Warren 1995). The ultimate hypothetical life of a creative psyche is about 85 years–Virginia Reed, age 12, is the youngest significant author of my knowledge (she wrote of her survival at Donner Pass; Stewart 1936), and R. W. P. King is the oldest, teaching at a Harvard electromagnetics lab and publishing his last book after his 97th birthday (Altshuler 2006).

(Many years ago when we were young, I once took Jerry Powell aside and suggested he give some doctoral candidate the thesis topic of living with a very real, secretive (and specific) butterfly guru-mystic for a year and trying to figure out and write down what this wild superman really knew. Surely this information, which will now someday be lost, would fill a bookcase of ordinary dissertations and give Rollins a good run for capturing public interest. To this day I think Jerry made a mistake in rejecting my idea because it "did not require original research." The sad thing is that 100 years from now, the study of the mad genius *would* be called original research–here is a challenge to all dissertation advisors: why must a thesis focus on an historical wizard rather than a living one?

(The real purposes of institutions of higher learning should be to see that knowledge is passed on from generation to generation and that students are taught how to think. For instance, instead of writing on why 13 year and 17 year cicada (*Magicicada septendecim* (L.)) have their lives programed on prime-number-based cycles (Yoshimura 1997), a really interesting question is why does *Homo sapiens* also base his activities and development on a time period which is a prime-number multiple of shorter periods?" In other words, *why does a week have 7 days?* Here is a truly new idea and thesis topic–*show how to extrapolate from insect behavior (17 years) to human behavior (7 days).* Most of the arguments for prime-number cicada periodicity carry over to human cultural competitiveness–only the boldness and imagination to transport is missing!)

Data and Data Presentation

Table 1 lists the articles, study and field work upon which this opus is based. The earlier of these articles include specific sites and dates where each species were found. This information is now available in printed or CD format, for New Mexico, Trans-Pecos Texas, Chihuahua, and (coming soon) Coahuila. It is over 450 pages of pure data, and its archived tabulation seems to obviate the need to duplicate the packing of this quantity of information onto these *Journal* pages: see (Toliver, Holland and Cary 2001) or (Holland 2008). Table 1 indicates what has been published previously, either formally or informally, in the earlier 17 articles, as each pertains to the 41 refugia. Figures 1 and 2 place these 41 refugia on maps.

I make one very emphatic suggestion–it is best not try to deduce state or county records from these maps and charts. Doing this led to many specious records from the first publication (Holland 1974). It is much surer to refer to the data tabulations.

Do to the great quantity of data, neither the butterfly species nor the montane islands can all be written out on each page of each table or image. Instead, mountains are represented by two-letter full caps keys, as described in Table 2. (Counties use the UC/LC combination introduced in (Stanford 1995) and (Stanford 2001)). This table also presents the approximate size in sections A of each refugium (sorry, Anglophobes, but a Section on a USGS map is a mile square, not a kilometer square), the number n of known species, the principal investigator, the approximate era of intensive study, the number of species known only from each island, its specific species density $n/\sqrt[4]{A}$, and a subjective assessment of the study thoroughness of each refugium. I differentiate between local endemics n_{lend}, which occur outside our study area but only enter one or two of our islands, and global endemics n_{gend}, which occur nowhere in the world save one or two of our islands. Global endemics are unusual in the Chihuahuan desert, very concentrated species such as *Apodemia chisosensis*, and very large isolated ranges such as the White Mts., Sacramentos and the Sierra del Carmens, excepted. While I cannot prove it, most of the refugia seem to shout out an isolation of 2000 to 4000 years, but the Sacramentos and Whites, with their 5 and 8 global endemics, respectively, compared to 3 or fewer everywhere else, clearly have widespread genetic drift of a sort one would expect to occur only after 12,000 years. (I am now coming to believe the Chisos + Sierra del Carmen isolation is also of this greater antiquity. Work being done there by Jim Brock is the most exciting exploration ongoing anywhere.) In any event, considerations such as these characterize the Chihuahuan desert as young compared to the Mojave, the Atacama, the Gobi, and the Greenland deserts. Sadly, the Great Sahara and most of Iraq also give an impression of youth–recent xerescaping by early man, (Williams 2000) or (Smith 1995) if you will. (See Table 3 for lists of the endemics of each refugium.)

Space permitting, in a subsequent table, I shall also give the high and low elevations, the longitude and latitude of the summit, distance from closest large refugium or "mainland", and the state of the land for each refugium, so one can perform their own regression analyses if desired. In many cases, early and late records are also available for each species at each refugium.

The central information of this work, the *sine qua non*, is Table 4. This Table gives abundance data for each of 447 butterfly species in each of 41 montane islands. Do not hesitate to use this table; it provides an almost unique insular montane database. I know of few other surveys large enough to be a truly valid numerical resource for statistical study of montane insular biology, certain works on the West Indies (Riley 1976), the Galapagos (Yeakley & Weishampel 2001), the East Indies (Tsukada &Nishiyama 1982, etc.), and especially the Great Basin (Austin *et al.* 1986 & Murphy 1992) excepted.

The key to Table 4 is unchanged from (Holland 1974):

4 or A–abundant, species actually a nuisance (over 100 per hour)
3 or C–common (over 15 per year)
2 or U–uncommon (2-15 per year)
1 or S–single record per year backed by specimen or photo
1 or V–visual or verbal record considered reliable
0 or [blank]–species absent
0 or Q–record considered unreliable
0 or P–record considered reliable but determination questionable
1 or M–a migratory species which moves freely across the Chihuahuan desert
1 or D–a desert species, at home away from the montane islands

The following symbols represent situations unanticipated in 1974

1 or E–extinct
0 or B–data, mostly from Hidalgo County, NM, for species which could be there, are found nearby in SE Arizona, but which I think were added to NM lists to boost the count of NM state records

I point out that the definition of a montane island is less precise than a political boundary. Thus, entries in Table 4 for things like *Apodemia phyciodoides* B. & B. in the San Luis Mts. may refer to a record two miles into Mexico, and do not imply a species is actually confirmed on US soil at this time.

The formula for computing the correlation coefficient ρ_{ij} between Ranges *i* and *j* was presented in 1974. Summations are done over $N = 447$, the complete count of species. It is important to know that the correlation coefficient varies from -1 to +1, not 0 to 1. Thus, if Fauna *i* is identical to Fauna *j*, ρ_{ij} will be 1. If the two faunas are totally without overlap, ρ_{ij} will be -1. If one releases 100 pairs of different species into a room and then catches exactly half at random, ρ_{ij} between the caught and uncaught samples will be 0 on the average. The $\rho_{ij} = 0$ state, not the $\rho_{ij} = -1$ state represents maximum disorder, confusion, or entropy. In order to reach a ρ_{ij} of -1, it is necessary to do a lot of deliberate staging, i.e. sorting or work.

I note that the correlation between two refugium populations can be interpreted as a dot-product in 449-species space between a unit vector characterizing each of the 41 refugia (Spain 1960))

$$u_{ik} = \frac{\frac{1}{\sqrt{N-1}}(X_{ik} - n_k / N)}{\left[\frac{1}{N}\sum_{i=1}^{N}(X_{il} - n_l / N)^2\right]^{1/2}} \quad \text{where} \quad \rho_{ij} = u_{ki}u_{kj} \quad \text{and } N = 449$$

Here X_{ik} is the score of Species *i* in Range *k*, and n_l is $\Sigma_j X_{ij}$, the total score of Species *i*.

One could probably define distance in this space (*ibid.* (16.1)), and also a Riemannian metric tensor (*ibid.* (14.2)). While there is no reason to think correlation space would be curved (*ibid.* (32.2)), its transformation into barrier antiquity probably would be.

Refugium Grouping and Dispersal Routes

In this paper, I begin by assuming that long-distance dispersal patterns of most species either follow major watercourses or mountain chains. In this way, the Chihuahuan refugia fall into about eight groups, as reflected in the tables. The first group consists of the Gila Mountain Complex and the Gila and San Francisco Rivers. It was initially assumed to include the central Gila Mts. (Mogollon Mts.), the Black Range, the San Mateo Mts., the Gallo-Mangas refugium (which have been studied), the Datil Mts., Alegre Mt., the Escudillo Mesa in Arizona, and several smaller ranges in Grant and Catron Counties (which have not been adequately studied or not sampled at all). This is the most difficult and extensive of the refugium groups. In addition to having the two rivers (the Gila and San Francisco) factoring its dispersal situation, it lies at the southeast end of the Mogollon Rim. It is the only part of New Mexico with major unexplored areas, some of which in the Mogollon sector are extremely inaccessible, and the one place in New Mexico where terrain is the factor causing our ignorance. The Pinos Altos Range and the Big Burro Mts. are additional refugia of the Gila Group; data exists for these last two (Ferris 1977 and 1978, Hubbard 1966, Zimmerman 2001), but I lack the resources to include them at this time. Thus, the Gila Complex includes at least five unexplored refugia and six explored ones, four of which we discuss here. Table 5 summarizes this situation. At the suggestion of several friends, this complex was expanded, just before going to press, to include the White Mts. of east central Arizona.

The second group of mountain refugia lie mainly in Luna and Hidalgo Counties, and have definite Sonoran rather than Chihuahuan affinities in the surrounding lowlands. In this group are the Florida Ranges, Cooke's Peak, the Animas Mts., the San Luis Mts., the Big Hatchet Mts., and the Peloncillo Mts. I shall refer to these as the Bootheel group. They are relatively well studied. The Sonoran Desert is better watered than the Chihuahuan, which partly compensates for a shortage of watercourses and intermediate stepping stones in this group. The Playas, Mimbres and Animas Rivers here flow in closed basins bearing their names. Again at the suggestion of colleagues, this group was expanded just before publication. It now includes a sizeable corner of the Sierra Madre Oriental, extending from Nuevo Casas Grandes and Madera to the Sonoran state line a bit east of the Rio Bavispe. A second refugium, consisting of the high country in Sonora between Colonia Mesa Tres Rios, the Rio Gavilan, and the Rio Bavispe, was also added. The addition of these two refugia permit comparisons between the outlying islands and actual sections of the Sierra Madre Occidental itself. On one hand, it is nice to have a discourse on the Chihuahuan refugia actually include a refugium in Chihuahua itself. On the other hand, we must live with the fact that the field hours of research in Chihuahua which we can draw from are almost certainly less than1% of the field hours invested in Texas or Arizona. The second of the two additional refugia I affectionately refer to as Huachinera Heights–it is one of the very few places where one can drive to 8000' in Sonora, and it is the one site in Mexico I have personally seen Douglas Fir (*Pseudotsuga taxifolia* (Poir.)).

The third or Rio Grande group of mountain refugia all lie close to the Rio Grande, and include the Franklin Mts., the Organ Mts., the Magdalena Mts., the Manzano Mts., Ladron Peak, the Sandia Mts.(which have been studied); and the San Andreas Range the Caballo Mts., the Oscuro Mts., and the Fra Cristobal Mts, (which are just now starting to receive serious attention).

The fourth group has definite Great Basin affinities, and I shall so name it. It includes the Chuska Mts., the Zuni Mts., Mt. Taylor, and the Jemez Mountains (although this last has good connections to the Rio Grande and the Rockies as well). The major ranges in this part of New Mexico are nicely researched, but many smaller ranges, especially in Arizona, are virtually unexplored. Included here are the Fort Defiance Plateau, Black Mesa, and the Carrizo Mts.

The fifth group of refugia include the Raton Mesa Complex (which I shall designate as Johnson Mesa and All the Rest, as the other mesas are not well delineated). Here I also have Capulin Volcano and Sierra Grande, plus several watercourses which eventually run out to the Mississippi. These watercourses form the Union County Wet Spots--our first non-montane refugia. They include the Dry Cimarron, the Carrizozo Creek, and the Seneca Creek drainages. This group has montane ties to the Rockies as well as drainage ties to the Midwest. It is relatively well studied. The area around Clayton Lake is especially peculiar, and is treated as its own refugium.

The sixth group of refugia are associated with the Pecos River, and include the Sacramento Mts., the Capitan Mts, and Carrizo Peak. They are well studied. I shall call them the Sacramento Group. A noteworthy satellite of this group is the Gallina Mts, which are not well researched. To this group, we have also added the refugium centered at Sumner Lake.

The seventh group are the West Texas stepping stones connecting the Rockies weakly to the Mexican Sierra Madre Oriental. In the West Texas Group are the Guadalupe Ridge, the Davis Mts., the Chisos Mts., and the Maderas del Carmen. The latter is in Coahuila, Mexico, and its exploration is just now getting productive. The other ranges are well known. The serious exploration of the Sierra del Carmen is, I predict, going to be the final frontier in the knowledge of American Rhopalocera. Anyone who is physically able should take part in this great adventure. Spend a few nights a week learning conversational Spanish and go visit our wonderful southern neighbors. I did this 30 years ago and have always regretted that I didn't do it 40 years ago. Coahuila is a friendly, cultured, delightful place to visit and learn.

There is a loosely connected eighth group of minor refugia on the watercourses, Ute Lake, and Caprock Escarpment of Quay County. These refugia all drain into the Canadian River, and the group should rightly include the Canadian River Canyon in Harding County as well. In fact, some Colfax County wetlands west of the Union County Wet Spots, are really misplaced and should be considered a part of the Canadian Complex. At present, the Canadian Complex includes the upper Canadian River Refugium (Maxwell Lakes National Wildlife Refuge, Mills Canyon, David Hill, and other parts of Harding County). It also includes the lower Canadian River Refugium (Ute Lake, Conchas Lake, Logan, and Tucumcari). Lastly, this group includes Caprock Escarpment with particular emphasis on the north facing slopes. This meandering North Face wanders several hundred miles through New Mexico and bears considerable resemblance to the

Pleistocene Relictia of western Nebraska discussed in several articles by Kurt Johnson (Johnson 1975 and 1977).

