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New Northern Distribution Records for Pattern Classes A, B, and D of *Aspidoscelis neotesselata* (Colorado Checkered Whiptail) in Colorado, and Biogeographic Sources of Northern Colonists

Aspidoscelis neotesselata (Colorado Checkered Whiptail) originated from a hybridization event between individuals of *A. tesselata* (Common Checkered Whiptail) and *A. sexlineata viridis* (Prairie Racerunner) (Parker and Selander 1976; Dessauer and Cole 1989; Walker et al. 1995; Taylor et al. 2015). *Aspidoscelis neotesselata* inherited its parthenogenetic mode of reproduction from *A. tesselata*, and embryogenesis in both species is initiated and completed independently of spermatozoa. Therefore, a local group of *A. neotesselata* females lacks the genetic cohesion of a local population of a sexually reproducing species, and clonal divergence—a consequence of random mutation—is the principal mode of evolution. Based on the mother-daughter pattern of descent in obligate parthenogens, with evolution expressing itself as clonal divergence, local groups of related parthenogenetic females are more appropriately referred to as "arrays" ("tokogenetic arrays" of Frost and Hillis 1990) rather than "populations."

Color pattern differences among arrays of *A. neotesselata* illustrate that clonal inheritance has not prevented postorigin evolution (Taylor et al. 2015). Although ontogenetic and individual variation add to the challenge of discerning discrete

HARRY L. TAYLOR*
Department of Biology, Regis University, Denver, Colorado 80221, USA
LAUREN J. LIVO
1835 South Van Gordon Street, Lakewood, Colorado 80228, USA
DANIEL J. MARTIN
Natural Resource Ecology Laboratory, Department 1499, Colorado State University, Fort Collins, Colorado 80523, USA
WILLIAM R. MAYNARD
1390 Farnham Point, Apt. 302, Colorado Springs, Colorado 80904, USA
APRIL ESTEP
Colorado Parks and Wildlife, Department of Natural Resources, 4255 Sinton Road, Colorado Springs, Colorado 80907, USA
RICK CLAWGES
Osage of Virginia, Inc., c/o Fort Carson Wildlife Program, DPW Environmental Division, 1626 Evans St., Fort Carson, Colorado 80913, USA
DICK ROTH
721 Spring Way, Pueblo, Colorado 81006, USA
JOEY KELLNER
9500 South Estes Way, Littleton, Colorado 80127, USA
TINA JACKSON
Colorado Parks and Wildlife, Department of Natural Resources, 6060 Broadway, Denver, Colorado 80216, USA

**Corresponding author; e-mail: htwhiptail@gmail.com*

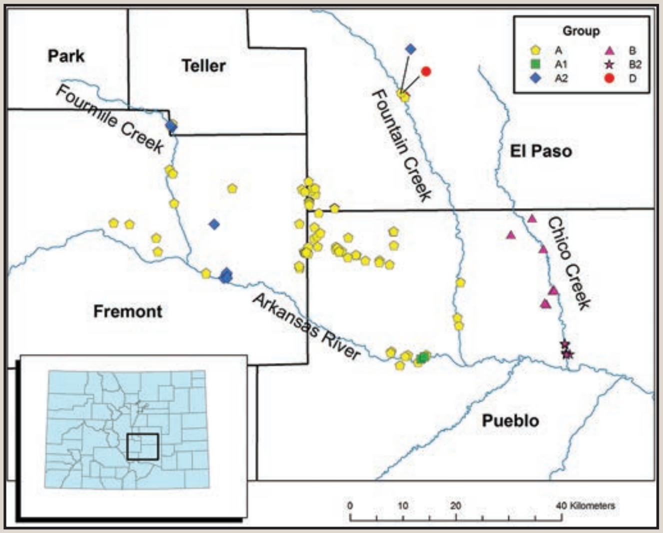

Fig. 1. Selected localities showing the geographic distributions of pattern classes A, B, and D of *Aspidoscelis neotesselata*, primarily north of the Arkansas River in El Paso, Fremont, Pueblo, and Teller counties, Colorado. Symbols identify localities detailed in Appendices 2 and 3. Yellow pentagons = pattern class A lacking statistical confirmation of A1 or A2 group; green squares = group A1 of pattern class A; blue diamonds = group A2 of pattern class A; magenta triangles = pattern class B lacking statistical confirmation of B1 or B2 group; magenta stars = group B2 of pattern class B; red circle = pattern class D.

Fig. 2. Photograph of an individual of *Aspidoscelis neotesselata* of pattern class B (with a partially regenerated tail) taken on 27 June 2014 at Chico Basin Ranch by William Maynard—the northernmost record of *A. neotesselata* B for Pueblo County, Colorado. This individual can be identified as pattern class B by the prominent longitudinal mid-vertebral line and transverse white bars crossing the lower lateral dark field.

Fig. 3. Individuals of *Aspidoscelis neotesselata* at Fountain Creek Nature Center and Fountain Creek Regional Park (Appendix 3). This area supports the northernmost self-sustaining array of *A. neotesselata* that has been discovered in Colorado. A) An individual of pattern class A, photographed by Don Erickson on 13 July 2012 at FCNC, El Paso Co., Colorado. B) A juvenile individual of *A. neotesselata* hatched in 2014, photographed by William Maynard on 27 October 2014 at the north end of Rice's Pond, FCNC. Photographs are not at same scale.

groups within this variation, specific color pattern attributes have been used to identify four color-pattern classes. These are designated by capital letters: A and B (Zweifel 1965), C (Walker et. al. 1997), and D (Walker et al. 2012).

