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DWARF POPULATIONS OF RUBBER BOAS (*CHARINA BOTTAE*) IN SOUTHERN CALIFORNIA

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Abstract—A 1993–1997 study of the southern rubber boa (*Charina bottae umbratica*) in the San Bernardino Mountains identified the local population as dwarf forms. We identified four additional populations of northern rubber boa (*C. b. bottae*) that are also of this dwarf phenotype. All dwarf-morph populations cluster together in southern California. We suggest other dwarf populations occur in the same region but lack adequate samples for verification.

Resumen—Un estudio de 1993–1997 acerca de la boa *Charina bottae umbratica* en las montañas de San Bernardino identificó la población local como forma enana. Identificamos cuatro poblaciones adicionales de la boa *C. b. bottae* que son también de este fenotipo enano. Todas las poblaciones de tipo enano están agrupadas en la región del sur de California. Sugerimos que otras poblaciones enanas existen en la misma región, pero carecemos de muestras adecuadas para verificar.

Despite having a large distribution in California, rubber boas (*Charina bottae*) have rarely been the subject of research in the state. In the Sierra Nevada Mountains, Hoyer (2015) has documented the species south of Sequoia National Park in the Greenhorn Mountains and across the southern Kern Plateau in Tulare and Kern counties. Just south of the Kern Plateau, the species occurs in the Scodie Mountains (Hoyer, 2015), Piute Mountains (Hansen and Uptain, 1984), Breckenridge Mountain (Rodriguez-Robles et al., 2001), and Tehachapi Mountains (Stewart, 1977) in Kern County. Farther south and west of Tejon Pass in the Los Padres National Forest, researchers have documented rubber boas on Mount Abel (Hoyer and Stewart, 2000*b*), Mount Pinos (Stewart, 1977), and Frazier Mountain (Hoyer, 2015) in Kern and Ventura counties. In 1943, wildlife biologists did not know that rubber boas occurred south of Carmel in the Coast Range of Monterey County, California, nor south of Sequoia National Park in the Sierra Nevada Mountains (Klauber, 1943). Since then, in Coastal California, researchers have observed the species farther south in the Santa Lucia Mountains of Monterey County (Burger, 1952; Rodriguez-Robles et al., 2001) and at Trish Hills in San Luis Obispo County (Schubert, 2011).

The idea that the southern rubber boa subspecies might be dwarf forms of the rubber boa arose from information received from Glenn Stewart in 1973 on 1 live and 20 vouchered specimens in which total lengths ranged from 235 to 455 mm (G. Stewart, pers. comm.). A similar sample of rubber boas from northwestern Oregon likely would contain one or more specimens in excess of 550–600 mm (Hoyer, 1974). A published note dealing with southern rubber boa taxonomy also indicated that smaller sizes were consistent among rubber boas of the San Bernardino Mountains and that they likely represent a dwarf form (Erwin, 1974). Because of geographical proximity, other regions in southern California likely have populations of the dwarf form of rubber boa, including Mount Abel, Sawmill and Grouse mountains west of Mount Pinos, the Piute and Scodie mountains east of Breckenridge Mountain, the southern Greenhorn Mountains north of Breckenridge Mountain, and the San Jacinto Mountains southeast of the San Bernardino Mountains.

An initial study, focusing on the southern subspecies (*C. b. umbratica*), took place in the San Bernardino Mountains from 1993 to 1997 (Hoyer and Stewart, 2000*a*, 2000*b*). The objectives were to (1) record information on aspects of life history, (2) determine if the southern rubber boa was a dwarf form of the species, (3) assess relative abundance, and (4) record information relating to taxonomy (Hoyer and Stewart, 2000*a*, 2000*b*). This study continues that work and focuses on other rubber boa populations in southern California that have never been the subject of investigation. During the course of this study, we encountered potential populations of the dwarf rubber boa.

Rubber boa taxonomy has always been uncertain but recent developments have attempted to address the issue. Molecular (mtDNA) studies place all rubber boa popu-

lations into southern and northern clades (Rodriguez-Robles et al., 2001). The southern clade was composed of the two southern rubber boa populations in the San Bernardino and San Jacinto mountains with all other tested populations belonging to the northern clade (Rodriguez-Robles et al., 2001). Rodriguez-Robles et al. (2001) estimated that the two clades were isolated from 12.3 to 4.4 million years ago. A second mtDNA study identified the boa population in the south of the Sierra Nevada Mountains as nesting within the southern clade. This third southern clade population in the southern Kern Plateau is over 160 km from the other two southern clade populations (Toshima, 2011). Dwarf-morph populations occur in both northern and southern clades and are isolated from one another by unsuitable environmental conditions at lower elevation (Rodriguez-Robles et al., 2001). In lieu of pending taxonomic changes, data on new populations, especially taxonomically significant dwarf forms, are pertinent to a better understanding of the species in its entirety.