There are several smaller ranges in West Texas, especially the Chianti Mts. and the Hueco Mts., which I omit because I lack data and resources. There are also many omitted ranges in Chihuahua itself (see Table 5). Additionally, I have left out the Rio Grande and Pecos River bottomlands because these areas are now too disturbed to glean any meaningful data.

The main points of interest in Tables 2 and 3 are the remarkable global endemic count (5) of the Sacramento Complex, the White Mountains of Arizona (8), and the Bootheel/Madera region (5); and the local endemic counts of the Jemez Mts.(5), and the Sierra del Carmen (6). Clearly the first three of these indicate a much greater antiquity than found on the other Chihuahuan refugia, and the last two that these refugia are *cul de sacs* terminating major influx highways. The Jemez have such a rich local endemic population, because they are at a double *cul de sac*, cutting the Rocky Mountains from the north at a Chihuahuan or semi-tropical flyway from the south. (Actually, all the Jemez endemics represent austral penetrations of Colorado Rockies animals.)

The Connection between Correlation and Population Dynamics

Table 6 presents our results for the refugium faunal correlations of the 41 Chihuahuan islands. It may be seen that the vast majority are positive–only four correlations connecting the southernmost islands with the most boreal are slightly negative. Thus, the Chihuahuan barriers, as represented here, mostly do not significantly exceed 100,000 years. Table 7 (to be explained in more detail later) transforms the arcane concept of correlation to the more simple idea of barrier antiquity.

I shall now consider if these results are consistent with the grouping that I have proposed. After that it remains to associate the correlation coefficients with dispersion routes, passability, and antiquity of blockage. All of these parameters require some sort of mathematical description or characterization if one wishes to deduce hard-core objective conclusions.

For instance, correlation coefficients above about 0.90 are seldom seen, even between identical areas joined with no barriers. One dimension barrier description must include is age. Thus, any barrier with correlation across it on the order of 0.90 should be presumed to be 0 to 10 years old. Although the proof is not obvious, it appears to take about 2000 years of isolation to reduce the correlation coefficient to 0.7. It could take well over a million years to reduce the correlation coefficient below - 0.4 For instance, the Hawaiian Islands are about 4 million years old, and at the time of their discovery by Europeans had a ρ of -1 (both native Hawaiian species endemic) with the outside world. However, Easter Island is about as isolated from the outside world as the Hawaiian Islands, but had a ρ of 0; its single native species (*Vanessa carye* Hübner) is not endemic (Pena 1997). (Statistical descriptions are not well suited to samples of one or two.) There are believed to be seven species of butterflies native to the Galapagos, three endemic and four found elsewhere, including *Vanessa carye*. Thus, these three Pacific refugia have an aggregate of five endemics and five species naturally occurring elsewhere–this is starting to get statistically treatable; the corresponding ρ was - 0.5 ± 0.05. (The Galapagos are of approximately the same age as the Hawaiian Islands; about 3 million years.) Given the track record of man to mess up everything, we should expect his influence to bring ρ closer to the chaotic state of $\rho = 0$. In point of fact, his presence has introduced three species to the Galapagos, resulting in $\rho = -0.38$.

Thus, one barrier parameter is age, a. The connection between a and ρ has a pole (age $\to\infty$) at $\rho = -1$ and a zero (age = 0) at $\rho = +1$. Hence, the dependence of a on ρ must be of the form

$$a = a_0 \frac{(1-\rho)^m}{(1+\rho)^n}$$

where m and n are powers to determine from the above considerations. From trial and error data matching, we suggest $a_0 = 100{,}000$, $m = 2$, and $n = ½$.

Let us present now a rather dramatic demonstration of the power of the above equation. Table 6 gives the antiquity versus ρ. Included here are the correlations and antiquities for the trail of stepping stones connecting the Sacramentos to the Sierra del Carmen, via the Guadalupe Ridge, the Guadalupe Mts., the Davis Mts., the Chisos Mts: correlations are 0.49, 0.68, 0.60, 0.46, 0.50 (see Table 6). The corresponding barrier ages are computed to be 10,860, 2530, 5060, 13,030, and 10,200 years (see Table 7). On the other hand, a direct lookup of the correlation between the two ends of this bridge gives $\rho = 0.24$. Here is the Big Question concerning the value of this study: *Do the individual barrier ages add up to the antiquity of the entire bridge?* Amazingly, the answer is YES, the sum is 41,660 years, and the entire bridge correlation gives 39,420 years. In general, especially for barriers with more than one credible path over or around, the agreement will be less dramatic unless modifications are added to the procedure. As a general rule, in the absence of alternative credible paths, the sum of the ages add up to the age of the sum ±10% if the ends of the path traced is east-west. For north-south paths, especially where the altitude is far greater at the north, the age agreement is much poorer, and the Antiquity Formula error may approach ± 50%. Table 7 also presents results of the above Antiquity Rule in eight other cases: Clayton Lake to Franklin Mts. (37,400 years vs. 66,800 years), Jemez Mts. to Sierra del Carmen (106,100 years vs. 75,100 years), San Luis Mts. to Sierra del Carmen (52,200 years vs. 51,600 years), Chuska Mts. to Clayton Lake (54,100 years vs. 56,300 years), Sierra del Carmen to Carrizo Peak (40,400 years vs. 62,000 years), Franklin Mts. to Gallo-Mangas Complex (38,900 years vs. 41,800 years), Clayton Lake to Capulin Volcano (33,100 years vs. 45,000 years), Jemez Mts. to Chisos Mts. (109,300 years vs. 94,100 years), and Peloncillo Mts. to Chuska Mts. (78,100 years vs. 51,900 years). The above results have an average discrepancy of 26% and a median discrepancy of 21%. The repeated use of Clayton Lake was deliberately used to stress the Formula; it is believed Clayton Lake was colonized from the Mississippi Basin, unlike the other refugia, There are places in Union County within sight of each other that have less correlation than the Sandia Mts. and the Sacramento Mts.

This work does not consider possible ambiguities in defining the closing of a natural barrier. Part of our uncertainty bracket may be related to this issue. Obviously, two leagues of open water isn't much of a barrier to *Danaus plexippus*, but should pretty well retard *Brephidium exilis* on most days.

Correlation of the Refugium Groups

The 41 x 41 correlation matrix of Table 6 is a bit too large to comprehend and consider unless one has spent years in the field on each refugium. Consequently, the refugia were placed in the eight groups, and values calculated for the inter-group correlations (see Table 8). For a good grouping system, all the refugia in Group *I* should have similar correlations to all the refugia in Group *J*, irrespective of *I* or *J*. In order to test our grouping, an 8 x 8 matrix was formed inter-relating the eight groups, with each group-matrix entry being the standard deviation of the associated refugium-matrix correlations. Ideally, these standard deviations should all be small, so each group-matrix entry should be small. Then sum of the 35 independent group-matrix correlation entries should be minimized for the optimum formation of the eight groups. (Note that the main-diagonal entries in the group-matrix correlations are very significant, unlike the corresponding individual-refugium matrix-diagonal entries, which are 1 by definition.

It is also possible to form a 8 x 8 group matrix of the average correlation of the associated refugia. The entries of this second group matrix approximate the antiquity of the isolation of the groups. (This approximation depends on the linearity of the relationship defining the antiquity of their separation, which by definition is actually given by the above nonlinear equation.). The standard deviation of the group-matrix components, which we have tried to minimize, is an estimate of the uncertainty of the approximation which we have made by forming refugium groups and relating to them instead of to the individual refugia.

Table 8 also gives the 8 x 8 matrix containing the intra-group standard deviations and the group-average standard deviations. It is desired to minimize the sum of the standard deviations in this matrix. Examinations of Table 8 shows that this matrix is dominated by the West Texas refugia, the Jemez Mountains refugium, the non montane Union County refugia, and the Rio Grande refugia. The West Texas and the Union County refugia are outliers, and cannot reasonably be moved to any other group.

The third entry in each cell of Table 8 shows the group standard deviations with the Jemez Mts transferred from the Great Basin Group to the Colfax-Union Group. The net impact of this transfer on the standard-deviation group-matrix sum is almost unobservable. It makes almost no difference where we place the Jemez. The only other conceivable alteration is to transfer the Franklin and Organ Mts. to the Bootheel Group. Not wanting to have one stone unturned, I leave the evaluation of this effort to the reader, but predict it will lead to nothing detectable.

Space permitting, in a subsequent table I shall also give the high and low elevations, the longitude and latitude of the summit, distance from closest large refugium or "mainland", and the state of the land for each refugium, so one can perform their own regression analyses if desired. In many cases, early and late-season records are available for each species at each refugium.

The above equation yields an antiquity of 11,000 years for the isolation of the Sacramento Mts. Complex from the Rio Grande Group, based on a group correlation value of 0.49. This antiquity is far from the accepted isolation of 2000–4000 years, but right on my hypothetical initial guess of 12,000 years. Likewise, the West Texas Group, based on a correlation value of 0.51, is much older than traditionally thought; 0.51 correlation gives 9600 years.

Such agreement is rare in fitting an artificial curve to reality. Determining the best class of function and the number of adjustable parameters for a fit like correlation to antiquity is a science and an art form in its own right, perhaps more common in computational physics than in biometrics (Holland & St. John 1999).

Other Barrier Parameters

After age, the second barrier parameter is leakiness. The above equation assumes no leaks once the barrier is up, and ρ decreases forever. While this might be reasonable for associating New Mexico with Hawaii, it probably does not do justice to actual gene flow across the Rio Grande Valley. In actuality, isolation should stabilize and saturate in several hundred to 100,000 years, depending on which islands and species families I am considering. It is at present an open question whether this flow is dominated by geographical parameters or climate change, but climate change is already incorporated into the first equation, so here incorporate only geographics. In particular, I now assume gene flow reaches equilibrium after a_0 years, where a_0 is hypothetically assumed not to exceed 100,000 years. I thus define barrier leakiness λ as $1/a_0$, which for the montane islands is at least $1/100{,}000 = 10^{-5}$, and may easily be 30 times this in some cases. Leakiness is factored into the equation by replacing a with $\min\{a, a_0\}$, and has the dimensions of reciprocal years.

There a third parameter needed to treat insular population dynamics: the *carrying capacity* of each island. Table 2 shows that the fauna of each island is approximately proportional to the fourth root of the size of each island. Similar relationships have been demonstrated for the fauna of the 16 channel islands of Southern and Baja California, except that this earlier work assumed a square root, not a fourth root, dependence on area. (Philbrick 1967) In the case of greatest simplicity, a newly created island i hosts a butterfly fauna $n(t)_i$ asymptotically approaching the carrying capacity from a zero start in decaying exponential fashion,

$$n(t)_i = n_{0i}(1 - e^{-\lambda t})$$

This, however, is an oversimplification. Thus, for the present, let us merely keep the existence of a second equation in mind to describe species saturation, but do not assume it will be exactly this.

To be absolutely precise, I should describe population dynamics by a set of insular reservoirs, all interconnected by very narrow passages. I would define population pressure of each reservoir to be proportional to the species count at each reservoir, normalized by the reservoir carrying capacity, and species to flow in both directions in each passage in proportion to the population pressure at each end, and in proportion to the leakiness of each passage. Note that the leakiness does not need to be the same in both directions–downwind leakage may be assumed to exceed upwind. Finally, I will need a species reaper at each island, as insular populations by definition are fragile. The above system can be expressed as a set of $2N$ coupled first order linear equations, the solution of which is well-known (see any introductory text to electronic circuit theory for the analytical approach or (Kunz & Luebbers) 1993 for the numerical approach).

This introduction of barriers and dispersion gives some idea of how these qualitative concepts are numerically related to correlation coefficients. They are connected much more formally, for example, in our reference to population dynamics of the Galapagos Islands (Yeakley & Weishampel 2000).

Conclusions

This paper is written to introduce some very different thoughts. It gives a probable reason why a week has seven days, and it describes how to compute the antiquity of a biological barrier with respect to any group of living organisms, given the correlation of the species distributions on opposite sides of the barrier. In most cases, this antiquity is ± 30%; in many cases the uncertainty is much less.