Histocompatibility among color pattern classes (Walker et al. 2012; J. E. Cordes and J. M. Walker, unpubl.) indicates that *A. neotesselata* originated from a single parthenogenetic hybrid, thereby nullifying a hypothesis that color pattern classes A and B were derived from different hybridization events (Densmore et al. 1989). Additional morphological groups, designated as A1, A2, B1, and B2 within pattern classes A and B, were revealed by multivariate statistical analyses of meristic characters (Taylor et al. 2015). Because pattern classes A, B, C, and D are typically allopatric, as are groups A1, A2, B1, and B2, pattern classes are useful for depicting fine-scale geographic distributions, and pattern class groups have value in identifying genealogical sources of disjunct arrays.

This project was a collaborative effort to clarify the distribution of *A. neotesselata* north of the Arkansas River in southeastern Colorado. New localities include those that add El Paso and Teller counties to the four-county distribution (Fremont, Las Animas, Otero, and Pueblo) previously known to define the general range of *A. neotesselata* in Colorado. We also report an elevation record for *A. neotesselata* in Teller County that substantiates one reported from Fremont County (Banta and Kimmel 1965). Finally, we identify the likely biogeographical sources of the northern arrays of pattern classes A and D that now define the northern boundary of the species' range in Colorado.

Methods and materials.—Only two whiptail lizards, *A. neotesselata* and *A. sexlineata viridis*, are present in the study area, and these species have distinctive color patterns and coloration, making species misidentification unlikely (Hammerson 1999, plates 8.55 and 8.56). We documented new distribution records of *A. neotesselata* by voucher specimens, photographs, and reliable observations. We obtained direct GPS coordinates for most localities (UTM coordinates based on GPS datum WGS84). In a few instances, the location was estimated by comparing the observation location with satellite images available on Google Earth©. For published localities, we used associated information to map estimated localities. We determined elevation for each set of coordinates by mapping them in National Geographic TOPO! © (Version 4.5.0) software and obtaining the elevation from the Quad level map (USGS 1 arc-second National Elevation Dataset, 1 meter vertical precision).

We used seven meristic characters in the multivariate analyses (Appendix 1; Table 2). The L-breaks character is subject to ontogenetic development. Therefore, we used linear regression to check reference samples for a relationship between L-breaks and snout–vent length (SVL). This relationship was

Table 1. Descriptive statistics for samples of *Aspidoscelis neotesselata* from southeastern Colorado. PNC A1 = pattern class A from Pueblo Nature Center; Fremont A2 = pattern class A from Fremont County; LJ D = pattern class D from La Junta (Appendix 2). Means ± SE and range limits are shown. Means sharing the same letter (a, b, c) are not significantly different at α = 0.05. Group assignments of voucher specimens by CVA are shown below specimen numbers. FCNC = Fountain Creek Nature Center, El Paso County.

Characters	Reference samples			FCNC vouchers			Teller Co. vouchers		
	PNC A1 N = 27	Fremont A2 N = 30	LJ D N = 18	396 A2	397 A2	398 D	399 A2	400 A2	401 A2
CV1	0.3 ± 0.19 a -1.3 to 2.0	1.1 ± 0.21 b -1.6 to 3.5	-2.4 ± 0.18 c -4.5 to -1.2	0.5	0.3	-1.7	2.3	1.8	2.7
CV2	-1.5 ± 0.22 a -3.8 to 0.5	1.0 ± 0.20 b -2.2 to 2.6	0.5 ± 0.12 b -0.4 to 1.5	1.4	2.6	0.7	1.1	0.7	0.2
LSG	23.0 ± 0.57 a 17–28	23.4 ± 0.45 a 18–28	17.7 ± 0.43 b 15–21	26	26	23	26	23	27
SDL	33.2 ± 0.25 a 30–35	35.2 ± 0.19 b 33–38	33.4 ± 0.26 a 32–36	34	35	33	37	37	36
GAB	81.9 ± 0.70 a 74–90	80.9 ± 0.51 a 76–87	76.4 ± 0.61 b 72–81	74	73	72	82	84	81
SPV	6.3 ± 0.19 a 4–8	7.3 ± 0.14 b 6–9	6.3 ± 0.16 a 5–7	7	7	6	6	6	6
FP	38.4 ± 0.27 a 36–41	39.9 ± 0.31 b 36–43	39.9 ± 0.29 b 38–42	40	42	39	39	39	38
L-breaks	3.0 ± 0.70 a 0–11	1.8 ± 0.40 a 0–10	1.2 ± 0.23 a 0–3	0	0	0	0	1	0
COS	11.9 ± 0.28 a 10–16	12.5 ± 0.20 a 9–15	12.3 ± 0.14 a 11–13	12	12	14	12	10	9
SVL	82.4 ± 1.42 a 70–96	85.1 ± 1.21 a 75–100	80.9 ± 2.49 a 59–94	83	88	88	101	96	78

