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A NEW SUBSPECIES OF *SATYRIUM TITUS* (LYCAENIDAE: THECLINAE) FROM SOUTH CENTRAL NEW MEXICO

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ABSTRACT. I here describe *Satyrium titus carrizozo*, the third of three endemic hairstreaks, and of five endemic Lycaenids occurring in the Sacramento Mts. of southern New Mexico. This is the only mountain range in New Mexico isolated long enough to have evolved endemic subspecies of Lepidoptera—my Antiquity Formula places its time of separation from the nearest area of potential gene-exchange as about 8000 years ago. The new taxon differs from other known Coral hairstreak populations by having both the VHW namesake coral and the inner coral whitecapping in the “*thecla*-spot” greatly reduced.

Additional key words: endemic, insular biology, refugia, antiquity, Coral Hairstreak, global warming, Sacramento Mts.

There appear to be about 10 subspecies of butterflies endemic to the Sacramento Mts. of Lincoln and Otero Counties in southern New Mexico. These mountains are isolated by the usual factors, with elevation being primary, and precipitation, flora, life zones, human activity, afternoon rainfall, fire and exotic introductions being secondary. The Sacramento Mts. are primarily limestone over granite, with occasional volcanic intrusions, and an occasional real oddity, such as a lava flow or snow white gypsum dry lake bed, epitomized by Lake Lucero at White Sands. Many basins in southern New Mexico are closed including the Tularosa Basin to the west of the Sacramento Mountains and the Orogrande-Dell City Basins to the south. Endemic butterflies include:

Poanes hobomok nr. *wetona* Scott
Satyrium titus carrizozo R. Holland
Callophrys affinis albipalpis Gorelick
Callophrys sheridanii sacramento Scott
Glaucopsyche lygdamus ruidoso R. Holland
Plebejus icarioides sacre R. Holland
Speyeria hesperis capitanensis R. Holland
Speyeria nokomis tularosa (R. Holland) (extinct?)
Euphydryas anicia cloudcrofti (Ferris & R. Holland)
Phyciodes cocyta nr. *incognitus* Gatrell
plus whatever Megathymidae, *Euphilotes*, *Celastrina*,
and *Apodemia* there be

This paper shall describe the second, and probably the rarest of the above surviving endemics. Basically, Gatrell (2004) claims only one subspecies of *Satyrium titus* (F.) for New Mexico, *S. t. immaculosus* (W. Comstock). As one passes south across New Mexico, the *S. titus* phenotype becomes dingy in two ways—the coral-colored areas shrink and what there is becomes duller red. South of Albuquerque, *S. titus* is very rarely encountered. There is one colony in the Manzano Mts, about 40 miles to the southeast, at about 8200 feet in New Canyon. This population is difficult to place, as

most specimens are females, while most specimens from other sites are males. I feel most comfortable postponing the issue of the Manzano Mts. affinity. Further south, I have found two mountain-top colonies, both near Carrizozo in the Sacramento Mts. complex. One is at the very summit of Nogal Peak, at exactly 10,000'. The other is at the Carrizo Peak microwave relay site, on a summit in its own right, but at 8800', about 800' below the true crest. These colonies, like all of *Satyrium titus* in New Mexico, are intimately associated with choke cherry (*Prunus melanocarpa* (Nelson)). A very tiny increase in global temperature shall push this taxon into thin air, and give it no place to live.

The Manzano and Sacramento colonies were serendipitously discovered during my lifelong project to explore everywhere in or near New Mexico. They were not found while specifically seeking *S. titus*.