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Table 1. Publications of butterfly lists pertaining to the montane islands of the Chihuahuan Desert

Publication (Species in Each Range	[Mountains Studied and Number of	Counties in Range	Author and Journal or Publication or Inclusion in H., T. & C.
Butterflies of the Chihuahuan Desert Montane Islands	38 mountain ranges and five canyon complexes	States of NM, AZ, CO, TX, Chih., Son, & Coahuila	L Holland, privately published, Albuquerque, 2008,
1. Butterflies of Six Central New Mexico Mountains, with Notes on *Callophrys (Sandia) mcfarlandi* (Lycaenidae)	MT,Mt.Taylor(75) AB, Sandia Mts. (94) MZ, Manzano Mts. (102) LP,LadronPeak(60) MG, Magdalena Mts. (87) VP, San Mateo Mts. (100)	Ci,Mk Be, Sa Be, To, Va So So So, Si	R. Holland, J. Lepid. Soc. 28 38-52, 1974.
2. A Check List of the Jutterflies of Grant County, •Jew Mexico, and Vicinity & two supplements	WB,GilaMts.(171) BR, Black Range (126)	Gr, Ca, Si Gr., Si	C.D. Ferns, J. Lepid. Soc. 30:38-49, 1976; first supplement *J.* Lepid. Soc. 1977; second supplement pub. by author, 1978.
3. Butterflies of Two Northwest sfew Mexico Mountains	ZM,ZuniMts. 1976 only (3), 1977 only (12), both years (84) CK,ChuskaMts. (101)	Ci,MK,MT V1K&SJ(NM)+ Ap & Na(AZ)	i. Holland, J. Lepid. Soc. 38: 220-234, 1984.
4. Butterflies of New Mexico's Cooks Peak	CO,Cooke'sPeak(85)	Lu	incorporated into Toliver, Holland, Toliver and Cary, 1992.
5. Butterflies of El Paso and Surrounding Areas	FM, Franklin Mts. (106)	DA, EP(TX)	L D. Moses and B. R. Belmont, unpublished manuscript, incorporated into Toliver, Holland, ind Cary, 1992.
5. Gray Ranch: Fire and Jutterflies in Southwestern New Mexico	AM,AnimasMts.(124)	Hi	S. J. Cary, Holarctic Lep. 1 : 55-68, 1994.
7. Butterflies of the JemezMts. of Northern New Mexico	*JZ,* JemezMts. (151)	RA,LA,Sa	R. Holland and S. J. Cary, J. Lepid. Soc. 50: 61-79, 1994.
8. Butterflies of the Gallo-vlangas Complex, West-Central •few Mexico	GM, Gallo-Mangas Mts. (89)	Ca	I. Holland, incorporated into roliver, Holland, and Cary, 2001.
9. Butterflies of Four South-Central New Mexico Mts.	OR, Organ Mts. (112) SC, Sacramento Mts. (136) CM, Capitan Mts. (104) GR, Guadalupe Mts. &Ridge (127)	DA Li, Ot *A* Ch,Ed,Ot,Cu(TX)	S. J. Cary and R. Holland, Report >f Lepidoptera Research, distributed at Guadalupe Mts. Nat. Park, 1986-1990s.
10. Checklist of the Lepidoptera of the Guadalupe Mountains National Park, Texas (see also #9forGR)	GN, Guadalupe Mts., Texas, (85) the first stepping stone between 4ew Mexico and the Sierra Madre Oriental of NE Mexico.	Cu(TX)	i Knudson & C. Bordelon, Texas Lepidoptera Survey, Publication 4, 1999.
.1. Checklist of the Lepidoptera of the Davis Mountains, Texas	DM, Davis Mts. (93) the second stepping stone between New Mexico and the Sierra Madre Oriental of NE Mexico.	JD(TX) Jeff)avis Co., TX	E. Knudson & C. Bordelon. Texas ^epidoptera Survey, Publication 3, 1999.
2, Checklist of the Lepidoptera of the Big Bend National Park, Texas	BB, Chisos Mts. (158) the third stepping stone between New klexico and the Sierra Madre Oriental of NE Mexico	Br(TX)	*1.* Knudson & C. Bordelon. Texas Lepidoptera Survey, Publication 7, 2000.

Publication	Mountains Studied and Number of Species in Each Range	Counties in Range	Author and Journal or Publication or Inclusion in H., T. & C.
13. Butterflies of Carrizo Peak (Physically Carrizo Peak is a part of the Capitans–9 above; it was not explored ante 1998.)	CZ, Carrizo Peak (90)	Li	RH, never finished due to access problems on private land; data informally available in weekly reports to Lincoln National Forest.
14. Preliminary List of the Butterflies Found at Capulin Mountain National Monument, Capulin, New Mexico	CV, Capulin Volcano (74)	Un	F. M. Brown, Mid-Continent Lepid. Ser. 2. 28:1–8, 1971.
15. An Inventory of the Butterfly Species on the Gila National Forest, Southwestern New Mexico	WB, Gila Mts. (171) BR, Black Range (126) GM, Gallo-Mangas Complex (89) VL, San Mateo Mts. (100)	Gr, Ca, Si Si Ca So, Si	D.A. Zimmerman, Biology Dept., Western New Mexico University, Silver City, Dec. 2001
16. Butterflies of the Raton Mesa complex, NE of Raton, New Mexico (see also #14 for Capulin Volcano)	RC, Raton, Johnson, Fisher Mesas (139)^ JM, Johnson Mesa (100) SG, Sierra Grande (86) CV, Capulin Volcano (74)	Co,Un,LA(CO) Co Un Un	R. Holland, S. J. Cary, R. E. Stanford, incorporated into Holland, 2008.
17. Butterflies of the Union County Wet Areas, Extreme Northeast New Mexico	UC, Union Co. Wet Areas (37) CL, Clayton Lake State Park (73)	Un, Ha Un	R. Holland, S. J. Cary, R. E. Stanford, incorporated into Holland, 2008; may be published separately also.
18. Butterflies Recorded in Northern Coahuila, Mexico, 2005(89), 2006(62), 2007(108)	MC, Sierra (Madeiras) del Carmen (122) the fourth stepping stone. Poisson series for the three trips is (only 13 missed), 31, 34, 50--amazing!!	State of Coahuila, Mexico	J. Brock, unpublished trip reports from 7–12 June 2005, 22–26 May 2006, and 17–23 June 2007. This data implies the 22 May to 23 June fauna is 130 species--compare with 13 above for 12 month result of 168 from US side of Rio Grande. First Prize, Jim.
19. Checklist of Butterflies for Rockhound State Park, including Florida and Little Florida Mts., Luna Co., New Mexico	FL, Florida & Little Florida Mts. (82)	Lu	S. J. Cary, New Mexico State Parks, 2005
20. Checklist of Butterflies for Clayton Lake State Park and Vicinity, Union County, New Mexico	CL, Clayton Lake State Park (73) UC, Union County Wet Areas (37)	Un Un	S. J. Cary, New Mexico State Parks, 2005
21. Checklist of Butterflies for Sugarite Canyon State Park, NM, Lake Dorothy Wildlife Area, CO, James M. John Wildlife Area, CO	RC, Raton Mesa Complex (139)	Un&LA(CO)	S. J. Cary, New Mexico State Parks, 2007
22. Checklist of Butterflies for Sumner Lake State Park, NM, DeBaca Co., NM	DB, Sumner Lake (49)	DeBaca	S. J. Cary, New Mexico State Parks, 2005
23. The Probable Case for *Apodemia phyciodoides* in New Mexico–A Chihuahuan Comedy	SL, San Luis Mts. (67)	Janos (Chih.), Bavispe (Son.)	R. Holland, News of the Lepidopterists' Society, 49(4):120–127, Winter 2007.
24. Field Notes for the USFWS on butterflies seen in 2000–2001, Big Hatchet Mts., Hidalgo Co., NM	BH, Big Hatchet Mts. (57)	Hi	G. Pratt, Field Notes for the USFWS on butterflies seen in 2000–2001, Big Hatchet Mts., Hidalgo Co., NM

Publication	Mountains Studied and Number of Species in Each Range	Counties in Range	Author and Journal or Publication or Inclusion in H., T. & C.
25. Some Butterflies of the Pinos Altos Mts., New Mexico	Gila Mountains Complex (unreported sector)	Gr	J. P. Hubbard, J. Lepid. Soc., 19: 231–232, 1965.
26. Additional Supplement to "A Checklist of the Butterflies of Grant County, New Mexico, and Vicinity"	WB, Gila Mts. (171) BR, Black Range (126)	Gr, Ca, Si Gr., Si	C.D. Ferris, J. Lepid. Soc. 30:38–49, 1977; first supplement J. Lepid. Soc.; second supplement pub. by author.
27. A Collection of Butterflies from Western Chihuahua, Mexico, Ent. News, 74: 157–162, 1956.	CJ, Colonia Juarez, from Janos to Madera & the Rio Gavilan, 1899 & 1977. Ent. News, 74: 157–162. 1956. (105)	Janos, Casas Grande, Madera,Chih.	Brock et al. The Great *Speyeria nokomis* hunt in Mexico, also Townsend as reported in 1898 by W, Holland:see (Clench, 1956)
	QC, Quay County, Lower Canadian River Canypns (37)	Qu, SM, Ha	
	HC, Harding County, Upper Canadian River Canyons (71)	Qu, Ha, Mo	
	CE, Caprock Escarpment (66)	Qu, Cu, Ro, Le, Gu, Ch, DB	
30. Rediscovery of *Apodemia phyciodoides* (Riodinidae)	HH, Huachinera Heights, mostly eastern Mun. Huachinera, Rio Gavilan & Rio Los Lobos, Son(25)	Mun.Huachin RGavilan&R LosLobosSon	Holland, R. & G. S. Forbes. J. Lepid. Soc. 35(3): 226–232, 1981...

Notes:

3. Poisson series is (1missed), 15, 82. In this case the interpretation is that, if I collected a third year in the Zuni Mts, I would, at most, increase my list by 1, not that I only overlooked one species. The implication is that it is time for me to move on, not that someone with a different search pattern would find only one new species (Sokolnikoff and Redheffer 1958).

7. It is interesting to note that the 100 species taken by John Woodgate in the Jemez Mts. 1912-1914 were 99% replicated by Holland in 1984–1985.

9. In 1986, Cary and Holland reported 122 species from the Guadalupe complex. Weekly excursions from February to October over the grueling 700 mile round-trip drive from Albuquerque-Santa Fe to the GMNP in 1987 added only two species. It is not rocket science to conclude that the job was ended. Since I do not know exactly how many species were seen in 1986 but not replicated in 1987, I cannot do a Poisson series, but if I estimate this number to be 8, I obtain (0.35 missed), 10, 114 (Sokolnikoff and Redheffer 1958).

17. Comment #3 does not fully apply here, as the Brock expeditions were performed with varying workers. However, it is still true that the Brock figure for missed species will not take into account the under sampling of peculiar and arcane groups such as the Megathymidae and the *Euphilotes*. The accuracy of the Poisson model for missed species depends on the absence of bias from the data–a requirement that is usually violated in many ways. Examples are mixing of data from wet and dry years, from wet and dry seasons, from unequal surveying effort, from unequal surveying skills, from providing unequal access, and from assuming all species are equally easy to see and identify. In every case, the use of biased data tends to make the estimate of missed species low.

Table 2. Summary of Montane islands, two-letter symbols associated, and fauna facts.

Montane Island Name	Coded Symbol	Species Present n	Local endemic $n_{lend.}$	Global endemic $n_{gend.}$	Years Worked by RH	Assessment of Coverage	Area A (approx.) Involved	$n/\sqrt[4]{A}$	$n/\log_{10} A$
Gila Mts. Complex									
Gila Mts.	WB	171	1	3	1965-1979(CF)	premier NM study	5000	20.34	46.23
Black Range	BR	126			1988-1995	inadequate access	500	26.65	46.68
San Mateo Mts.	VL	100		1	1972-1973	adequate	300	24.03	40.37
Gallo-Mangas Mts. complex	GM	89		1	1994-1995	marginal	300	21.39	35.93
White Mountains of Arizona	AZ	116	1	7.5	1975-present	nice	8000	12.27	29.72
Bootheel Complex									
Florida Mt. Ranges	FL	82			1985-2005(SC)	remarkable considering terrain	200	21.81	35.64
Cooke Peak	CO	85			1988-1995	inadequate access	25	38.01	60.8
Animas Mts.	AM	124	2	1	1991-1994(SC)	thorough	750	23.69	43.13
San Luis Mts.	SL	67	1		1985-1994	inadequate access	750	12.8	23.3
Big Hatchet Mts.	BH	57			2000-2001(GP)	inadequate access	100	18.02	28.5
Peloncillo Mts.	PM	134		2	1981-2004	good, thorough	300	32.2	54.1
Sierra Madre of Mun. Casas Grandes, Madera, & E Janos	CJ	105	4	2	1970-1980	kid in a candy store	8000	11.1	26.9
Sierra Madre of Rio de Los Lobos & Rio Gavilan, Son.	HH	25	2.5		1978-1994	bull in a china shop	500	5.29	9.26
Rio Grande Complex									
Franklin Mts.	FK	106	2	0	1979-1985	inadequate by itself	50	39.86	62.39
Organ Mts.	OM	112		1	1979	thorough	50	42.12	65.92
Magdalena Mts.	MG	87			1971	adequate	200	23.13	37.81
Manzano Mts.	MZ	103			1967	thorough	150	29.43	47.33
Ladron Peak	LP	60			1968	inadequate access	20	28.37	46.12

Montane Island Name	Coded Symbol	Species Present n	Local endemic $n_{lend.}$	Global endemic $n_{gend.}$	Years Worked by RH	Assessment of Coverage	Area A (approx.) Involved	$n/\sqrt[4]{A}$	$n/\log_{10} A$
Sandia Mts.	AB	94			1964-2008(MT)	thorough	50	35.35	55.33
	Great Basin Refugia								
Chuska Mts.	CK	107	1.5	1.5	1972-1978	thorough; land abused	1000	19.03	35.67
Zuni Mts.	ZM	99	1		1976-1977	south slope access poor	1000	17.6	33
Mt. Taylor	MT	75			1966	no access to east slope	500	15.86	27.79
Jemez Mts.	JZ	151	5		1983-1985	no Valle Grande data	1500	24.26	47.54
	Colfax/Union County Refugia								
Raton Mesa Complex	RC	139	2.5	1.5	1993-1998	no access to highest mesa	1500	22.34	43.76
Johnson Mesa	JM	100		1.5	1993-1998	thorough	250	25.15	41.7
Capulin Volcano	CV	74			1969&93-1997(FB)	thorough	20	34.99	56.88
Sierra Grande	SG	86			1993-1998(SC)	marginal	400	19.23	33.05
Union County Wet Spots	UC	37	1		1993-1997	enough to be interesting	100	11.7	18.5
Clayton Lake State Park	CL	73	3		1993-1997	good	20	34.52	56.11
	Sacramento Complex								
Sacramento Mts.	SX	136		5	1964-2001	very thorough	1500	21.85	42.82
Capitan Mts.	CM	104		1.5	1980-1982	adequate	200	27.66	45.2
Carrizo Peak	CZ	90		.5	1997-1998	incomplete	100	28.46	45
Sumner Lake	DB	49			1985-2005	axcellent;dep auperate	20	23.17	37.66
	West Texas Complex								
Guadalupe Ridge Complex	GR	127		.5	1986-1987	thorough	1000	22.58	42.33
Guadalupe Mts. Nat. Park	GN	85		.5	1986-1987	adequate	250	21.38	35.45
Davis Mts.	DM	93	2		1994-1997	excessive guesswork	1000	16.54	31
Chisos Mts.	BB	158	5	2	1963-1964	adequate w/ other work	400	35.33	60.72