found in sample A2 and removed by using only specimens > 65 mm SVL in the analyses. We used the seven univariate characters in a principal components analysis (PCA) of a pooled sample of voucher and reference specimens to produce a set of uncorrelated principal components; these were used as characters in a canonical variate analysis (CVA) for definitive comparisons (Jombart et al. 2010). Because all characters were measured on the same scale (discrete counts of scales and femoral pores), we used a variance/covariance matrix to obtain coefficients used to compute principal component scores. A variance/covariance matrix retains the relative variances of original characters, so that characters with larger variances are given greater weight in developing the principal components (Neff and Marcus, 1980). We used reference samples of A1, A2 and D as a priori (preidentified) groups (Appendix 2), and stepwise selection of principal components to include in the CVA (*F*-to-enter probabilities < 0.05 that did not exceed 0.06 when other components were added to the model). The six voucher specimens from Fountain Creek Nature Center (FCNC), El Paso County, and Shelf Road, Teller County, were included in the CVA as unassigned individuals for classification to the reference sample each most closely resembled. We used Mahalanobis D^2 distance as a resemblance index (smaller D^2 values = greater resemblance and higher probability of correct classification of vouchers). Mahalanobis D^2 distances are sensitive to multivariate outliers (Tabachnick and Fidell, 2013). Therefore, we checked each reference sample for multivariate outliers by evaluating D^2 distances from each specimen to the centroid of the remaining cases. Specimens would be identified as outliers from a standard table of critical values for Chi Square; i.e., those with D^2 values exceeding a critical Chi-square value at $P = 0.001$, and degrees of freedom defined by the number of characters (principal components) included in the CVA model (Tabachnick and Fidell, 2013). We used SPSS© and NCSS© software for statistical routines, tests, and scatterplot construction.

Results.—Three key pieces of evidence formed the foundation of this study. First, Dick Roth discovered *A. neotesselata* in Teller County on 16 July 2004 (Fig. 1; Appendix 3) and documented a new elevation record of 2138 m for this species (UTM 13S 480729E, 4279916N). We augmented this Teller County record with voucher specimens collected on 21 August 2014, approximately 0.3 km S of Dick Roth's 2004 observation location (Appendix 3). All were representatives of pattern class A (Fig. 4A: a–c).

Second, a photograph taken by William Maynard on 27 June 2014 at Chico Basin Ranch (CBR), Pueblo County (Fig. 2; Appendix 3), documented a new northern record for pattern class B of *A. neotesselata*. Latitudinally, the photographic location (UTM 13S 548568E, 4261673N) is approximately 24 km N of the previous northernmost record for pattern class B (UTM 13S 554644E,

Table 2. Loadings: correlations between seven meristic characters and principal components 1, 2, and 4 and between five principal components (selected for inclusion in the CVA model) and canonical variates 1 and 2: multivariate statistical analyses of *Aspidoscelis neotesselata* pattern classes A and D from southeastern Colorado.

Characters	Loadings				
	PC1	PC2	PC4	CV1	CV2
LSG	0.321	0.927	-0.014		
SDL	0.286	0.168	0.664		
GAB	0.966	-0.090	-0.014		
SPV	0.281	-0.085	0.571		
FP	-0.336	0.170	0.752		
L-breaks	0.599	-0.506	0.073		
COS	0.093	-0.220	0.323		
PC1				0.559	-0.310
PC2				0.429	0.019
PC4				0.126	0.705
PC5				-0.037	-0.241
PC7				0.128	0.181
Eigenvalues	18.489	12.375	3.013	2.066	1.349
Percentage of variance	44.6	29.9	7.3	60.5	39.5

4238113N) at Pueblo Chemical Depot (PCD), Pueblo County (Taylor et al. 2006a). We made two unsuccessful attempts in August 2014 to collect a voucher specimen from the CBR location.

Third, a photograph taken at FCNC by Don Erickson on 13 July 2012 (Fig. 3A) and posted on http://www.donerickson.com/reptiles/reptiles.html provided the first evidence of *A. neotesselata* in El Paso County. Significantly, this photograph and voucher specimens collected from the photographic location (UTM 13S 524574E, 4284921N) document a new northernmost record for *A. neotesselata* in its natural range. A young individual, photographed on 27 October 2014 by William Maynard (Fig. 3B), indicates that *A. neotesselata* had reproduced successfully at FCNC in 2014. We collected three voucher specimens of *A. neotesselata* from FCNC (Appendix 3), two of pattern class A (Fig. 4B: d, e), and one of pattern class D (Fig. 4B: f). The latter was unexpected because the distribution of pattern class D is centered on a small area associated with railroad yards in northeast La Junta, Otero County, approximately 125 straight-line km SE of FCNC (Walker et al. 2012; Taylor et al., *in press*). We determined the morphological affiliations of voucher specimens from FCNC and Teller County by a CVA in which reference samples of A1, A2, and D were used as a priori groups (Appendix 2), and the six voucher specimens were included as unassigned for classification to group. Two outliers in the PNC sample and four specimens with SVL < 65 mm in the Fremont County sample were excluded from the definitive multivariate analyses. Reference samples differed significantly for different combinations of univariate characters (Appendix 1). Reference samples A1 and A2 differed in SDL, SPV, and FP, whereas the reference sample of pattern class D differed from A1 in LSG, GAB, and FP, and from A2 in LSG, SDL, GAB, and SPV (Table 1). The CVA model (Table 2) classified 68 of the 75 reference specimens (90.7%) to correct samples of origin. Reference sample PNC A1 had 4 of 27 specimens misclassified as Fremont County A2, and reference sample Fremont A2 had 3 of 30 specimens misclassified: 2 to PNC A1 and 1 to LJD D. None of the individuals in the LJD D reference sample was misclassified. This overall high level of classification success was reflected by the significant differences in CV1 among the three reference samples (Table 1).