MATERIAL STUDIED

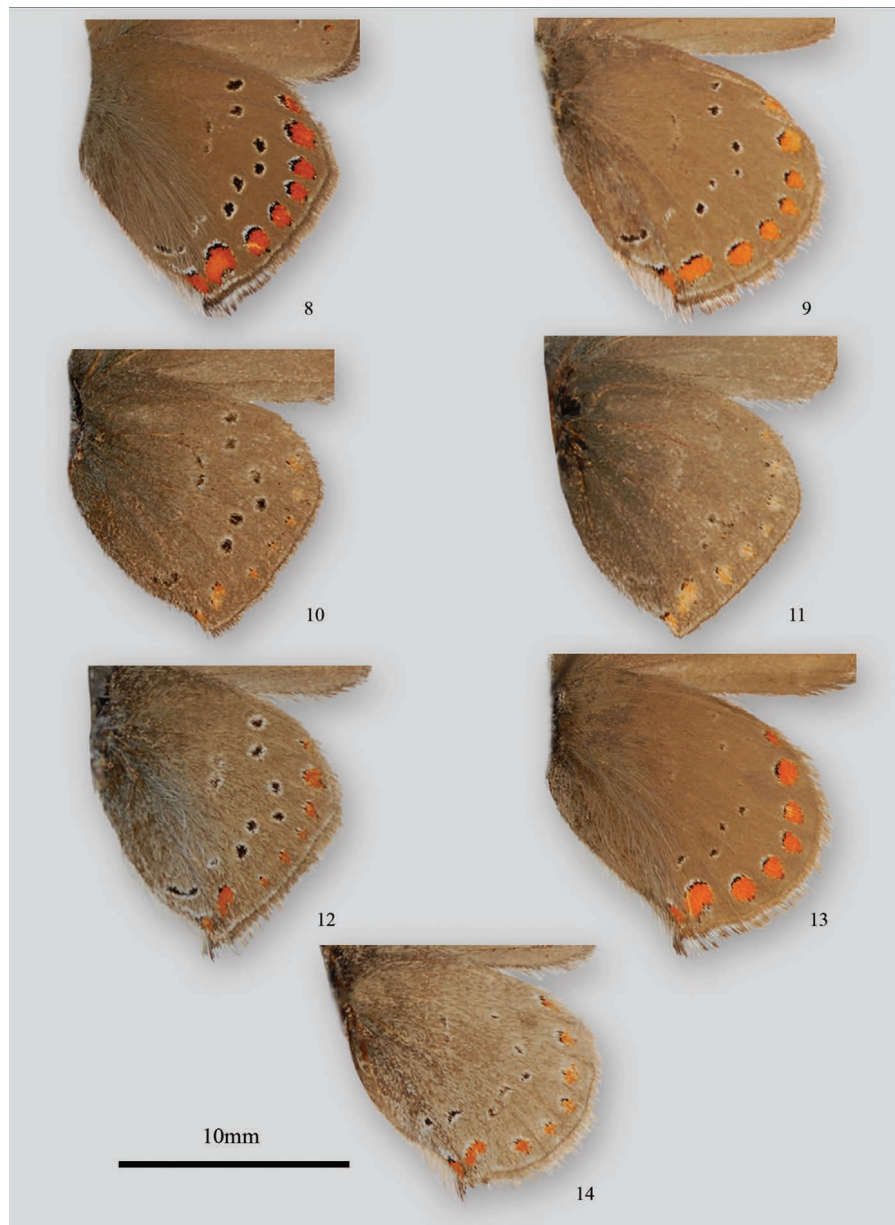
I have found useful illustrations of the *S. titus* subspecies in Ferris & Brown (1980), Scott (1986), Howe (1975), Holland (1982), and especially Gatrell (2004). Figures referred to here by number only are from the plate in Gatrell. At this time, I have the following material before me from New Mexico or just across the state line in Colorado:

***Satyrium titus immaculosus*: Males.** Las Animas Co., Colorado, 8800', N. slope of San Francisco Pass, Raton Mesa Complex, 17-vii-97, leg. R. Holland & E. Caprisecca: *S. t. immaculosus* specimen which is a fair match for Fig. 21, no reduction in the VHW “*thecla*-spot” coral marking or elimination of their whitecaps.