Montane Island Name	Coded Symbol	Species Present n	Local endemic n_{lend}	Global endemic n_{gend}	Years Worked by RH	Assessment of Coverage	Area A (approx.) Involved	$n/\sqrt[4]{A}$	$n/\log_{10} A$
Sierra (Maderas) del Carmen	MC	122	3.5	3	2005-2007(JB)	great start on ultimate	3000	16.48	35.09
Canadian River Complex									
Lower Canadian River	QC	37			1985-2007(SC)	inadequate	2000	5.53	11.21
Upper Canadian River	HC	71	2.5		1985-2007(SC)	fairly good	200	18.88	30.86
Caprock Escarpment	CE	66	.5		1985-2007(SC)	terrain difficult, inadequate	5000	7.85	17.84
STDEV		30.81	1.42	1.21			982.22	7.69	11.33
AVERAGE		100.06	2.35	1.56			643	25.01	42.82
RATIO		0.31	0.6	0.78			1.53	0.31	0.26

Table 3. Endemics, global (G) and local (L), found in each refugium

Refugium	Endemics: note–any global endemic is automatically a local endemic
Gila Mts. (WB)	*P. saepiolus gertschi* (G), *S. ilavia* (G), *P. icarioides buchholzi* (G), *S. nokomis nitocris* (G), *O. alberta daura* (G) *P. alcestis oslari* (G), *T.ruptifasciata* (L), *H. uncas lasus* (L) 6/2 + 2/2
San Mateo Mts. (VL)	*O. chryxus socorro* (G) 1
Gallo-Mangas Mts. (GM)	*P. icarioides buchholzi* (G), *C. tullia subfusca* (G) 2/2
White Mts. (AZ)	*L. rubidius ferrisi* (G), *P. saepiolus gertschi* (G), *P. icarioides buchholzi* (G), *S. aphrodite bylbis* (G), *S. nokomis nitocris* (G), *S. mormonia luski* (G), *C. tullia subfusca* (G), *O. alberta daura* (G), *E. anicia magdalena* (G), *P. peckius* (L) 3 + 5/2 + 1
Franklin Mts. (FM)	*E. daira* (L), *P. dina* (L), *M. zerynthia* (L), *S. blomfilsia* (L) 4/2
Organ Mts. (OM)	*E. polingi organensis* (G) 1
Animas Mts. (AM)	*U. dorantes* (L), *C. ethlius* (L), *P alcestis oslari* (L) 2 + 1/2
Peloncillo Mts. (PM)	*A. aryxna (G), S. shiva (G), A. jada (L), D. laure (L), C. roeita (L), C. georgina (L) 1 + 2/2 +4*
San Luis Mts. (SL)	*C. fulvia coronado* (L) 1
Colonia Juarez Region (CJ)	*P. bailowitz* (G), *P. melissa mexicana* (G), *N. terlooti* (L), *C. chihuahua* (L), *C. pyracmon* (L), *S. mazans* (L), *C. estela* (L) 2 + 5
Huachinera Heights (HH)	*E. socialis* (L), *N. terlooti* (L), *C. dospassosi* (L) 2 + 1/2
Zuni Mts. (ZM)	*P. indra minori* (L) 1
Chuska Mts. (CK)	*E. anicia chuskae* (G), *C. meadii damei* (L), *C. emimarginata* (L), *E. ellisii* (L), *P. batesii* (L) 1 + 1/2
Jemez Mts. (JZ)	*H. juba* (L), *O. sylvanoides napa* (L), *L. heteronea heteronea* (L), *L. sylvinus itys* (L), *C. augustinius irioides* (L), *C. polios obscurus* (L), *B. selene tollandensis* (L), *B. chariclea helena* (L), *S. cybele carpenteri* (L), *O. chryxus chryxus* (L) 10/2
Raton Mesa Complex (RC)	*P. icarioides femnegra* (G), *S. hesperis ratonensis* (G), *O. uhleri uhleri* (L), *E. martialis* (L), E. ausonides coloradensis (L), *O. uhleri uhleri,* (L), 1 + ½ + 5/2
Johnson Mesa (JM)	*P. icarioides femnegra* (G), *S. hesperis ratonensis* (G), 1 + 1/2
Union County (UC)	*L. weidemuyerii angustifascia* (L) 1
Clayton Lake (CL)	*A. numitor* (L), *L. dione* (L), *L. hyllus* (L), *S. idalia* (L) 2 + 2/2

Capitan Mts. (CM)	*P. icarioides sacre* (G), *S. hesperis capitanensis* (G), *G. lygdamus ruidoso* (G) 3/2
Sacramento Mts. (SX)	*C. affinis albipalpis (G), C. sheridanii sacramento (G), G. lygdamus ruidoso (G), S. titus carrizozo (G), P. icarioides sacre (G), S. hesperis capitanensis (G), E anicia cloudcrofti (G) 3 + 4/2*
Carrizo Peak (CP)	*S. titus carrizozo* (G) 1/2
Guadalupe Ridge (GR)	*A. carlsbadensis* (G) 1/2
Guadalupe Mts. (GN)	*A. carlsbadensis* (G) 1/2
Davis Mts. (DM)	*E. vestris metacomet* (L), T. drusius (L) 2
Chisos Mts. (BB)	*P. haferniki* (G), *Agathymus chisosensis* (G), *Apodemia chisosensis* (G), *A. maria lajitaensis* (G), *C. nimbice* (L), *C. rawsoni* (L), *E. isabella zoraco* (L), *H. sosybius* (L), *B. hyperia* (L), *A. celia* (L), *G. stigmaticus* (L), *E. tamerund* (L) 2 + 2/2 1 + 7/2
Sierra del Carmen (MC)	*Z. dorus* ssp nov. (G), *P. haferniki* (G), *Neominosis* sp. nov. (G), *C. portrillo* (L), *H. macaira* (L), *H. lavinia* (L), *P. cingo* (L), *A. tolteca prenda* (L), *C. nimbice* (L), *C. longula* (L), *Z. guzanta* (L), *C. isobeon* (L), *H.sosybius* (L), *A. celia* (L), *G. stigmaticus* (L), *E. tamenund* (L) 2 + ½ + 12/2
Harding County canyons (HC)	*Lycaena philaeus americana* (L), *S. favonius violae* (L), *S. saepium* (L), *L. hyllus* (L) 1 + 3/2
Caprock Escarpments (CE)	*S. favonius violae* (L) 1/2

Table 4. Abundance of butterflies in the 41 mountain range and canyon complex Chihuahuan montane islands

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE	rowΣ
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canadan River Cx			
006	*E. clarus huachuca* Dixon	C	C	U	S	U										A	C	C		U	Q			C	C	C	S	C		S	A	C	U					U					20
007	*E. exadeus* (Cram.)																																										0
008	*P. leo arizonensis* (Skin.)		S									U				S															S				S		S						6
010	*C. albofasciatus* (Hew.)						Q					S			U																						S		C				5
011	*C. zilpa namba* Evans																																				S	S					2
018	*Z. dorus* (Edw.)	C	C	C	C				U	U			A	U			U	C		C	Q			C	U	U	C				A	C	C				Q						20
018	*Z. dorus* ssp. nov.																																						C				1
020	*C. arizonensis* (Skin.)						S	S				U			U																						Q	C	C				7
022	*U. dorantes* (Stoll)								U																																		1
032	*A. fulgerator azul* (Reak.)																																		S		Q		U				3
037	*A. cellus* (Bdv. & LeC.)	U				S			C	V		U	U																								Q	C	C				9
038	*A. pseudocellus* (Coolid. & Clem.)												C	C																													2
039	*A. cincta* (Plötz)													C																								U	A				3
041	*A. casica* (H.-S.)								U			S	S																								C	U	C				6
045	*T. drusius* (Edw.)																																				S	Q					2
047	*T. pylades* (Scud.)	C	C	A	C	U	C	U	C	U	U	C		C		C	C	C		C	C	C	C	C	C	S	U	C			C	C	C		C	C	C	C	C		U		33
050	*T. mexicana dobra* Evans		U			U								U		C		U			U			C							C	C											9
051	*C. portrillo* (Lucas)																																						U				1
053	*C. hippalus* (Edw.)						C		U		C	S	S		C	C																					S	C	U				10
055	*C. caicus* (H.-S.)	C	C					U	C			U																			S								C				7
057	*A. araxes arizonensis* G. & S.	S							C	C		U																									S	Q					6
068	*S. ceos* (Edw.)	U	S	A			C	S	C	C		U	U		U	C	C			Q											S				S		U	S	C				18
069	*S. mazans* (Reakirt)												S																														1
071	*P. catullus* (F.)	C	U	C			C	U	C		U	U	U		C	C	C		U			S		C	U		U	U	C	U	C	U	U	S	C	U	C	U	C	U		U	31
072	*P. mejicanus* (Reak.)			S												U		C		C					U		S				U						Q	Q			U		10
073	*H. alpheus* (Edw.)	S													U	S	C	S	U	S	C	C	C	U							S			S				C					14
079	*G. stigmaticus* (Mabille)																																				S	U					2
080	*T. ruptifasciata* (Plötz)	S																																									1
082	*C. georgina* (Reak.)											S																															1
084	*G. inversius* (Butl, & Druce)																																				Q						1
086	*E. icelus* (Scud. & Burg.)	C	U	Q	S	S											Q	C		C	U			C	C	U	U				C		C										15
087	*E. brizo burgessi* (Skin.)	C	C	C	U		C	C	C	C	U	U	U		U	C	C	C	C	C	C	C	C	C	C	U	U	U	C	U	C	C	U		C	U	U	C			C	C	36
088	*E. juvenalis clitis* (Edw.)							S	U	C	U	U																									Q	S					7
089	*E. telemachus* Burns	C	C	C	A	U		U	S						C	A	C	C	C	C	C	A	C	A	C	C	C		C		A	C	C		A	U	Q	C			U		29
091	*E. meridianus* E. Bell	C	C	U	S	U	C	U	C	C	U	C	U			U		U	U	S				Q	C						U				C	Q	Q	U			U	S	25
092	*E. scudderi* (Skin.)											S																									Q	U				U	4
093	*E. horatius* (Scud. & Burg.)																				Q	S		U	C	U	U	C	C	U	C	C	C										12
094	*E. tristis tatius* (Edw.)	C	S	U		U		U	C	C	C	U	U	C	C	U															U	U			C	C	C	U	C			U	21
095	*E. martialis* (Scud.)																								C	C																	2
096	*E. pacuvius* (Lintner)	C	S	U	C	U			U	C			C	U				U			U		U	C				C				U							C				16
098	*E. funeralis* (Scud. & Burg.)	M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	S	S	S	M	S			M		M	M	M	M		M	M	S	M	M		M		34
101	*E. persius/afranius* (Lintner)	U	C	C	C	C						U	C			C	C	C		C	C	C	C	C	C		U	U	C	U	C	C	U		U						U	U	26
103	*A. pallida* (R. Felder)																																										0
104	*E. tamenund* (Edw.)																																				Q	S	U				3
109	*S. pulverulenta* (R. Felder)														U	C															U				U			C	C				6