Historically, wildlife biologists have considered rubber boas rare, despite a wide distribution in western North America. In 1971 the California Department of Fish and Wildlife (formerly California Department of Fish and Game) listed the southern rubber boa as Rare (Threatened) based on the opinions of a panel of herpetologists and wildlife biologists (California Department of Fish and Wildlife, 2005). In 1980, the Threatened status of the southern rubber boa was reaffirmed by a 5-year review (California Department of Fish and Wildlife, 1994). Erwin (1974) also considered southern rubber boas to be rare. However, wildlife biologist have performed few sampling efforts to support the perception of rarity.

Some sampling efforts indicated at least some strong pockets of southern rubber boa. Data recorded on all species of snakes encountered in the San Bernardino Mountains from 1,700 m and above indicated that, instead of being rare, southern rubber boas are likely the most numerically abundant snake (Cunningham, 1966; Hoyer and Stewart, 2000*a*). The position gained support during a 1-day search in 2001 for the California mountain kingsnake (*Lampropeltis getula californiae*) in the San Bernardino Mountains. Of 25 specimens in five snake species, 19 were southern rubber boas (Hoyer, 2015). Contrary to the perception of rarity, researchers considered the species to be common in parts of Washington (Lewis, 1946), and in California (Ross, 1931). The publication of a sample of 338 live specimens in Oregon (Hoyer, 1974), which increased to 1,167 live specimens by 1990 (Hoyer and Storm, 1992), further dispelled the notion of rarity.

Materials and Methods—*Site Selection*—To assess the relationship between a southern rubber boa population in the San Bernardino Mountains and populations of the species elsewhere in southern California, beginning in April 1996, we visited regions known or suspected to have populations of rubber boas. Regions visited included the San Jacinto Mountains in Riverside County; the San Gabriel and Sawtooth mountains in Los Angeles County; Trish Hills in San Luis Obispo County; Mount Pinos, Mount Abel, Frazier Mountain, Alamo Mountain, and the San Emigdio Ridge in Ventura and Kern counties; the Tehachapi Mountains, Breckenridge Mountain, Piute Mountains, and Scodie Mountains in Kern County; and the northern and southern Greenhorn Mountains and the southern Kern Plateau in Kern and Tulare counties.

We also collected data on large-morph boas from the Mount Saint Helena region of the Mayacamas Mountains where Sonoma, Lake, and Napa counties converge in northern California. In northwestern Oregon, we found boas within 6 km south and 20 km west of Philomath. In the Salem, Oregon, region, we found most specimens within the city limits of southern Salem and within 6 km east of Salem. In southern Oregon, we conducted searches in the Hyatt Lake region.

Because of various constraints (e.g., accessibility, temperature, precipitation), efforts to acquire representative samples became centered in Mount Pinos, the Tehachapi Mountains, Breckenridge Mountain, and the southern Kern Plateau. During the same time period, we acquired information on boa populations of the large morph in various regions of the species' distribution. We used the large-morph rubber boa populations from Hyatt Lake and northwestern Oregon (Hoyer, 1974) for making comparisons with the dwarf-morph populations.

Collection Events—From 1997 through 2018, we conducted searches in southern California mostly from mid-April to mid-May. The duration of searches at any given locality lasted from 1 to 6 days. We searched at more than one locality during each trip from Oregon to California.

Captures—We searched under natural and artificial cover objects as previously described (Hoyer, 1974; Hoyer and Stewart, 2000*a*). We employed a modest amount of artificial cover, mostly discarded carpet placed on rock outcrops, at a few selected sites in the Tehachapi Mountains, Mount Pinos, and Breckenridge Mountain, and at five sites in the vicinity of Hyatt Lake. We employed road cruising at night on the southern Kern Plateau and on Mount Pinos. We recorded capture date, elevation, global positioning system coordinates, weights (g), total and tail lengths (mm), presence/absence of pelvic spurs, coloration (body, eye, pelvic spurs), scale counts (caudal, ventral, middorsal), head scale configurations, and presence or absence of tail tip injury (Hoyer, 1974; Hoyer and Stewart, 2000*a*). The information recorded on head and body scalation features serves as a natural tagging system which allows the identification of recaptured specimens (Hoyer, 1974). In that manner, we avoided duplications during searches made from one year to the next.