Colfax Co., New Mexico, 8400', Red Hill, Johnson Mesa, leg. R. Holland & S. J. Cary, 10 total, 5 on 4-vii-96, 4 on 27-vii-96, 1 on 19-vii-97: two specimens which are acceptable matches for Fig. 21, except the VHW coral is more brilliant than in the figure, six specimens



Figures 1–7. *Satyrium titus* from New Mexico. **1.** *Satyrium titus immaculosus* ♂. Red Hill, Johnson Mesa, Colfax Co., NM, 8400', 18-vii-97, leg. R. Holland & S. J. Cary. CNC LEP 00032025. Note the coral does not coalesce into a band of eight circular spots for this ssp. (Type 1). **2.** *Satyrium titus immaculosus* ♀. New Canyon CG, Manzano Mts., Torraine Co., NM, 8200', 29-vii-67, leg. R. Holland. CNC LEP 0032026. Note the coalescing of the coral into a band of eight circular spots (Type 1). **3.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032027 **4.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032029 **5.** Holotype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 19-vii-98, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032028 **6.** Paratype ♀ of *Satyrium titus carrizozo*. Summit of Nogal Peak, near Carrizozo, Lincoln Co., NM, Sacramento Mts. Complex, 10,000', 9-viii-75, leg. R. Holland. Note that, while the area of the coral and its intensity is not reduced in this specimen, it is coalesced into a band of seven round dots. CNC LEP 00032030 **7.** Paratype ♀ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral. CNC LEP 0032031



Figures 8–14. *Satyrium titus* VHW maculation. **8.** *Satyrium titus immaculosus* ♂. Red Hill, Johnson Mesa, Colfax Co., NM, 8400', 18-vii-97, leg. R. Holland & S. J. Cary. CNC LEP 00032025. Note the coral does not coalesce into a band of eight circular spots for this ssp. (Type 1). **9.** *Satyrium titus immaculosus* ♀. New Canyon CG, Manzano Mts., Torrance Co., NM, 8200', 29-vii-67, leg. R. Holland. CNC LEP 0032026. Note the coalescing of the coral into a band of eight circular spots (Type 1). **10.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032027 **11.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032029 **12.** Holotype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 19-vii-98, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032028 **13.** Paratype ♀ of *Satyrium titus carrizozo*. Summit of Nogal Peak, near Carrizozo, Lincoln Co., NM, Sacramento Mts. Complex, 10,000', 9-viii-75, leg. R. Holland. Note that, while the area of the coral and its intensity is not reduced in this specimen, it is coalesced into a band of seven round dots. CNC LEP 00032030 **14.** Paratype ♀ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral. CNC LEP 0032031

are acceptable matches for Fig. 21, one specimen is unique in having the HW coral markings enhanced both dorsally and ventrally, and one specimen has noticeably enhanced coral markings ventrally only. All of these individuals have just a vestige of whitecaps. A specimen shown in our Fig. 1 is one of the matches.

Union Co., New Mexico, 7500', parking area, NE approach to Sierra Grande, 20-vii-97, leg. S. J. Cary: *S. t. immaculosus* specimen matching Fig. 21, but with whitecaps and the coral more brilliant on the VHW, and with just a trace of coral on the DHW, no coral anywhere on the FW.

Taos Co., New Mexico, 7500', Arroyo Hondo, 24-viii-85, leg. R. Holland: *S. t. immaculosus* specimen which is a good, whitecapped match for Fig. 21; same data, but at 8000', 30-vii-64, leg. R. Holland: another good match for Fig. 21, but with the whitecaps missing from the coral markings.

Females. Sandoval Co., New Mexico, 8000', Paliza Canyon, Jemez Mts, 21-vii-84, leg. R. Holland: *S. t. immaculosus* female, matching Figs. 22 and 28 well ventrally and Fig. 22 fairly well dorsally (evidence of type 3(C) bird attack (Sargent 1976)).

Satyrium titus of uncertain affinity: **Males.** Torrance Co., New Mexico, 8000', New Canyon CG, Manzano Mts, 29-vii-67, leg. R. Holland: atypical *S. t. immaculosus* specimen with the coral area 40% reduced, and with the normally coral areas straw-colored instead, reminiscent of *Strymon melinus* ab. *meinersi* Gunder (Holland 1980, 1982), otherwise a fair match for Fig. 21.