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE		
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacramento Cx				West Texas Complex					Canadan River Cx				rowΣ
110	*S. zampa* (Edw.)	S					C	C	U			U	U		C																					S	U	S						10
111	*C. nessus* (Edw.)	U	U				C	C	U	U		S	U		C	U			C											U	U	U		U	C	U	U	S		V	U			21
112	*C. limpia* Burns																																		S		C	U						3
115	*P. xanthus* (Edw.)	U		S	U	S										U						C		C	C						U													9
116	*P. scriptura* (Bdv.)	S	U	U	U	S					S					U	S	S	U		S	C	U	S	U	U	U	S	C	U	U		U		C			S			S			25
117	*P. albescens/communis* (Grote)	D	D	D	D	D	D		D	D	D	D	D	U	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		40
119	P. *philetas* Edw.						C		C	U		C									S															S	Q	S	C					9
120	*P. oileus* (L.)	S							U	C		U																																4
121	*H. domicella* (Erich.)		S						S			S			U																						Q	U						6
123	*H. ericetorum* (Bdv.)																				U	U		S																				3
124	*H. macaira* (Reak.)																																						U					1
125	*H. lavinia* (Hew.)											S																											U					2
126	*P. bailowitzi* ms.												S																															1
127	*P. cingo* Evans																																						S					1
128	*P. pirus* (Edw.)	C	U	C	C	S											C	U		C	C			C	C	U	C	C	U	U							S							17
129	*P. haferniki* H. Freeman																																					C	C					2
130	*P. polingii* (W. Barnes)	C	U			U										C															C		A				S		C					8
131	*P. aea* (Dyar)																																						C					1
132	*P. penaea* Dyar																																						S					1
133	*A. n. neumoegeni* (Edw.)	U						U							U	C															C													5
133	*A. n. carlsbadensis* (S. &. T)																																		U	U								2
133	*A. n. chisosensis* H. Freeman																																			U		U						2
133	*A. n. florenceae* (S. & T.)																																				Q							1
134	*A. polingi* (Skinner)											U																																1
135	*A. aryxna* (Dyar)	C							C		S				U																													4
136	*A. m. maria*(B. & B)														S																				U	U	Q	U						5
139	*A. m. lajitaensis* H. Freeman																																					U						1
144	*M. y. coloradensis* C. Riley			C												V		C	C	C					U	S																		7
144	*M. y. reubeni* S., T. & S.																														U	U												2
144	*M. y. winkensis* H. Freeman																																		S									1
144	*M. y. navajo* (Skinner)	C	U		C	S		V	U	U					U						U	C	U	U																				12
145	*M. u. ursus* Poling														U																						Q							2
145	*M. u. violae* S. & T.																														U				U	Q	Q	U						5
147	*M. s. streckeri* (Skinner)					S														U	U	U		S							U													7
147	*M. s. texana* B. & M.																								U	S	S	U												U		U		6
147	*M. s. elidaensis* D.Stal., T. & V.S.																																							U		C		2
151	*A. numitor* (F.)																													C														1
152	*A. arene* (Edw.)						U	U				U			S	U															U				C	Q	S							9
154	*O. garita* (Reak.)	C	C	U	C	U							U			C	C	Q				C	C	C	C	C	C	C			C	C									U			19
155	*O. edwardsii* (W. Barnes)	U	C	U	U	C			C				U			S	C	U				C	C	C	U	U	U	S			S	U			C	C	C		C		U			24
156	*C. aurantiaca* (Hew.)	C	C	U		S	C	C	C	U	C	C	C	U	C	C	C		C	S									U	S	C	U	C	U	C	C	C	C	C	U	U	U		31
157	*C. minima* (Edw.)																																					S						1
158	*A. prittwitzi* (Plötz)											C																									C							2
160	*C. ethlius* (Stoll)																																				U							1
164	*P. ocola* (Edw.)																																				Q							1
170	*S. (syraces) shiva* (Evans)											S																																1
172	*A. exoteria* (H.-S.)	U	U			S			C			U	S	U																														7

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE			
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canada n River Cx					rowΣ
173	*A. cassus* Edw.	C	U		C	U			C			S	U	C				S				C		C							S	C					U	S							15
174	*A. aenus* Edw.	C	C	U		S	C	U	C			C			U	C	C	C	C	U	Q	C		C	U	U	U		C	C	U	C	C	U	U	U	C	C	C	U	C	U			34
176	*A. oslari* (Skin.)	C		S			U		S			S				C		U		S		S		C	U	U	C	U	U	U	C	U	U		C	C	Q	U	C	U	C				26
177	*A. elissa* Godman																																												0
179	*A. texanae* E. Bell	S	U	S				S	C			U			U	C	S					S									S				U	Q	C	C		S					16
183	*A. nereus* (Edw.)	U	C			S		U	C			C				U																					C								8
184	*A. nysa* Edw.								U			S				U																		S	U		Q	U	U	S		S			10
185	*A. eos* (Edw.)	U	S	C				S	C		C							S						S		U		S	U	C	C	U	U	U	C	C	C	U	C	U	C	C			24
186	*A. vialis* (Edw.)																							C	C	C												S							4
188	*A. celia* Skin.																																					U	C						2
190	*A. tolteca prenda* Evans											S																											C						2
191	*A. phylace* (Edw.)	S	U	Q	C	S						S	U		C			C				C		C	U	U	C	C			U					S	U		C						19
192	*A. fimbriata* (Plötz)													C																															1
197	*N. julia* (H. Freeman)																																				Q	U	U						3
200	*L. eufala* (Edw.)						S	S							C																				S		Q	U	U						7
202	*L. accius* (J. E. Smith)											S																							S		Q	C	C						5
209	*H. phyleus* (Drury)								S			S			C	C			U	A											C				U		S	U	U						11
211	*H. uncas uncas* Edw.	C			C	C						S					U	U	U	C	C	C	C	C	C	C	C			S			C	S	U	S	Q			U	U	U			24
211	*H. uncas* nr *lasus* (Edw.)	U																																											1
212	*H. juba* (Scud.)																				S			U																					2
215	*H. colorado colorado* (Scud.)																							C	C	U	U	C																	5
215	*H. colorado susanae* (L. Miller)	U			S	C															Q	C																							5
215	*H. colorado ochracea* Lindsey																																												0
216	*H. woodgatei* (R. Williams)	C	C	C	C								S				C				C	C	C	C											U	Q	U								13
219	*H. pahaska pahaska* Leussler		U	U	A	U	U	U	C			C			U	C	U	C		C	C	A	C	C	C	U	C	C	U	C	C	A	C		U		C				U	U			30
219	*H. pahaska williamsi* Lindsey	U	U																																										2
222	*H. viridis* (Edw.)	C	C		C	S		S	C			C				C	U	C		C	U	C	C	C	U	U	C	C	U	C	C	A	U	S	C	C	Q				C	U			30
229	*H. nevada* (Scud.)					U																		U	C																				3
230	*P. rhesus* (Edw.)	C	C	C		U																C	U	C	S	U	S	S	U		U	U									U	U			16
231	*P. carus* (Edw.)	S	U	U								S	S		U	S				U					U	U				S	S		U		S		U			U	C	C			18
232	*P. peckius* (W. Kirby)					S																																							1
233	*P. sabuleti* (Bdv.)																				C			U																					2
234	*P. draco* (Edw.)			Q		A										A	U						C	C	C																				7
236	*P. themistocles* (Latreille)	U				C															C	C		C	C	U		S			A	U													10
238	*P. origines rhena* (Edw.)																								U	U	U	U																	4
239	*P. mystic dacotah* (Edw.)																										S																		1
240	*P. vibex brettoides* (Edw.)																																				Q		S						2
245	*A. campestris* (Bdv.)	U	U	U			S		U						C	S	U	C			S			S	C	C	C	C		C	S	C	U	S	C	C	C	U	C		C	U			27
248	*P. rhexenor* Godman & Salvin																																	U											1
249	*P. hobomok wetona* Scott												U												A						U	U	C												5
251	*P. taxiles* (Edw.)	C	C	C	C	U										C	A	C	U	C	C	C	C	C	C	C	C	C			C	C	C				Q	U	C						24
256	*P. melanie* (Edw.)								U																												Q	U	C						4
257	*S. morrisoni* (Edw.)	S	C	A	C	C	U			C	Q		U			C	C	C			C	C	C	C	U						C	U			U	U	U								22
258	*O. sylvanoides napa* (Edw.)																							C																					1
260	*O. y. yuma* (Edw.)																																												0
260	*O. y.anasazi* S Cary & Stanford																																												0
261	*P. snowi* (Edw.)		U		C	S											U				Q	C	C	C	U	U																			10

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE			
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacramento Cx				West Texas Complex					Canadan River Cx					rowΣ
262	*A. logan lagus* (Edw.)																								U	U		U	U	U		S		S	U		U			C	U	U			12
265	*N. simius* (Edw.)	C	S		S	S						S				U				U				C	U	U	C				S	U	S		U		S				U	S			18
274	*E. vestris vestris* (Bdv.)	U		Q	U	S										S		U		U	C							C			S				C	S		U	C						14
274	*E. vestris kiowah* (Reak.)																							C	C	C	C		U	U	S										C				8
274	*E. vestris metacomet* (T. Harris)																																			S	U								2
276	*A. hianna turneri* H. Freeman																							U	U	U																			3
278	*A. deva* (Edw.)	C	U			S			U			U	S																																6
279	*A. lunus* (Edw.)	S							C			U																																	3
280	*A. vierecki* (Skinner)	C	C	C			C	U	S		U				U	C	C	C	C	C	C	C	S	C	U	U			S	U	C	C		S	C	S	C	S	S	C	U				31
281	*A. pittacus* (Edw.)	C					S	C	C			U				S																					C								7
282	*A. python* (Edw.)	U	C	C		S		S	U		U	S			C	U	C	U	U	U		C		C							S	C			C	C	Q	U							22
283	*A. cestus* (Edw.)																																												0
284	*A. edwardsi* B. & M.											U																									C	U							3
294	*B. philenor philenor* (L.)	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M		M	M		M		M	M		M		M	M	M	M	M	M	M	M	M	M		M	M			34
295	*B. polydamus* (L.)						S																																						1
298	*P. machaon bairdii* Edw.	S		U	U	U												U	C	U	U	C		U																					10
301	*P. polyxenes asterias* Stoll	D	D	D		D	D	D	D		D	D		D	D	D	D	D	D	D	D	D		D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D			36
301	*P. polyxenes coloro* W G Wright						S									S																													2
302	*P. zelicaon* Lucas																				C	C		C	U	U																			5
303	*P. indra minori* Cross																					S																							1
304	*P. thoas* R. & J.																																				Q								1
306	*P. cresphontes* Cram.	C	S				U		U	V	U	U	U		C			S	V						S							V			C	U	Q	U	U						18
307	*P. astyalus* Godart																																					S							2
308	*P. ornythion* Bdv.															S																S			U		Q	U	S						6
318	*P. rutulus* Lucas	C	C	C	C	C									U		C	U		U	C	C	C	C	U		V	S			C	C							C						19
319	*P. eurymedon* Lucas																							C	S																				2
320	*P. multicaudata* W. F. Kirby	C	C	Q	V	U	C	S	C	C	C	U	V		C	C	C	C	C	C	U	U	C	C	C	S	U	C		U	C	C	C	S	C	C	C	C	C	U	S				38
323	*P. pilumnus* Bdv.								U			C			U																														3
325	*P. palamedes* Drury																																												0
326	*E. socialis* Westwood													C																															1
327	*K. lyside* (Godart)						S	U	U			C			U														S		U				U	Q	C	C	C			U			13
328	*N. iole* Bdv.	M	M	M	M	M	M		M	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M		M	M			37
329	*E. daira* (Godart)														S																														1
330	*E. boisduvaliana* (C. & R. Feld.)								U	U		U			U																				S			S							6
331	*E. mexicana* (Bdv.)	C	C		V	S	C	C	A		C	C			C	A	C	C	C	S	V	U	U	U	U	U	U	U			U	C	U		C	C	U	C	A			U			32
334	*A. nicippe* (Cram.)	M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M		M		M	M	M	M	M	M	M	M	M	M	M		M			37
336	*P. proterpia* (F.)	U							C			C			C																U						Q	S	S						8
337	*P. lisa* (Bdv. & LeC.)														U									S								S				U	U	C	C	S					8
338	*P. nise nelphe* (R. Felder)							S	S			S																										S	C						5
339	*P. dina* (Poey)														S																														1
340	*C. philodice eriphyle* Edw.	C	U	U	S		U				U	U	C		U	U	U	C	U	U	U	U		C	C	U	U	U	S		C	C		C	A	C	Q	S			U	U			31
341	*C. eurytheme* Bdv.		D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D			38
344	*C. alexandra alexandra* Edw.																				Q			C	C																				3
344	*C. alexandra apache* Ferris	C	C		A	U												C																											5
358	*Z. cesonia* (Stoll)	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M		M	M		M	M	M	M	M	M	M	M	M	M			M			36
360	*A. clorinde* (Godart)								S			S																							S	S	Q								5
361	*A. maerula* (F.)											S			S											S											Q	U							5

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE	rowΣ
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canada n River Cx			
362	*P. sennae marcellina* (Cram.)	C	C	U	U		C	C	C		C	C	C		C	U					V	C			U						V	U	U	C	C	S	U	U	C			U	25
362	*P. sennae eubule* (L.)	S																										S															2
364	*P. agarithe* (Bdv.)	S							U		U	U	U		U																				C	Q	S	C	C				11
365	*P. philea* (L.)																														S						Q	U					3
367	*A. statira* (Cram.)						S																														S						2
369	*A. pima* Edw.						U	U	U	C		U	C		U	C																											8
370	*A. sara thoosa* (Scud.)	C	C	C	C		C	C	C	C		U			C	C	C	U	C	C	C	C	U	C							C	U	C								U	U	24
373	*E. ausonides coloradensis*(HEd)																								S																		1
375	*E. olympia* (Edw.)																								C	U		U													C	C	5
378	*E. lotta* (Beut.)	C	C	U			C	C	C	C		U	C		C	C	C				C			U																			14
380	*G. drusilla* (Cram.)	S																																				S					2
382	*N. menapia* (F. & F.)	C	U	U														C		U	C	C		C	S						C	U	U										12
383	*N. terlooti* Behr											B	U	S																													3
384	*C. nimbice* (Bdv.)																																					U	C				2
389	*P. marg. macdunnoughii* Rem.				C															C				C	C	U																	5
389	*P. marg. mogollon* Burdick	C				C																									C												3
392	*P. rapae* (L.)	S	C	S	U	S			S			U			C	U		U		A	U	U		U	C	U				U	C		U		U		Q	U					22
393	*P. beckerii* (Edw.)																				C	Q			C				S														4
394	*P. protodice* (Bdv. & LeC.)	D	D	D	D	U	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	D	40
396	*P. sisy. transversata* R Holland						C		C	C		U	C		U																												6
396	*P. sisy. elivata* (B. & B.)	C	C	C	C		U	U								C	C	U	U	C	C	C	U	C	C	C					U	S	U		C						C		22
397	*A. monuste* (L.)											S																										S				U	3
401	*L. philaeas americana* T.> Harris																																								V		1
403	*L. arota schellbachi* Tilden	U																C		C	Q		U	C	C				U														8
405	*L. dione* (Scud.)																													U													1
408	*L. rubidus ferrisi* (K. John. & Ba.)					C																																					1
409	*L. rubidus siris* (Edw.)																																										0
410	*L. heteronea heteronea* Bdv.																							U																			1
411	*L. hyllus* (Cram.)																													U											U		2
415	*L. helloides* Bdv.																				C			C	S																U		4
418	*H. crysalus* (Edw.)	C	C	S	S	U		C					U	U			U	C		C	C	U	U	C	C	C	C				U	U	S			S			C				23
422	*A. halesus* (Cram.)	C	C	C		S	C	C	U	U		U	C		C	C	U	U	S	U	U	U		U							U		S		C	C	U	C	S			U	27
425	*A. jada* (Hew.)											S																															1
428	*S. behrii crossi* (W. D. Field)																	S		U	C	U		C	C	C																	7
431	*S. sylvinus itys* (Edw.)																							U							Q												2
432	*S. titus immaculosus* (WComst)																	U						U	C	C	U	S									Q						7
432	*S. titus carrizozo* R. Holland																														U		U										2
434	*S. calanus godarti* (W. D. Field)																			U				C	C	C	C										Q						6
437	*S. l. aliparops* (Mich. & dos P.)																																				Q						1
440	*S. saepium* (Bdv.)																							Q																	U		2
441	*S. favonius violae* (S. & T.)																																								S	S	2
442	*S. ilavia* (Beut.)	U				S																																					2
443	*F. polingi polingi* (B. & B.)																															U			C	S	U	C					5
443	*F. polingi organensis* Ferris															C																											1
444	*P. alcsetis alcestis* (Edw.)																												U			U		S	S		Q			U	U		7
444	*P. alcestis oslari* (Dyar)	U							U																																		2
446	*C. simaethis sarita* (Skin.)																														V												1