Each of the three voucher specimens from Teller County was assigned to reference sample A2 by the CVA (probabilities of 0.990 for HLT 399; 0.957 for HLT 400; and 0.937 for HLT 401). The two voucher specimens of pattern class A from FCNC were also assigned to reference sample A2 (probabilities of 0.969 for HLT 396 and 0.987 for HLT 397). Our identification of specimen HLT 398 as pattern class D was supported by its classification to the reference sample of pattern class D from La Junta ($P = 0.963$). The probability that HLT 398 actually represented A2, the group to which the other two FCNC vouchers were classified, was only 0.021. These robust classifications of voucher specimens are shown graphically by their positions in A2 and D clusters of canonical variate scores (Fig. 5). Although CVA classified FCNC and Teller County voucher specimens of pattern class A to group A2, vouchers from these two localities are distinctly different in GAB scores. All FCNC vouchers (pattern class A as well as pattern class D) most closely resembled the reference sample of pattern class D in GAB (Table 1).

Discussion.—Our locality records (Fig. 1; Appendices 2 and 3) extend the known distribution of *A. neotesselata* into Teller and El Paso counties, verify a previously reported elevation record, and establish a new northern range limit for *A. neotesselata* in Colorado. These new county records are of particular significance because they provide information regarding the ecological amplitude and the potential for range expansion in *A. neotesselata*.

The range of *A. neotesselata* extends approximately 173 km WNW beyond the range of *A. tesselata* in Colorado (Taylor et al. 2006b). Therefore, because triploid *A. neotesselata* inherited a diploid genome from *A. tesselata* and a haploid genome from *A. sexlineata viridis* (Neaves 1969; Parker and Selander 1976; Taylor et al. 2015), the greater ecological breadth of *A. neotesselata* may be related to the genome inherited from *A. sexlineata* (Taylor et al. 2006b). A natural experiment based on elevation records for the three species supports this hypothesis. We have not encountered *A. tesselata* above 1507 m in Colorado. Specimens of both *A. tesselata* and *A. neotesselata* were collected at this elevation by HLT on 11 June 2005 from a juniper (*Sabina monosperma*) woodland north of Lockwood Canyon and west of the Sharp Ranch road, U.S. Army Pinyon Canyon Maneuver Site, Las Animas County (UTM 13S 601962E, 4151131N). Other prominent plants at this site were skunkbush sumac (*Rhus* sp.), snakeweed (*Gutierrezia* sp.), and a cactus (*Opuntia imbricata*). Therefore, 1500 m might represent an approximate upper ecological limit for *A. tesselata* in Colorado. In contrast, the new elevation record of 2138 m for *A. neotesselata* in Teller County is similar to the maximum elevation (2103 m) reported for *A. neotesselata* in Fremont County (using the name *Cnemidophorus tessellatus*) by Banta and Kimmel (1965). This is slightly lower than the upper elevation of 2286 m reported for *A. sexlineata* in Colorado by Banta (1968b). Therefore, based on these data, the upper elevation boundary for *A. neotesselata* is approximately 600 m higher than that of *A. tesselata*. In addition, the northern distribution record of *A. neotesselata* from FCNC, El Paso County,