Females. Torrance Co., New Mexico, 8000', New Canyon CG, Manzano Mts, 9-vii-67, leg. R. Holland: a typical *S. t. immaculosus* specimen with the coral area normal dorsally and on the hindwing ventrally with

whitecapping, but missing on the VFW, otherwise an acceptable match for Figs. 22 and 28; 8400', New Canyon CG, Manzano Mts, 29-vii-67, leg. R. Holland: two quasi-typical *S. t. immaculosus* with the coral area reduced 50% dorsally and 70% ventrally, and almost no whitecaps, but otherwise acceptable matches for Figs. 22 and 28; 8000', New Canyon CG, Manzano Mts, 9-vii-67, leg. R. Holland: a typical *S. t. immaculosus* specimen with the coral area normal dorsally and on the hindwing ventrally, but missing on the VFW, VHW coral reduced 30%, vestigial whitecaps, otherwise an acceptable match for Figs. 22 and 28.

Satyrium titus carrizozo: Males. Lincoln Co., New Mexico, 8800', microwave relay, mostly July, Carrizo Peak, leg. R. Holland [& E. Caprisecca]; 10,000', summit of Nogal Peak, Sacramento Mts. Complex, 9-viii-75, leg. R. Holland: six types and paratypes, one aberration (see Table 1).

Females. Lincoln Co., New Mexico, 8800', microwave relay, Carrizo Peak, leg. R. Holland [& E. Caprisecca]; 10,000', summit of Nogal Peak, Sacramento Mts. complex, 9-viii-75, leg. R. Holland: two types and paratypes (see my Table 1 and Figs. 6, 7, 13, & 14).

OBSERVATIONS AND CONCLUSIONS

Combining specimens from both *S. titus* colonies, I, thus, have a type series of 6 males and 2 females to work with; any thought of using statistics would necessarily seem to be of modest intent. Nevertheless, I did do some ANOVA (Table 1), and came to some unexpected conclusions.

The trait I considered was the coral reduction factor in the sixth column. First, I examined the reduction in the two Lincoln County populations. To my surprise, upon ignoring the possibility of sexual dimorphism, this

Table 1. Extant specimens of *Satyrium titus carrizozo* from Lincoln County, New Mexico

Location	CNC Number	sex & mm wingspan	date	white caps	DHW coral	VHW coral	status	Resembles Gatrell Fig.	Illustrated in Holland Fig.
Carrizo Pk.	32029	♂ 28.5	11-vii-97	none	none	95% reduced	holotype	none	5 & 12
Manzano Mts.	32026	♂ 27.5	9-vii-97	none	enhanced	70% reduced	paratype	27 pale	
Carrizo Pk.	32027	♂ 27.5	11-vii-97	none	enhanced	70% reduced	paratype	none	3 & 10
Carrizo Pk.	32028	♂ 30	25-vii-97	none	enhanced	70% reduced	paratype	none	4 & 11
Nogal Pk.		♂ 25.5	9-viii-75	yes	enhanced	30% reduced	paratype	27 pale	
Nogal Pk.		♂ 28.5	9-viii-75	yes	enhanced	50% reduced	paratype	none	1982
Nogal Pk.		♂ 27.5	9-viii-75	none	normal	70% reduced	aberrant	none	1982
Carrizo Pk.	32031	♀ 31	19-vii-98	none	none	90% reduced	allotype	18	7 & 14
Nogal Pk.	32030	♀ 31	9-viii-75	yes	normal	normal	paratype	28	6 & 13

reduction was statistically distinguishable between just the two colonies with a significance on the order of $p < 10^{-4}$. While this is not an ideal situation to use ANOVA, it should give perfectly correct evaluations. If both sexes are considered in a single test, I obtained $F(1,7) = 147$. A value of 12.3 would have yielded $p < 10^{-2}$, and 29.2 would mean $p < 10^{-3}$. In this probability region, every time F doubles, p is reduced by a factor of 10. Thus, the odds against the reductions in coral being due to chance alone in the Carrizo Peak colony compared to the Nogal Peak colony are about 10^{-5} .