Size/Age Classes—We defined three size/age classes of juveniles, subadults, and adults for all boa populations. Because all dwarf-morph populations are similar, we used the same size/age classes for those populations. To obtain consistent and reliable results, we used the "stretch" technique for obtaining total and tail lengths. This method involves pinning the tail with one hand and repeatedly stretching the snake until obtaining the greatest length (Hoyer, 1974). For some live specimens, this method requires patience until the snakes become calm and then relax. This method, also used for preserved specimens, has

proven to be consistently more reliable than other methods for small, live snakes (Hoyer, 1974).

The juvenile class included specimens considered to be approximately 1 year or younger in age. We chose the upper limits of the juvenile class on the basis of the largest neonate recorded from all of the identified dwarf-morph populations and the largest neonates recorded for each of the two large-morph populations. We established the lower limits of males and females classed as adults by observing the smallest males that exhibited courtship behavior and the smallest females that contained ova. The subadult male and female classes ranged between the upper limits of the juvenile class to the lower limits of the adult male and female classes.

To determine if a boa was in breeding condition, we placed newly captured, small males in 75-L aquaria with one or two females in reproductive condition. The aquaria had suitable hides so the boas had a sense of security. Upon encountering females, most mature males will exhibit courtship behavior almost immediately. For some males, we needed more trials, and repeated the above process for up to four consecutive days. If males failed to court, we could not be certain they were not sexually mature. We established the lengths of the smallest adult males that did exhibit courtship behavior. We performed all captures and retentions in compliance with permits obtained from the California Department of Fish and Wildlife, and released all snakes where found for possible subsequent recapture events.

There are at least two possible caveats to these methods. First, it would be presumptuous to believe we actually found the smallest adult male and smallest adult female that has ever reached mature status in these dwarf populations. Secondly, neonates and juveniles released in the wild and later recaptured can reach maturity at various ages and lengths, for both sexes (R.F.H., pers. observ.). In that respect, these two caveats probably offset one another for establishing the lower limits of these size and age classes.

Size Comparisons—The criteria used for making size comparisons included (1) smallest recorded lengths at which males and females reach mature status; (2) range, mean, and maximum lengths of adult males and females; and (3) range, mean, and maximum lengths and weights of neonates. All dwarf-morph populations occur at an elevation of about 1,500 m and higher, whereas large-morph populations occur from sea level to higher elevations in mountainous terrain. We compared the combined data from the five dwarf-phenotype populations with a northwestern Oregon boa population found at elevations from 75 to 200 m. We made a second comparison with the large-morph population found near Hyatt Lake, where specimens were collected between 1,500 and 1,600 m.

Statistical Analysis—We performed statistical analysis using analysis of variance. We examined significant effect with a Tukey post hoc procedure. Tukey post hoc analysis enables us to identify where we found differences in the data and which populations group together. We performed analysis in Excel. Our alpha value was 0.05.

RESULTS—*Captures and Size/Age Classes*—We found representative samples of rubber boas in five regions in southern California and found smaller samples at six other regions (Fig. 1; Table 1). We caught more females as subadults and more males as adults (Table 1). In earlier studies, Hoyer (1974) also found this pattern in age classes to be true.

The similar range of lengths for captured specimens for the five boa populations in southern California support the position that the dwarf rubber boa occurs on Mount Pinos, the Tehachapi Mountains, Breckenridge Mountain, and the southern Kern Plateau as well as where researchers first documented them in the San Bernardino Mountains (Table 2). Although the male boas in the southern Kern Plateau were significantly smaller than the other populations ($P = 0.023$) and the females on Mount Pinos were significantly larger than other populations in southern California ($P = 0.015$), the females were larger than males in all populations ($P = 0.00012$; Hoyer, 1974).

For these five dwarf morph rubber boa populations, the smallest males that exhibited courtship behavior measured 352 mm (southern Kern Plateau and San Bernardino Mountains), 340 mm (southern Kern Plateau), and 333 mm (Tehachapi Mountains). The smallest females that palped ova or produced litters measured 454 mm (Tehachapi Mountains), 445 mm (San Bernardino Mountains), 441 mm (Breckenridge Mountain), 438 mm (San Bernardino Mountains), and 435 mm (southern Kern Plateau).

For the boa populations in northwestern Oregon, adult males ranged from 454 to 638 mm, and adult females ranged from 546 to 781 mm (Table 3; Hoyer, 1974). We based the lower limits of adult females from Hyatt Lake on two females of 540 mm that possessed ova or produced a litter. The range of female lengths at Hyatt Lake was 540–692 mm. We estimated the lower limits of adult males from Hyatt Lake to be 438 mm. Therefore, the range of adult male lengths was 438–543 mm.