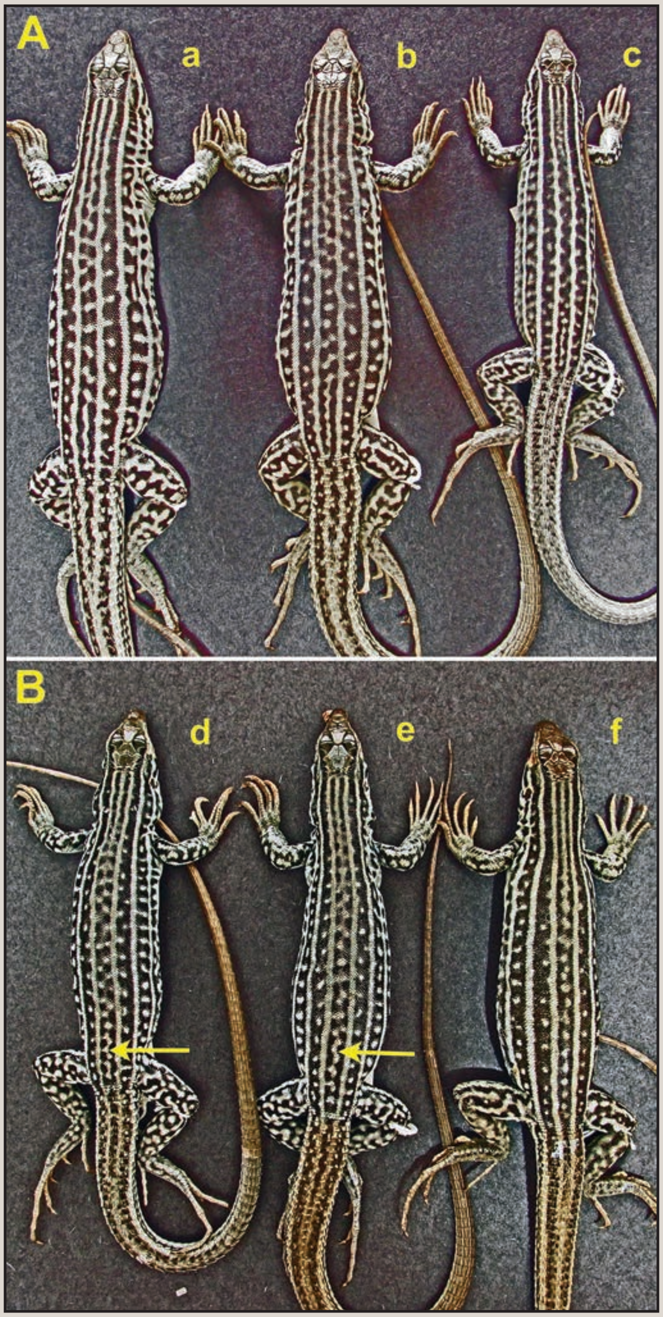

Fig. 4. Voucher specimens of *Aspidoscelis neotesselata* of pattern class A (a–e), and pattern class D (f). A. Shelf Road, Teller County, Colorado: a. HLT 399: 101 mm SVL; b. HLT 400: 96 mm SVL; c. HLT 401: 78 mm SVL (all collected 21 August 2014). B. Fountain Creek Nature Center, El Paso County, Colorado; d. HLT 396: 83 mm SVL (collected 18 July 2014); e. HLT 397: 88 mm SVL; f. HLT 398: 88 mm SVL (both collected on 15 August 2014). See Appendix 3 for details. Photographs are not at same scale. We identified specimen f (HLT 398) as pattern class D based on relatively uncluttered dark fields and a linear series of spots, rather than a short irregular-line (arrows), as found posteriorly in the vertebral field of pattern class A (also seen in specimens a–c). HLT 398 also had pale-tan spots and stripes, rather than gray (as shown for specimens a–e). Multivariate analysis of meristic characters confirmed this visual identification of specimen f as pattern class D.

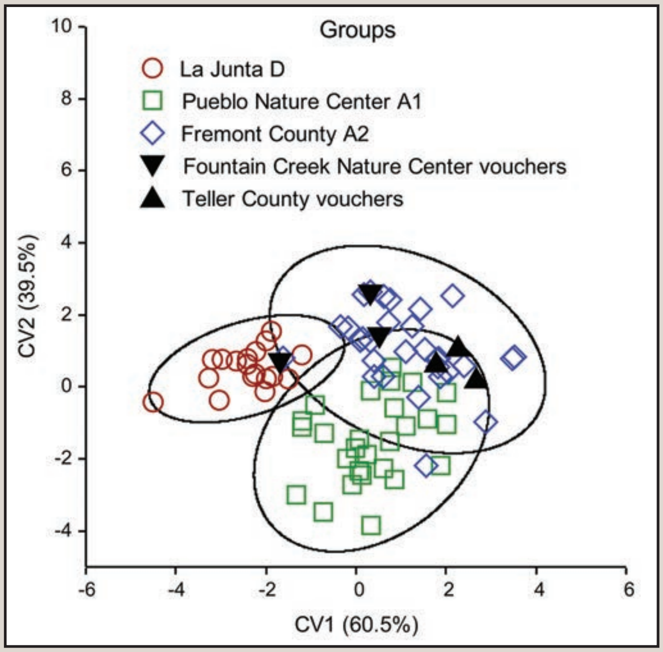

Fig. 5. Scatterplot of canonical variate scores CV1 and CV2 based on functions derived from CVA of three reference samples (a priori groups) of *Aspidoscelis neotesselata* from southeastern Colorado: group A1: 27 specimens from Pueblo Nature Center, Pueblo County; group A2: 30 specimens from north of Florence, Fremont County; group D: 18 specimens from La Junta, Otero County. Scores for six voucher specimens from Fountain Creek Nature Center, El Paso County, and Shelf Road, Teller County, were from classifications of vouchers, treated as "unknowns," by the CVA. Axis percentages are proportions of variation accounted for by canonical variates CV1 and CV2, and ellipses enclose the 95% confidence limits of the score distributions.

is only ca. 6 km farther north than the northern record from Teller County, suggesting that a northern latitudinal limit may have been identified for *A. neotesselata* in its natural range.

A number of alternative scenarios could account for the presence of pattern class A at FCNC. First, habitats associated with Fountain Creek might have served as a dispersal corridor from Pueblo to FCNC, a distance of approximately 51 straight-line km (Fig. 1). Pattern class A occurred along Fountain Creek within the city limits of Pueblo in the 1960s (Walker et al. 1996), and also north of Pueblo (Fig. 1) as documented by a specimen collected in 1965 near Fountain Creek, via Overton Road, 12.4 km N of Hwy U.S. 50 (G. Hammerson, pers. comm.). There is a distributional gap between this record and FCNC. On 9 August 1994, Hobart Smith, David Chiszar, and Lauren Livo searched the vicinity of Fountain Creek in El Paso County, approximately 15 km N of the Hammerson record. Representatives of *A. sexlineata*, but not *A. neotesselata*, were encountered. However, our multivariate evidence identified the two voucher specimens of pattern class A from FCNC as representatives of group A2 from Fremont County, not A1 from Pueblo County, thereby contributing no support for arrival by northward dispersal along Fountain Creek. It is unlikely that pattern class A arrived at FCNC by dispersal from the east. Banta (1968a) used a pitfall trapline (July through October, 1963) to assess the herpetological community 22.5 km E of FCNC. Fifty-seven individuals of *A. sexlineata* were among the 586 reptiles and amphibians captured, but *A. neotesselata* was not represented.