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE	
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canadan River Cx			rowΣ
447	*C. longula* (Hew.)																																						C				1
448	*C. amyntor* (Cram.)																																					S					1
452	*C. affinis homoperplexa* (B&B)																							C	U	U	S	S		S													6
452	*C. affinis apama* (Edw.)	U		S	C	U							U	U							U	C																					8
452	*C. affinis albipalpis* Gorelick																														U												1
454	*C. s. sheridanii* (Edw.)																																										0
454	*C. s. sacramento* Scott																														U												1
456	*C. gryneus siva* (Edw.)	C	U	U	C	C	C	C	C	C	U	U	C			C	U	C		C	C	C	C	C	C	C	C	C	C	U	C	C	A	U	C	C	C	C	U		U		36
460	*C. xami* (Reak.)	U								U			S																								Q	S	S				6
461	*C. mcfarlandi* Clench & Ehrlich						U	S			C				U	U	C	C	C	A		U		U							C	U	U	U	U	U	U	C		U	C	U	22
462	*C. spinetorum* (Hew.)	C	C	A	U	U	Q							U		U	U	C		C	C	C	C	C							U	C	U		U	Q	Q		C		U		23
463	*C. dospassosi* (Clench)													S																													1
463	*C. estela* (Clench)												U																														1
464	*C. augustinius irioides* (Bdv.)																							U																			1
464	*C. a. annetteae* dos Passos	U	U			S		U	U	C		U																															7
465	*C. fotis fotis* (Strecker)												A								C	A		S																			4
467	*C. polios obscurus* (F. & F.)																							U																			1
469	*C. henrici solatus* (C. & W.)															C																			C	U	Q	C					5
472	*C. eryphon* (Bdv.)	C	C	Q	U	U		C													A	C	U	C	C	U					Q												13
474	*Z. guzanta* (Schaus)																																						A				1
479	*C. isobeon* (Butler & H. Druce)																																		S	Q	Q		C				4
480	*S. melinus franki* W. D. Field	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	D	39
485	*S. bebrycia* (Hew.)														S																							S					2
491	*S. istapa* (Reak.)																																				Q	S					2
493	*S. serapio* (G. & S.)																																					S					1
495	*M. leda* (Edw.)	C	C	S		S	U	U	C		U	U	C	U	U	U					S	S		S							Q	U	C		U	S	Q	C				S	24
497	*M. azia* (Hew.)																																				S	U	S				3
502	*E. quaderna sanfordi* (dosPassos)	C	C	A		U		S	C	C			A				C	S																			Q	C	C				13
505	*L. cassius* (Cram.)																																			U		S					2
506	*L. marina* (Reak.)	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	39
507	*B. exilis* (Bdv.)	D	D	D	D	D	D	D	D		D	D	D		D	D	D	D	D	D	D	D	D	D			D		D		D	D	D	S	D	D	D	D	D		D	D	34
509	*Z. cyna* (Edw.)							U					S																						U	S	Q	S	C				7
510	*C. chihuahuae* ms (Clench)												S																														1
510	*C. comyntas* (Godart)	U				S			C	C		C	C																								Q	C					8
511	*C. amyntula* (Bdv.)	C	U	C	C			U		C							U	C		C	U	C	C	C	C	U	C					C	S		C								19
512	*C. emimargineta* Scott																				C																						1
513	*C. ladon* (Cram.)	C	C	C	C	A	C	C	C	C	C	S	C		U	C	A	C	C	U	C	C	U	C	C		U				C	A	C		C	C	U	C	C				32
513	*C. ladon gozora* (Bdv.)		S	U							U													S											U								5
522	*H. ceraunus gyas* (Edw.)	U	S			S	U	U	U		U	U			U	S															U	S			U			U					14
528	*E. centralis* (B. & M.)	U	U	U	U	C											U	S		C		C	S	C	S	S	U	U			U									U			17
530	*E. ellisii* (Shields)																				U																						1
535	*E. ancilla* (B. & M.)																							Q																			1
536	*E. rita rita* (B. & M.)	C	C	C				U	U			U				C	U		C	C				U														S					12
536	*E. rita coloradensis* (Mattoni)																								S	S																	2
537	*E. pallescens emmeli* (Shields)																																										0
538	*E. spaldingi* (B. & M.)				S	S												S			Q	U		A																			6
539	*G. piasus daunia* (Edw.)																				C	C		S																			3

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	OR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE		
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacramento Cx				West Texas Complex					Canadan River Cx				rowΣ
540	*G. lygdamus oro* (Scud.)			C														U		U	C	C	C	C	C	C		U			U	C									S			13
540	*G. lygdamus arizonensis* McD.	C	C		U	S																																						4
540	*G. lygdamus*"*ruidoso* RHolland"																														C	C												2
543	*E. isola* (Reak.)	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D		D	D	D	D	D		38
546	*P. melissa* (Edw.)	C	U	U	C	A									U		C	C		U	C	C	C	C	C	C	C	C		U	U	C			C					U	C	S		24
547	*P. melissa mexicana* Clench												S																															1
548	*P. saepiolus gertschi* dosPassos	U				U																																						2
548	*P. saepiolus whitmeri* Brown																				U			C	C																			3
550	*P. icarioides lycea* (Edw.)	C	C																		C	C	C	C	U	U		U																9
550	*P. icarioides buchholzi* dosPass.	U			C	S																																						3
550	*P. icarioides sacre* R Holland																														U	C												2
550	*P. icarioides femnegra* R Holland																								U	U																		2
553	*P. lupini texanus* (Goodpasture)	D	D	D	D	S	D	D	D	D	D		D		D	D	D	D	D	D	D	D	S	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D		38
556	*P. glandon rustica* (Edw.)	U		C	U	U												C	C	U	C		C	C	C																			11
561	*C. nemesis australis* (Edw.)	S	U					S	C	C		V																										C	C					8
562	*C. perditalis* B. & M.																																						S					1
564	*C. rawsoni* McAlpine																																				Q	C						3
566	*C. arizonensis* McAlpine							S	U		U	U																										S	C					6
571	*E. zela cleis* (Edw.)	U							C	C		U	U																									S						6
572	*E. ares* (Edw.)								C	U		U	U																															4
575	*A. mormo mormo* (F. & F.)				C	U															C	S		C																				5
576	*A. mormo-mejicanus* blend zone	C			C	U																																						3
577	*A. mejicanus mejicanus* (Behr)	C	C		C		C	C	C	U		U	S		U	C															C		C				Q							14
577	*A. mejicanus pueblo* Scott			C													C	U	C	C					C	U	V	C			C													10
578	*A. duryi* (Edw.)															U																			U			C						3
579	*A. palmerii arizona* Austin	U					U		U	C	S	A	U		U	C															S	S	C				Q	U						14
580	*A. hepburni* G. & S.																																					S						1
583	*A. phyciodoides* B. & B.									C			C																															2
584	*A. nais* (Edw.)	C	U		C	A							A					U				C	U	C	S	S																		12
585	*A. chisosensis* H. Freeman																																					C						1
586	*L. carinenta larvata* (Strecker)	C	C			S	C	U	C				U		U									S							U	C	U		C	U	U		C		S	S		18
586	*L. carinenta bachmanii*(Kirtlnd)	C		U							C	C						C		U	C		S		U		U	S	U															12
588	*D. plexippus* (L.)	M		M	M	M	M		M		M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M			M		35
589	*D. gilippus bernice* (Cram.)	M	M	M	M	M	M	M	M		M	M	M		M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M	M			37
590	*D. eresimus* (Cram.)											S																									S	S						3
591	*L. halia* Hübner																																					S						1
593	*L. arthemis arizonensis* Edw.	C	C				U	C	C	C		C	U			C	C				Q										C	S	U		U	S	C	C	C					19
594	*L. w. weidemeyerii* Edw.						Q							C	U		C	C		C	C	C	C	C	C	S	U				C	C	C						C					17
594	*L. w. angustifascia* (B. & M.)	C	C	C	C																																							4
596	*L. a. watsoni* (dos Passos)																												S															1
596	*L. a. archippus* (Cram.)																	C						U	S	S				U											S			6
596	*L. a. obsoleta* (Edw.)	U	S					S	U			S	U																					S	U		Q	U						10
599	*A. eulalia* (B. Doubleday)	C	C	A	C		C	C	C	C	C	C	U		C	C	C	C	C	U	C	C	C	C	C	V		U			C	C	C		C	C	C	C	A			S		33
601	*D. moneta poeyi* Butt.																																					U	C					2
602	*A. vanillae incarnata* (Riley)	U					U		U			U	U		U	S				U					U			S		U	U	V	V	S	C	U	C	C	C			S		21
603	*D. iulia* (F.)																																				Q							1
605	*E. isabella zoracon* Reak.																																					U						1

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	MR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	RN	DM	BB	MC	QC	HC	CE	rowΣ
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canada n River Cx			
606	*H. charithonia vazquezae* C &B	S													S																				U			S	C				5
608	*E. claudia* (Cram.)	D	D	D	D	D	D	D	D	D	D	D	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		D	39
609	*E. hegesia* (Cram.)											S	U		S																							S					4
612	*B. selene tollandensis* (B. & B.)																							U																			1
621	*B. freija browni* (Higgins)																																										0
623	*B. chariclea helena* (Edw.)																							C																			1
625	*S. cybele carpenterii* (Edw.)																							C																			1
626	*S. aphrodite ethne* (Hemming)																							S	A	C	C	C															5
626	*S. aprodite byblis* (B. & B.)					U																																					1
627	*S. idalia* (Drury)																													V													1
628	*S. nokomis nitocris* (Edw.)	U				S																																					2
628	*S. nokomis nokomis* (Edw.)																				C	Q									E												3
628	*S. nokomis coerule.* (W. Holland)												C																														1
629	*S. edwardsii* (Reak.)																							U	U					V													3
632	*S. zerene platina* (Skin.)																																										0
637	*S. hesperis ratonenis* Scott																								A	A		S															3
637	*S. hesperis electa* (Edw.)																							C	C	C																	3
637	*S. hesperis dorothea* Moeck																	C		C			C																				3
637	*S. hesperis capitanensis*RHollnd																														C	C	U										3
637	*S. hesperis nausicaä* (Edw.)	C	C	A	A	A											C				A																						7
639	*S. mormonia eurynome* (Edw.)																							C	U																		2
639	*S. mormonia luski* (B. & M.)					U																																					1
640	*A. celtis celtis* (Bdv. & LeC.)																																										0
640	*A. celtis antonia* (Edw.)																			C					U	U			C	C				S	C	C				C	S	U	11
641	*A. celtis montis* (Edw.)	U	C	C			C	U	C		C	U			U	C	C		C						C					C	C	C					Q	U					18
641	*A. leila* (Edw.)									C		U	C		C																							C	C				6
642	*A. clyton subpallida* B. & M.																																				U	S					2
642	*A. clyton texana* (Skin.)	S							U																										U	Q			C				5
644	*D. laure* (Drury)											S																															1
646	*B. hyperia* (Cram.)																																					S					1
647	*M. amymone* (Ménétriés)										U																			U					U		Q	S	C				6
648	*E. monima* (Stoll)																																				Q						1
650	*M. ethusa* (Doyère)																																					S					1
651	*M. cyananthe skinneri* Mengel																														S												1
660	*D. anna* (Guer.-Men.)																																					S					1
664	*M. zerynthia* Hübner														S																												1
666	*M. petreus* (Cram.)	S										S																									Q	S					4
670	*S. blomfilsia* (f.)														S																												1
672	*V. virginiensis* (Drury)	C	U	C	C	S	C		C			U	U		U	C	C	C	U	C	C	C	S	C	U	S	S	U		U	C	C	U	C	C	S	U	U	C	U	U	U	36
673	*V. cardui* (L.)	M	M	M	M	M	M		M		M	M	M		M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M		M	M	36
674	*V. annabella* (W. D. Field)	C	U	S	C	U	U	U	U				C		U	C	C	U	S	U	C	C	U	C	U			U			C	U	U		U	S	C	U	U				29
675	*V. atalanta rubria* (Früh.)	U	U	U	U	S	C	V	U	U	U	U	C		U	C	U	U	U	U	C	C	S	U	A	U	U	U		U	C	S	U	U	C	C	C	U	C		S	C	38
677	*A. milberti* (Godart)	U				U											S				V		U	U	C			S			C	U	A								S		12
679	*N. californica* (Bdv.)	C	U		U	S												S			U	U		U	C																		9
680	*N. antiopa* (L.)	C	C	C	C	U	U		C	U		S	U		C	C	C	C	C	C	C	C	C	C	C			U		U	C	C	C	U	C	C	C	U	C			U	33
681	*P. interrogationis* (F.)	S	S									S			U	S	V	Q		U					S			U		U	U	U		S	C		Q	U	C			U	19
683	*P. satyrus* (Edw.)	C	C	C		S	U		C			S				C	U	U		U	U	C		C	U	U	U	U		U	C	C	C		U						S		24