We compared the range and mean adult lengths between the combined five dwarf morph boa populations from southern California (Table 2) and the two Oregon larger-morph boa populations. There was significant size difference between all populations with the southern California population being smallest and the northwestern Oregon population being the largest ($P = 0.0032$; Table 3). Female boas were significantly larger than males in all populations.

We compared neonate lengths and weights between the boa population in southern California and the combined data on neonates from Mount Pinos, the Scodie Mountains, and the southern Greenhorn Mountains, because the low numbers did not allow statistical analysis individually (Table 4). There are three size groupings that are statistically significant ($P = 0.008$) among neonate males. The southern Kern Plateau boas are the smallest, followed by those from the San Bernardino Mountains and Breckenridge Mountain. The largest sizes come from the Tehachapi Mountains and the combined Mount Pinos, Scodie Mountains, and the southern Greenhorn Mountains (Table 4). For females there are only two groupings with statistical

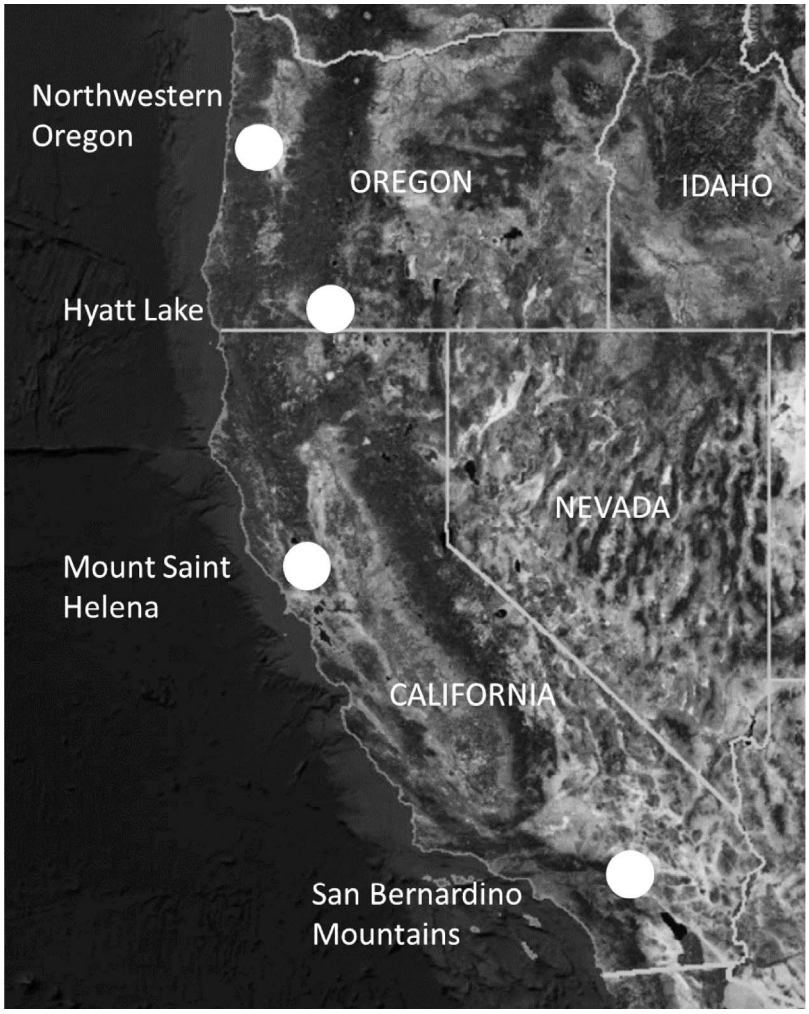

FIG. 1—The three primary regions where we made size comparisons of rubber boas. We sampled large-morph boas in Oregon and small-morph boas in southern California, around the San Bernardino Mountains. We made additional measurements at Mount Saint Helena, for a possible intermediate boa population.

TABLE 1—Summary table of samples of the dwarf-morph rubber boa populations by size and age classes, plus data on six other populations. Juveniles: <230 mm; subadult males: 230–332 mm; subadult females: 230–434 mm; adult males: >332 mm; adult females: >434 mm.