Although human introduction of pattern class A into FCNC cannot be excluded, there are potential source arrays of pattern class A located on the U.S. Army Fort Carson Installation southwest of FCNC (Fig. 1; Appendix 3). Fort Carson arrays have not been sampled and statistically confirmed as representing group A2, but they are geographically proximate to the A2 reference sample from Fremont County (Fig. 1; Appendix 3). The Teller County array of pattern class A is also linked to the A2 reference by the strong, multivariate classification of voucher specimens to that group and by a chain of observations north of Cañon City (Fig. 1, Appendix 3).

Similarly, the new northern record for pattern class B in Pueblo County is connected to the source array of group B2 at PCD by a well-defined path of observations along Chico Creek, (Fig. 1).

The discovery of a new pattern class of *A. neotesselata* (pattern class D) was an accidental surprise based on the capture, by nine-year old Michelle Keefer, of an individual of pattern class D that had wandered a short distance from its highly localized range within the city limits of La Junta (Walker et al. 2012). Therefore, the discovery of an individual of pattern class D at FCNC was unexpected. Although dispersal from the small local array of pattern class D at La Junta across 128 km of questionable habitats seems unlikely, there are other possible explanations for its presence at FCNC.

First, pattern class D might have been introduced into the FCNC area. The inherent capacity of *A. neotesselata* to establish an array following introduction is illustrated by a self-sustaining array of *A. neotesselata* in Grant County, Washington, approximately 1600 km NW of its natural range in Colorado (Weaver et al. 2011). That human introduction might have been involved in the geographic distribution of some of the arrays of *A. neotesselata* in Colorado is illustrated by the following example. On 29 May 2004, Joey Kellner, Paul Differding, and Melissa Van Dreese photographed an adult *A. neotesselata* (pattern class A) located approximately 1.61 km from the nearest road in Chatfield State Park, Douglas County, Colorado. It is unknown whether this individual represented an intended release or inadvertent transport to the area. Although J. Kellner checked the observation area several times in subsequent years, *A. neotesselata* was not reencountered. The Chatfield State Park locality is approximately 94 straight-line km N of FCNC and has an elevation of approximately 1724 m. According to our evidence, the latitude of Chatfield State Park exceeds the tolerance boundary for the perpetuation of arrays of *A. neotesselata* in Colorado.

A second possibility is that pattern class D appeared at FCNC by expression of an alternative developmental pathway in one or more eggs of an individual of pattern class A at that locality. Pattern classes A and D are members of the same basic morphological subgroup (subgroup A: groups A1, A2, and D versus subgroup B: groups B1, B2, and C: Taylor et al. 2015). They have similar color pattern features (Fig. 4), but statistical differences can be revealed by quantification of color pattern characters (Walker et al. 2012). Similarities between pattern classes A and D extend to ranges of variation for the univariate meristic characters used in the present study. Of the seven characters analyzed, GAB was the only character in HLT 398 (FCNC D) with a value (72) outside the range limits (74–90) of reference samples A1 and A2 (Table 1). However, if pattern class D originated at FCNC from an individual of pattern class A, the morphological link to that event is tenuous. Our CVA provided a probability of only 2% that HLT 398 represented group A2 rather than pattern class D. Specimen HLT 398 was 88 mm in SVL when collected, which exceeds the average size of 102 gravid females of *A. neotesselata*: SVL = 84.8 ± 0.72 SE, 68–101 (Taylor et al. 2006b). If HLT 398 had originated at FCNC, it would have been a potential contributor to several reproductive seasons of recruitment. If pattern class D is established and sympatric with pattern class A at FCNC, this can be ascertained by photographic evidence, and this investigation will begin in 2015.

Aspidoscelis neotesselata is endemic to southeastern Colorado (Walker et al. 1997). It is regarded as a species of special concern by Colorado Parks and Wildlife, is ranked as Near Threatened in the 2014 IUCN (International Union for the Conservation of Nature) Red List, and is currently under consideration for listing under the Endangered Species Act (http://www.fws.gov/southeast/candidateconservation/pdf/Petition_53AmphibiansReptiles.pdf, submitted 11 July 2012). Contemporary distribution information on *A. neotesselata*, such as presented herein, and continuing efforts to develop standardized monitoring protocols; e.g., Great Plains Reptile Monitoring Project (www.reptilemonitor.org), should contribute to understanding its status in nature and facilitating decisions on appropriate management protocols.