Pelham species number	SPECIES	WB	BR	VL	GM	AZ	FL	CO	AM	SL	BH	PM	CJ	HH	FM	MR	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SC	CM	CZ	DB	GR	GN	DM	BB	MC	QC	HC	CE	rowΣ
		Gila Mts. Complex					Bootheel Complex								Rio Grande Complex						Great Basin Rf				Union/Colf `Complex						Sacram ento Cx				West Texas Complex					Canada n River Cx			
686	*P. gracilis zephyrus* (Edw.)	U	U	C	C	C										C	C	C		C	C	C	C	C	C			S	U		C	C	C										19
687	*P. faunus hylas* (Edw.)					S																		C																			2
688	*A. jatrophae luteipicta* (Früh.)																																		S								1
691	*S. stelenes biplagiata* (Früh.)																																		S		Q						2
693	*J. coenia* Hübner	U	C	S		S	C	U	U			C	U		C	C					U			U	U			U		U	C	V	U		C	U	U	C	C	U	U		26
695	*J. evarete nigrosuffusa* B. & M.	S	U		S		C	U	U			C	U										S										S		U	U	U	U	C				15
701	*E. anicia magdalena* B. & M.					C																																					1
701	*E. anicia eurytion* (Mead)																																										0
701	*E. anicia alena* B. & B.																				A	C		C																			3
701	*E. anicia hermosa* (W. Wright)	U							C	C	C	U																															5
701	*E. anicia chuskae* (Ferris & RH)																				A																						1
701	*E. anicia cloudcrofti* (F. & RH)																														C												1
703	*P. minuta minuta* (Edw.)																								S	S									Q	Q	Q					C	6
704	*P. arachne arachne* (Edw.)	U	C	U	C								C								A	C	S	U	U	U	U																12
704	*P. arachne nympha* (Edw.)					U							U																														2
705	*C. janais* (Drury)																																		S				C				2
706	*C. definita definita* (E. Aaron)														C	U															U	S			C	Q		U					7
710	*C. rosita* A. Hall											S																															1
711	*C. theona thekla* (Edw.)	C	C				C	C	C	C	U	C	S		C	A															A		S		S	S	U						16
711	*C. theona bolli* (Edw.)																											S										C				S	3
711	*C. theona chinatiensis* (Tink.)																																		C	Q	U	C	S				5
712	*C. cyneas* (G. & S.)								U																														U				2
713	*C. fulvia fulvia* (Edw.)	C	C		U	U	C	C	C	U		U	U			C	C	U	S	C	C	A		C	S				U	U	U	U	U	S	C	S	Q	S			U	C	31
713	*C. fulvia coronado*(Smth&Brock)									S																																	1
715	*C. nycteis drusius* (Edw.)	U		C		C											C	C		C	C	C	C	C	C	C							S										13
716	*C. gorgon carlotta* (Reak.)																							U	C	C		C		C				U						S	U		8
718	*C. lacinia crocale* (Edw.)	C	U	C		S	C	U	U	C	U		U		C	C	A	C	S	S				U	U	U		U			C	U	U		C	S	U	U	C			U	29
722	*C. acastus sabina* (W. Wright)	C	C	C			U	U									S																C										7
722	*C. acastus acastus* (Edw.)																				C	U	U	U																			4
724	*C. palla calydon* (W. Holland)																																										0
726	*M. elva* H. Bates											S																															1
727	*D. dymas dymas* (Edw.)	U		C			C		C	C	C				U	C	C		C		C	C													C		Q	C					15
727	*D. dymas chara* (Edw.)									U		U																															2
728	*T. elada ulrica* (Edw.)	U					C		C	U		U	U		U																				S		C	U	C				12
730	*A. texana* (Edw.)	C	U				C	S	C	C			U		U	A		U	S												C	S	C	S	C	U	U	C	C				20
735	*P. graphica vesta* (Edw.)								S			S	S		U	S		S	S									S			S	S	U		C	C	C	C	C	S			17
735	*P. picta picta* (Edw.)																								U	C				U				U	C	U	S	U		U	C		10
736	*P. picta canace* (Edw.)	C	U				U	S	S			C	U		S	U			S	U	A		C								C	A	C		C								17
739	*P. mylitta arizonensis* Bauer	C	C	C	C		C	U	C				C			C	C	C	C	C	C	C	C	C	C	C		C	U	U	A		U		U	S				U	S		28
740	*P. phaon* (Edw.)														U														S	U				C	C	S	Q	U	C				9
741	*P. tharos* (Drury)	C	U			S		U	U	U		U	S		U	S		S		U				U	C			U	C	C	C	C		C	A	S		U	C	S		U	26
742	*P. cocyta incognitus* Gatrelle	U																						C	C	C	C	C		C	C												9
743	*P. batesii* (Reak.)																				C																						1
744	*P. pulchella camillus* (Edw.)	C	U	S	C	A										S		C		C	C	C	C	C	C			S	C	U	A	C	U		S						U		21
746	*A. aidea* (Guérin-Méneville)									U		U	U		U															U					C	U	Q	S	C				10
747	*A. andria* Scudder	C	V				U	V	U	C	C	U	U		U	V		U						S	V	V	U	U	U	V	U	U	U		U	S	U	U		U	U	A	29
748	*Anaea* ap.																																						S				1

Pelham species number	SPECIES	WB	BR	VL	GM	AZ		FL	CO	AM	SL	BH	PM	CJ	HH		FM	OR	MG	MZ	LP	AB		CK	ZM	MT	JZ		RC	JM	CV	SG	UC	CL		SC	CM	CZ	DB		GR	GN	DM	BB	MC		QC	HC	CE			
		Gila Mts. Complex						Bootheel Complex									Rio Grande Complex							Great Basin Rf					Union/Colf `Complex							Sacramento Cx					West Texas Complex						Canadan River Cx					rowΣ
758	*C. tullia ochracea* Edw.																			C				Q			C		U	U	C																						6
758	*C. tullia subfusca* B. & B.				C	A																																																2
759	*C. pyracmon* (Butl.)													U																														Q										2
760	*C. pertepida dorothea* (Nab.)	C	C	A	C	U				C		U	C	U				C	C	C	C	C		U	C	U	U		U	U	U	U		U		C	C	U			C			C	C			U					30
760	*C. pertepida avicula* (Nab.)																																									C	Q										2
762	*P. xicaque allyni* L. Miller													U																																							1
763	*H. sosybius* (F.)																																													S							1
764	*H. hermes* (F.)																																											Q									1
769	*M. rubr. cheneyorum* (R. Cherm.)					U								U																																							3
769	*M. rubr. rubricata* (Edwx.)	C	U	U					S	C		U	C																			U																C	S				10
769	*M. rubr.smithorum* (Wind)																	C	C																	C	C	U			C	C	C	C	A								10
770	*C. pegala texana*																			U		U							C	C	C	C		C											S								8
770	*C. pegala boopis* (Behr)	S																									C																					U	C				5
770	*C. meadii damei* B. & B.																							C																													1
771	*C. meadii meadii* (Edwx.)																		C	U	C	U					V																										5
771	*C. meadii mexicana*	U	U	U	U					U				C				C																							C	C	U	U									12
772	*C. sthenele-meadii* hybrid zone																							C																													1
773	*C. oetus charon* (Edwx.)	U		C										C					A	C		C		C			C		C	C	U	S				C		C															14
774	*G. patrobas tritonia* (Edwx.)	U	U						U	C			C	U			U																																				7
789	*N. ridingsii ridingsii* (Edw)	S		U																					C	C	C		U	C	U	C						U															10
789	*N. ridingsii neomexicana*Austin				C	U																																															2
790	*Neominois* sp nov																																													C							1
793	*O. melissa lucilla* B. & M.																																																				0
796	*O. chryxus chryxus* (Doubleday)																										C																										1
796	*O. chryxus socorro* R.Holland			C																																																	1
797	*O. alberta capulinensis* Brown																												C	C	C	C																					4
797	*O. alberta daura* (Strecker)	U				A																																															2
800	*O. uhleri uhleri* (Reak.)																												U																								1
	line 452																																																				
	Crude Species Count line 457	171	126	106	89	116	0	85	85	124	67	58	134	106	26	0	106	112	88	105	60	95	0	118	101	75	154	0	139	130	74	85	36	73	1	138	104	90	49	0	128	98	163	161	122	0	38	71	66	0	0	449
																																																				4043

Table 5. Status of the knowledge of the Gila and the undocumented omitted refugia by refugium

ALL GILA-GROUP REFUGIA	STATUS
Mogollon or central	Somewhat weak due to difficulty of penetration
Black Range	Satisfactory data and documentation
San Mateo Mts	Well known and documented
Gallo-Mangas Subcomplex	Well known and documented
Pinos Altos Range	Well known and documented but omitted here
Big Burro Mts.	Well known and documented but omitted here
Escudillo Mesa (Arizona)	Probably well known, but weakly documented
Datil Mts.	Not well known, no published documentation
Alegre Mt.	A 10,000 ft. mountain which has never been visited
San Francisco River Canyon	Good considering terrain, weak documentation
Numerous other outlying Mts.	Generally unexplored
White Mts. (Arizona)	Well known and documented
UNDOCUMENTED REFUGIA OUTSIDE THE GILA GROUP	
San Andreas Range	Explored but weakly documented
Oscuro Mts.	Apparently unexplored, military reservation
Caballo Mts.	Explored but poorly documented, depauperate?
Fra Cristobal Mts.	No known reports
Fort Defiance Plateau (Arizona)	Some formal study by the Navajo Nation
Black Mesa (Arizona)	Navajo Nation study of status unknown
Carrizo Mts. (Arizona)	Explored but undocumented, extreme abuse of land
Gallinas Mts.	Explored but undocumented, depauperate?
Chianti Mts. (Texas)	Well explored and documented but omitted here
Hueco Mts. (Texas)	Explored but undocumented, depauperate?
Sierra de Nido (Chihuahua)	Possibly explored from La Campaña Agricultural Station
Barranca de Cobre (Chihuahua)	Well explored, poorly documented
Cumbres de Majelca (Chihuahua)	No activity known to me
Barranca de Urique (Chihuahua)	Probably explored but undocumented
Parral Watercourses (Chihuahua)	Explored but undocumented

Table 6. Correlation coefficients of the butterfly fauna for the Chihuahuan Refugia