If one only considers the Lincoln County males, the relevant ANOVA statistic is $F(1,5)$, (Turner & Thayer 2001) and my data lead to a Lincoln County only value of 65 (Zelen & Severo 1965). The required $F(1,5)$ value for 99.9% confidence is 47, so there is quite eloquent statistical evidence that today even the two Lincoln County colonies are totally isolated even from each other. (Yes, you can easily see Nogal Peak from Carrizo Peak, and back again.)

It would be possible to do a similar statistical analysis of the Lincoln Co. *S. t. carrizo* things with the Colfax Co. specimens taken on Red Hill, but the difference here is so strikingly evident, I do not think it is necessary.

One may ask, "How long have the two *S. t. carrizo* colonies been isolated?" Quite by chance, I have a value available for the butterfly distribution correlation between the main part of the Sacramento Mts. and Carrizo Peak: it is .69, implying a separation antiquity of 4100 years (Holland 2009). Alternatively, the maximum correlation between the Sacramento Complex and any other range where *Satyrium titus* is known to occur is .60 with the Manzano Mts. This implies the Divine Engineer had 8000 years to tweak *S. t. immaculatus* into *S. t. carrizo*, assuming He started in the Manzanos.

Satyrium titus carrizo, new subspecies

Diagnosis and Description. Let me define *Satyrium titus carrizo* to be an isolate offshoot of *Satyrium titus immaculatus*, the only subspecies which it resembles or could interact with because of its range. The coral markings of *S. t. carrizo* midway between the veins may actually be enhanced post-medially on the DHW of males, but are eliminated on the VFW. Species signature "thecla-spot" coral markings suffer over 70% reduction on the VHW of *S. t. carrizo*, and the whitecaps are totally suppressed over all the coral "thecla-markings". What coral markings are retained on the VHW are of a subdued hue in *S. t. carrizo*, and it may require electronic enhancement to detect the relevant scales. This is especially true of all midcell

coral markings on the VHW caudal of Vein Cu_2 . If $>1/2$ the individuals in a population bear these last three traits, the population is *S. t. carrizo*. Note that this is at least somewhat a statistically defined subspecies. Occasionally a specimen will occur which is not distinguishable from *S. t. immaculatus*; the female paratype in Figs. 6 & 13 is such a case. The male holotype and allotype appear in my Figs. 5 & 12, 7 & 14, respectively. The other female paratype appears in my Figs. 6 & 13. Two additional males, including another male paratype, already appear in the open literature (Holland 1982). In my Figs. 3, 4, 10, & 11, for comparison, I show two additional males of *S. t. carrizo*. The dorsal surfaces of the type material shown in Fig. 5 and Fig. 7, the type pair, are an almost featureless deep, uniform brown. One of the confusing Manzano Mts. females appears in Figs. 2 & 9, and a male *immaculatus* appears in Figs. 1 & 8. The coral coloring in the VHW of *S. t. carrizo* is either reduced to an arc of circles (Figs. 12 & 14, Type 1), or still further reduced to tiny broken marginal patches (Figs. 10 & 11, Type 2). Type 1 and 2 coral markings are not usually seen except on *S. t. carrizo* and the Manzano Mts. specimens.

Etymology. The etymology here may be somewhat confusing. The nearby town is Carrizozo, New Mexico, but the butterfly is found on Carrizo and Nogal Peaks. Carrizo is Spanish for grassy, Carrizozo is an emphatic "grass all over the place," and Nogal means walnut. The name *carrizo* is selected to include the Nogal Peak population as well as the Carrizo Peak population. Carrizozo is masculine.

Primary types will be placed in the Canadian National Collection and paratypes will be donated to Colorado State University.

DISCUSSION

This paper is the sixth of about 14 in which I shall describe Sacramento Mts. endemics (Holland 1988, 2003, 2009; Scott 2006; Ferris & Holland 1982; Gorelick 2005). Except for its association with 'Prunus' almost nothing is known about the ecology of the new subspecies. The only credible habitat threats are spraying and fire. As with all mountain top denizens, the prognosis for survival until 2100 is poor. The flight of *Satyrium titus* in New Mexico is univoltine, from mid-July to mid-August.

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