Acknowledgments.—Don Erickson discovered *A. neotesselata* at Fountain Creek Nature Center, and we extend our thanks for permission to use his photographic documentation. Thanks to Nancy Stone Bernard, Supervisor of FCNC and Tim Wolken, Community Services Director, for information on sighting locations and permission to collect voucher specimens. Voucher specimens and reference samples were collected under the provisions of Scientific Collecting License HP772 issued to HLT by Colorado Parks and Wildlife, Department of Natural Resources. We thank Libby Henits, Special Licensing Coordinator, CPW, for facilitating license addenda as arrays of *A. neotesselata* in El Paso and Teller counties were brought to our attention. We thank U.S. Army, Pueblo Chemical Depot (access coordinated by K. M. Canestorp, U.S. Fish and Wildlife Service and operations security approval facilitated by Clark Jones, U.S. Fish and Wildlife Service) for permission to collect a sample of *A. neotesselata* at PCD. We thank Roger Peyton, Forestry and Natural Resources Section, Directorate of Public Works, Environmental Division, Fort Carson, for facilitating operations security approval for records of *A. neotesselata* on Fort Carson Military Installation. Collection of samples on the Pinyon Canyon Maneuver Site was approved by U.S. Army (access coordinated by R. Bunn, DECAM, Ft. Carson Army Installation); on-site assistance was provided by M. Klavetter and D. Sharps. We thank Tim Warfel for alerting us to photographic documentation of *A. neotesselata* at Chico Basin Ranch, and Duke Phillips and Michael Moon for permission to conduct research on that property. The Colorado State University survey efforts conducted by Celina Bycenski, Devin Jacobs, Jake Milford, Molly Parren, Ed Schmal, Melissa Thompson, and Beth Wittmann were enhanced by valuable advice provided by Cameron Aldridge and Larissa Bailey. Funding for that effort was provided under a competitive State Wildlife Grant in cooperation with the U.S. Fish and Wildlife Service's Wildlife and Sport Fish Restoration Program, Colorado Parks and Wildlife, Texas Parks and Wildlife, Colorado State University, Colorado State Land Board, and the U.S. Geological Survey. We thank Robert Day for facilitating access to Fort Carson for the Colorado State University survey crews. We are grateful to Steve Wilcox for assistance in the field and technical assistance in preparing Fig. 3. We appreciate the careful reviews of the manuscript provided by William B. Neaves, Charles J. Cole, and K. M. Canestorp.

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Appendix 1

Morphological meristic characters: **L-breaks**: bilateral count of number of dark disruptions (breaks) in the pale lateral stripe. Pale scales in the stripe may accumulate melanin during ontogeny to form localized transverse bridges between dark fields (Taylor et al. 2003). **COS**: bilateral total of circumorbital scales. **FP**: sum of femoral pores on both thighs. **GAB**: number of granular dorsal scales in a single row around midbody. The third ventral row of enlarged ventral scales, lateral to the mid-sagittal line, terminates anteriorly in the axillary region. The 15th ventral scale posterior to this terminus established the point for beginning the GAB count. **SPV**: number of scales separating clear medial margins of paravertebral stripes as close as possible to the counting position for GAB. **LSG**: bilateral total of number of lateral supraocular granules. These granular scales are located between the supraoculars and superciliary scales, and the count includes all scales anterior to a line extended from the suture line between the third and fourth supraoculars. **SDL**: number of subdigital lamellae on the fourth toe of one foot (right was chosen unless damaged).

Appendix 2

Reference samples of *Aspidoscelis neotesselata* assembled in 1998, and 2002–2006. HLT numbers = Regis University numbers. UTM coordinates are based on GPS datum WGS84. (1) *A. neotesselata* A1: Colorado, Pueblo County, Pueblo Nature Center (UTM 13S 528035E, 4235693N): HLT 53–74, 102, 104, 180–184; N = 29. (2) *A. neotesselata* A2: Colorado, Fremont County, several sites north of Florence including (13 S 490238E, 4250759N: southernmost site) and (13 S 490785E, 4251693N: northernmost site): HLT 85–93, 96, 98–101, 105, 106, 108–115, 190–192; Sixmile Park, Indian Springs Ranch (UTM 13S 488250E, 4261108N) : HLT 94, 95, 193–197; N = 34 (pooled). (3) *A. neotesselata* D: Colorado, Otero County: La Junta (UTM 13S 628661E, 4206010N): RU 02090, 98083, 98084, HLT 333, 335–348; N = 18. (4) *A. neotesselata* pattern class B2: Colorado, Pueblo County: U.S. Army Pueblo Chemical Depot. Found at several localities adjacent to Chico Creek, including: (13S 554931E, 4235951N: southernmost site) and (13S 554644E, 4238113N: northernmost site): HLT 1–6, 11–14, 18–22, 33–38, 107, 133–136, 178, 179; N = 28.

Appendix 3

New distribution records of *Aspidoscelis neotesselata*. HLT numbers = Regis University numbers. UTM coordinates are based on GPS datum WGS84.

Locations documented by voucher specimens: **Teller County:** Shelf Road north of Cañon City: HLT 399 (UTM 13S 480638E, 4279276N); HLT 400 (480320E, 4279645N); HLT 401 (480483E, 4279391N), Pattern class A, collected by Lauren Livo, Steve Wilcox, and Harry Taylor on 21 August 2014. **El Paso County**: Fountain Creek Nature Center (13S 524574E, 4284921N): HLT 396, Pattern class A, collected by HLT on 18 July 2014; HLT 397, Pattern class A and HLT 398, Pattern class D, collected by Lauren Livo, Steve Wilcox, and Harry Taylor on 15 August 2014.