		Gila			Bootheel						Rio Grande						Great Basin				Colfax/Union						Sacrame			West Texas				
		BR	VL	GM	FL	CO	AM	SL	BH	PL	FM	OM	MG	MZ	LP	AB	CK	ZM	MT	JZ	RC	JM	CV	SG	UC	CL	SX	CM	CZ	GR	GN	DM	BB	MC
		.76	.57	.52	.49	.54	.55	.38	.36	.41	.32	.52	.54	.52	.38	.44	.39	.45	.39	.40	.31	.23	.30	.34	.19	.25	.55	.54	.53	.44	.34	.31	.21	.31
	BR		.63	.58	.50	.60	.51	.31	.33	.40	.36	.60	.63	.54	.43	.46	.40	.52	.43	.43	.33	.27	.32	.35	.20	.28	.56	.58	.54	.46	.39	.36	.22	.30
	S. M.			.52	.39	.35	.33	.28	.35	.19	.28	.50	.73	.61	.52	.56	.48	.52	.51	.45	.41	.33	.32	.39	.22	.28	.48	.51	.44	.39	.30	.28	.19	.18
	Gallo				.24	.24	.18	.16	.11	.10	.13	.34	.50	.56	.33	.49	.52	.63	.59	.51	.38	.29	.39	.38	.16	.19	.37	.42	.38	.26	.20	.16	.02	.07
	Florida					.71	.66	.51	.57	.55	.62	.66	.48	.36	.55	.32	.27	.30	.21	.20	.21	.14	.15	.28	.18	.30	.48	.46	.52	.55	.55	.55	.46	.34
	Cooke						.62	.45	.45	.54	.49	.57	.43	.29	.44	.29	.24	.28	.21	.13	.17	.13	.14	.19	.21	.21	.43	.40	.45	.47	.45	.47	.34	.27
	Animas							.57	.50	.73	.50	.53	.38	.26	.38	.20	.12	.21	.15	.10	.08	.04	.12	.24	.15	.26	.36	.40	.41	.46	.44	.50	.44	.38
	San Luis								.37	.45	.38	.35	.29	.22	.24	.13	.13	.11	.16	.06	.06	.00	.05	.13	.05	.09	.23	.23	.28	.27	.29	.27	.29	.20
	Big Hatchet									.45	.45	.44	.37	.30	.48	.22	.15	.21	.15	.11	.18	.12	.15	.24	.17	.26	.33	.40	.35	.48	.48	.41	.43	.29
	Peloncillo										.48	.45	.23	.17	52	.20	.08	.11	.10	.00	.06	.00	.08	.18	.14	.23	.30	.29	.33	.40	.34	.45	.41	.31
	Franklin											.50	.26	.28	41	.22	.14	.21	.11	.00	.07	.00	.09	.23	.12	.29	.36	.36	.36	.49	.46	.45	.41	.34
	Organ												.61	.47	.54	.46	.31	.40	.36	.33	.29	.20	.25	.37	.22	.32	.62	.56	.58	.60	.48	.45	.44	.26
	Magdalena													.64	.60	.61	.49	.57	.55	.51	.44	.36	.41	.45	.20	.30	.55	.59	.53	.44	.39	.35	.28	.25
	Manzano														.52	.78	.52	.57	.57	.60	.53	.44	.50	.50	.24	.35	.56	.60	.54	.41	.41	.27	.18	.19
	Ladron															.55	.33	.41	.35	.32	.31	.23	.22	.28	.19	.29	.42	.42	.42	.45	.44	.32	.34	.18
	Sandia																.52	.53	.52	.53	.52	.43	.44	.43	.26	.34	.50	.52	.53	.40	.31	.19	.10	.07
2810.54	Chuska																	.67	.56	.54	.40	.29	.29	.31	.11	.19	.35	.40	.38	.25	.18	.11	.01	.03
STDEV x 10e3 + AVE	Zuni																		.67	.66	.44	.40	.42	.38	.21	.23	.45	.52	.42	.34	.28	.20	.09	.07
ENTIRE BIG CHART	Taylor																			.55	.46	.36	.40	.42	.22	.20	.38	.49	.41	.28	.24	.17	.04	.09
	Jemez																				.63	.53	.51	.44	.22	.26	.43	.48	.39	.21	.23	.12	.03	.01
	Raton Mesa																					.78	.61	.57	.29	.38	.42	.42	.41	.25	.24	.15	.01	.02
	Johnson																						.68	.57	.26	.36	.31	.24	.32	.22	.22	.12	.00	.00
	Capulin																							.62	.33	.33	.39	.38	.43	.23	.25	.17	.04	.08
	Sierra Grande																								.27	.50	.47	.51	.43	.35	.34	.28	.16	.21
	Union County																									.50	.29	.31	.28	.33	.25	.17	.11	.04
	Clayton Lake																										.38	.41	.35	.43	.38	.28	.17	.16
	Sacramento																											.73	.69	.49	.39	.35	.26	.24
	Capitan																												.65	.55	.47	.38	.28	.27
	Carrizo Peak																													.46	.44	.38	.28	.26
	Guadalupe Ridge																														.68	.52	.56	.41
	Guadalupe Peak																															.60	.46	.39
	Davis																																.46	.40
	Chisos																																	.50
	Sierra delCarmen																																	
	rev 12-28-07																																	

Table 7. The relationship between correlation ρ (%) across a barrier and its antiquity a

$$a \text{ (years)} = 100{,}000(1 - \rho)^{2\frac{1}{2}}/(1 + \rho)^{\frac{1}{2}}$$

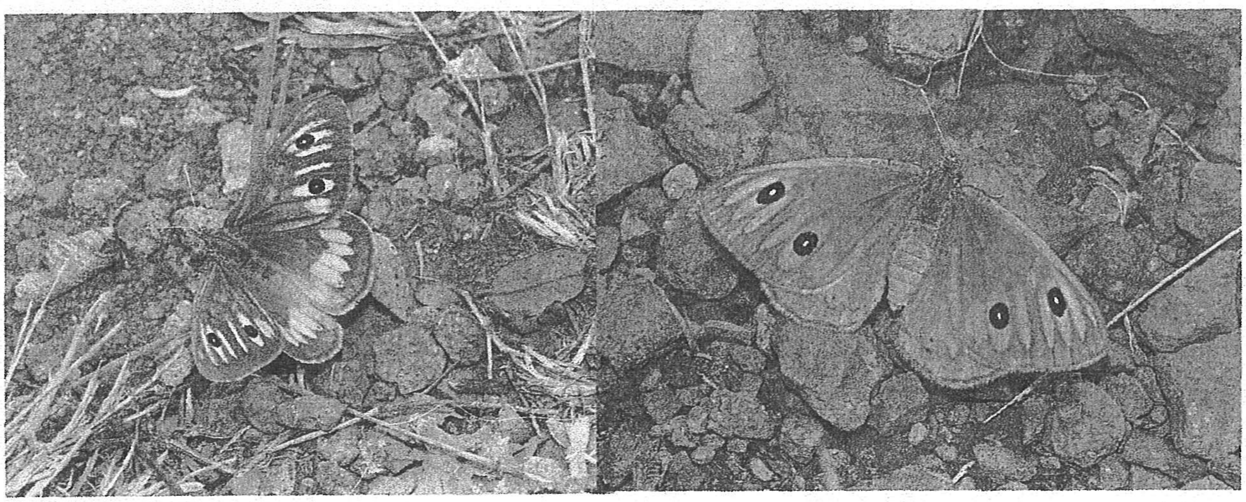
SX-MC (ρ = .24, a_0 = 100,000) vs SX-GR-GN-DM-BB-MC (ρ = .50, .46, .60, .68, .49, a_0 =100,000)
(4521 vs 1430 +1773 + 800 + 252 + 1521 = 4166)

	2.5									
ρ	.5	ρ	a/10	ρ	a/10	ρ	a/10	CL-FM .29 3738	MC-CZ .27 4040	PL-CK .08 7811
-29	22431	21	5042.84	45	1863.04	69	411.59	CL-AB-SX-FM	MC-BB-DM-GN-GR-CZ	PL-WB-GM-ZM-CK
-27	21274	22	4864.71	46	1773.41	70	378.08	.34, .50, 36	.50, .46, .60, .68, .46	.41, .52, .52, .67
-25	20172	23	4691.1	47	1686.67	71	346.34	6681	6202	5186
-23	19121	24	4521.92	48	1602.79	72	316.32			
-21	18120	25	4357.11	49	1521.71	73	288			
-19	17164	26	4196.57	50	1443.38	74	261.31	JZ-MC .02 10614	FM-GM .28 3888	FL-CK .27 4040
-17	16253	27	4040.22	51	1367.73	75	236.23	JZ-AB-SX-MC	FM-OM-BR-WB-GM	FL-CO-BR-WB-GM-ZM-CK
-15	15383	28	3888	52	1294.74	76	212.7	.52, .49, .23	.50, .50, .76, .52	
-13	14552	29	3739.82	53	1224.33	77	190.69	7508	4181	.71, .60, .76, .52, .63, .67
-11	13760	30	3595.62	54	1156.47	78	170.16			3837
-9	13003	31	3455.31	55	1091.1	79	151.05			
-7	12281	32	3318.83	56	1028.18	80	133.33	SL-MC .20 5225	CL-CV .33 3318	
-5	11591	33	3186.11	57	967.657	81	116.96	SL-AM-FL-FM-MC	CL-UC-CV	FL-GM .24 5187
-3	10932	34	3057.08	58	909.483	82	101.89	.57, .66, .62, .34	.50, .33	FL-CO-BR-WB-GM
-1	10304	35	2931.68	59	853.613	83	88.08	5161	4500	.71, .60, .76, .52
1	9703.5	36	2809.83	60	800	84	75.49			2095
3	9130.8	37	2691.48	61	748.598	85	64.07		JZ-BB -.03 10932	
5	8584.5	38	2576.56	62	699.361	86	53.77	CK-CL .19 5413	JZ-AB-MZ-CM-SX-GR-GN-DM-BB	
7	8063.3	39	2465	63	652.245	87	44.56	CK-MT-JZ-AB-CL		
9	7566.4	40	2356.75	64	607.204	88	36.38	, .55, .53, .34	.53, .78, .60, .56, .49, .68, .60, .46, .50	
11	7092.7	41	2251.75	65	564.194	89	29.19	5634		
13	6641.4	42	2149.94	66	523.171	90	22.94		9414	
15	6211.5	43	2051.25	67	484.091	91	17.58			
17	5802.3	44	1955.64	68	446.91	92	13.06			
19	5413	45	1863.04	69	411.586	93	9.33			

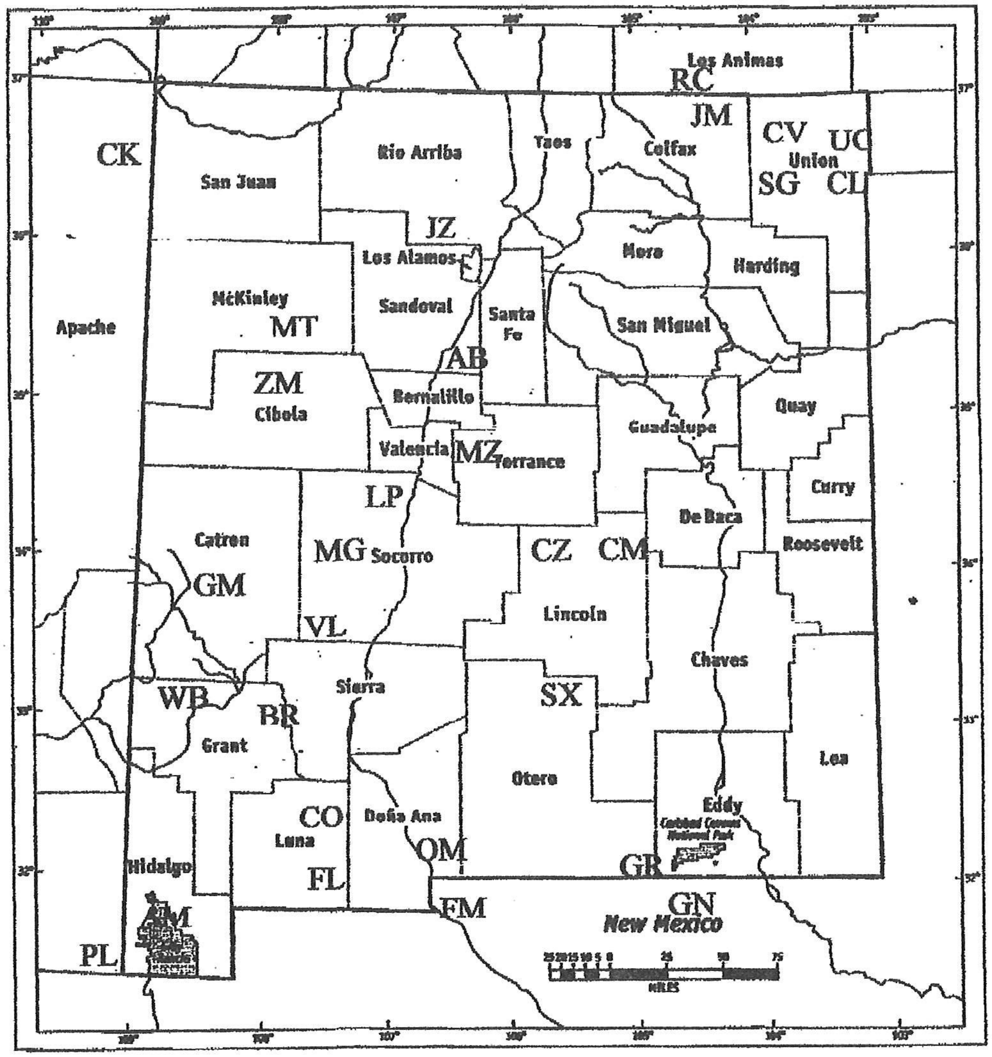
Table 8. Standard deviations and averages of correlations of the seven refugium groups

	Gila	Bootheel	Rio Grande	Great Basin	Colfax-Union	Sacramento	West Texas
Gila	.09 .60	.13 .39	.12 .50	.11 .40 .11	.07 .28 .08	.05 .52	.11 .33
Bootheel		.10 .55	.13 .38	.08 .15 .07	.08 .15 .08	.08 .37	.10 .40
Rio Grande			.17 .49	.16 .45 .15	.13 .31 .15	.09 .49	.13 .35
Great Basin				.06 .61	.13 .35 .14	.05 .43 .05	.10 .14 .10
Colfax-Union					.16 .47	.07 .38	.12 .19
Sacramento						.04 .69	.10 .37
West Texas							.16 .51

Left entry shows intra-group standard deviation of correlation within group pairs with Jemez Mts. (JZ) in Great Basin Group.
Middle entry shows inter group correlations after intra-group averaging over group pairs (with JZ in Great Basin Group).
Right entry corresponds to post-shift left entry after shifting JZ to Union-Colfax Group (if entry changes because of shift).



Neomino [illegible], Sierra del Carmen, Coahuila, courtesy of Jim Brock.


Los Animas
RC
JM
CV
UC
Union
SG
CL
CK
San Juan
Rio Arriba
Taos
Colfax
JZ
Los Alamos
Mora
Harding
McKinley
MT
Sandoval
Santa Fe
San Miguel
Apache
AB
ZM
Cibola
Bernalillo
Quay
Guadalupe
Valencia
MZ
Torrance
Curry
LP
De Baca
Catron
MG
Socorro
CZ
CM
Roosevelt
GM
Lincoln
VL
Chaves
Sierra
SX
WB
BR
Grant
Lea
Otero
Eddy
CO
Doña Ana
Luna
OM
Hidalgo
FL
GR
FM
GN
New Mexico
PL
MILES