Other locations (order of information for each set of coordinates: UTM Zone, Easting, Northing, Elevation, Evidence, Observer): **El Paso County:** Pattern class A: Fountain Creek Nature Center (13S 524584E, 4284914N, 1708m, Photo, D.E.); Fountain Creek Regional Park (13S 523913E, 4285600N, 1711m, Photo, W.R.M.; 13S 524649E, 4284668N, 1706m, Photo, W.R.M.); Ft. Carson Army Base (13S 505111E, 4267384N, 1887m, Sight, *; 13S 505700E, 4266964N, 1876m, Sight, *; 13S 506399E, 4268921N, 1926m, Sight, *; 13S 506413E, 4264709N, 1819m, Sight, *; 13S 506431E, 4265124N, 1836m, Photo, *; 13S 506446E, 4264425N, 1820m, Sight, *; 13S 506450E, 4265039N, 1837m, Sight, *; 13S 506488E, 4265110N, 1829m, Sight, *; 13S 506820E, 4267141N, 1880m, Sight, *; 13S 507022E, 4267605N, 1888m, Photo, *; 13S 507597E, 4267596N, 1881m, Sight, *; 13S 507647E, 4266417N, 1871m, Sight, *; 13S 511247E, 4263852N, 1823m, Photo, *; 13S 511254E, 4263754N, 1839m, Sight, *). **Fremont County:** Pattern class A: Ft. Carson Army Base (13S 504459E, 4252913N, 1614m, Sight, *; 13S 504555E, 4252482N, 1600m, Sight, *; 13S 504590E, 4260876N, 1793m, Photo, *; 13S 504591E, 4252452N, 1603m, Sight, *); Pathfinder Regional Park (13S 486880E, 4251652N, 1579m, Photo, W.R.M.); Shelf Road (13S 480107E, 4271286N, 1872m, Photo, L.J.L.; 13S 480736E, 4270478N, 1897m, Photo, D.R.; 13S 480938E, 4264888N, 1761m, Photo, H.T., L.J.L.). **Pueblo County:** Pattern class A: Ft. Carson Army Base (13S 505458E, 4255581N, 1773m, Sight, *; 13S 505497E, 4255618N, 1754m, Sight, *; 13S 505659E, 4255386N, 1723m, Sight, *; 13S 505659E, 4255424N, 1720m, Sight, *; 13S 505874E, 4255492N, 1758m, Sight, *; 13S 505882E, 4255482N, 1757m, Sight, *; 13S 505948E, 4255340N, 1750m, Sight, *; 13S 506203E, 4255160N, 1704m, Sight, *; 13S 506283E, 4256486N, 1770m, Sight, *; 13S 507326E, 4258077N, 1772m, Sight, *; 13S 507420E, 4260184N, 1776m, Sight, *; 13S 507954E, 4258496N, 1767m, Sight, *; 13S 508009E, 4256528N, 1718m, Sight, *; 13S 508265E, 4262876N, 1792m, Sight, *; 13S 508536E, 4259117N, 1769m, Sight, *; 13S 511466E, 4255929N, 1697m, Sight, *; 13S 511480E, 4256480N, 1733m, Sight, *; 13S 511779E, 4256234N, 1721m, Photo, *; 13S 512113E, 4255492N, 1686m, Photo, *; 13S 512582E, 4255657N, 1718m, Photo, *; 13S 513715E, 4254481N, 1664m, Sight, *; 13S 513819E, 4258191N, 1792m, Sight, *; 13S 515233E, 4254918N, 1679m, Sight, *; 13S 515314E, 4254834N, 1677m, Sight, *; 13S 516997E, 4253838N, 1738m, Sight, *; 13S 519674E, 4253475N, 1664m, Sight, *; 13S 519713E, 4253874N, 1664m, Sight, *; 13S 521564E, 4253076N, 1671m, Sight, *; 13S 522358E, 4259302N, 1750m, Sight, *; 13S 522370E, 4259328N, 1749m, Sight, *; 13S 522408E, 4256672N, 1717m, Sight, *); Lake Pueblo State Park (13S 523427E, 4234087N, 1502m, Photo, L.J.L.; 13S 524414E, 4235801N, 1449m, Photo, L.J.L.; 13S 524937E, 4236027N, 1446m, Photo, L.J.L.; 13S 526848E, 4234657N, 1438m, Photo, W.R.M.); Pattern class B: Chico Basin Ranch (13S 544539E, 4258617N, 1556m, Sight, T.P., A.E.; 13S 548568E, 4261673N, 1539m, Photo, W.R.M.; 13S 550641E, 4255880N, 1489m, Photo, W.R.M.; 13S 550877E, 4245784N, 1453m, Photo, C.B.; 13S 551158E, 4245521N, 1449m, Photo, D.M.; 13S 551176E, 4245559N, 1449m, Photo, B.W.; 13S 552293E, 4248083N, 1472m, Photo, C.B.; 13S 552552E, 4248139N, 1460m, Photo, E.S.; 13S 552646E, 4248172N, 1449m, Photo, C.B.). **Teller County:** Pattern class A: Shelf Road (13S 480394E, 4279433N, 2090m, Sight, L.J.L.; 13S 480534E, 4279383N, 2093m, Sight, L.J.L.; 13S 480729E, 4279916N, 2143m, Sight, D.R.).

* Individuals reporting observations of *A. neotesselata* on Ft. Carson Army Base include: Richard Bunn, Chris Caris, Rick Clawges, Bobby Day, April Estep, Michael Christine Farrell, Danny Follett, Raquel Levya-Lander, Daniel Martin, Jake Milford, Nina Nedrow, Erin Parks, Tracy Perfors, and Beth Wittmann. Observers at other localities: Celina Bycenski (C.B.), Don Erickson (D.E.), April Estep (A.E.), Lauren J. Livo (L.J.L.), William R. Maynard (W.R.M.), Daniel Martin (D.M.), Tracy Perfors (T.P.), Dick Roth (D.R.), Ed Schmal (E.S.), Harry Taylor (H.T.), and Beth Wittmann (B.W.).