	No. of juveniles		No. of subadults ($P = 0.016$)[a]		No. of adults ($P = 0.018$)[a]		
	Males	Females	Males	Females	Males	Females	Total
San Bernardino Mountains	5	5	0	9	53	37	109
Southern Kern Plateau	2	0	6	7	12	5	32
Breckenridge Mountains	6	2	4	16	40	17	85
Tehachapi Mountains	1	2	1	9	47	19	79
Mt. Pinos	7	6	6	12	22	15	68
Mt. Abel	1	0	0	1	1	0	3
Frazier Mountain	0	0	0	1	1	0	2
Piute Mountains	0	0	0	0	1	0	1
Scodie Mountains	0	0	0	0	0	1	1
S. Greenhorn Mountains[b]	0	0	0	0	10	3	13
N. Greenhorn Mountains[c]	1	1	2	2	3	7	16
	23	16	19	57	190	104	409

[a] Statistical significance, $P < 0.5$.
[b] South of Alta Sierra.
[c] North of Alta Sierra.

TABLE 2—Range, maximum, and mean adult lengths of captured specimens for five dwarf-morph rubber boa populations in southern California, based on the smallest courting male (333 mm) and smallest female with ova (435 mm).

	Adult males			Adult females[a,b]		
		Length (mm)			Length (mm)	
	n	Range	Mean	*n*	Range	Mean
San Bernardino Mountains	53	352–479	403.6	36	438–549	485.6
Southern Kern Plateau	12	337–454[a]	380.2	5	435–521	489.8
Breckenridge Mountains	40	333–467	406.3	17	438–508	473.9
Tehachapi Mountains	47	333–495	427.9	18	454–543	498.8
Mt. Pinos	22	365–470	415.6	15	438–573[a]	512.2

[a] Statistical significance, $P < 0.05$.
[b] Includes two groups that were identified in the Tukey test.

TABLE 3—Range and mean adult lengths for rubber boa populations from southern California, northwestern Oregon, and Hyatt Lake, Oregon, populations.

	Adult males			Adult females[a,b]		
		Length (mm)			Length (mm)	
	n	Range	Mean	*n*	Range	Mean
Five dwarf populations	174	333–495[a]	410.7	91	435–573[a]	490.6
Hyatt Lake, Oregon	105	438–543[a,b]	479.7	66	540–692[a,b]	599.1
NW Oregon	153	454–638[a,c]	534.6	135	546–781[a,c]	650.9
Mt. St. Helena region	6	454–489[a,b]	470.0	3	549–578[a,b]	566.3

[a] Statistical significance, $P < 0.05$.
[b] Includes two groups that were identified in the Tukey test.
[c] Includes three groups that were identified in the Tukey test.

TABLE 4—Range and mean of the lengths and weights of dwarf morph neonates of rubber boas in southern California. The three combined populations are Mount Pinos, Scodie Mountains, and southern Greenhorn Mountains. Due to the lack of numbers we combined them for statistical analysis.

		Size (mm)		Weight (g)	
	n	Range	Mean	Range	Mean
Neonate males					
San Bernardino Mountains	18	178–211[a]	195.7	3.9–5.4	4.7
Breckenridge Mountains	8	175–213[a]	191.3	4.4–7.3	5.7
Southern Kern Plateau	7	168–206[a,b]	185	4.4–6.6	5.3
Tehachapi Mountains	16	184–225[a,c]	210.4	5.0–7.7	6.3
Combined 3 populations (low no.)	12	181–229[a,c]	208.9	4.5–7.3	6.2
Mt. Pinos	2	213–229	221	6.1–7.3	6.7
Scodie Mountains	3	206–213	209.7	5.5–6.1	5.8
S. Greenhorn Mountains	7	181–213	193.7	4.5–6.3	5.7
Neonate females					
San Bernardino Mountains	28	171–216[a]	196.4	4.0–5.7	4.7
Breckenridge Mountains	6	181–203[a]	189.8	4.2–5.6	4.9
Southern Kern Plateau	10	159–203[a]	187.3	5.1–7.0	5.8
Tehachapi Mountains	20	171–222[a,b]	206.6	5.1–7.2	6.2
Combined 3 populations (low no.)	7	197–222[a,b]	213.2	4.5–7.4	6.3
Mt. Pinos	4	211–222	217	6.0–7.4	6.7
Scodie Mountains	2	206–213	209.5	5.5–6.3	5.9
S. Greenhorn Mountains	1	197	197	4.5	4.5

[a] Statistical significance, $P < 0.05$.
[b] Includes two groups that were identified in the Tukey test.
[c] Includes three groups that were identified in the Tukey test.

TABLE 5—Range and mean of the lengths and weights of neonate rubber boas from seven dwarf-morph populations from California and two large-morph populations from Oregon.

		Size (mm)		Weight (g)	
	n	Range	Mean	Range	Mean
Neonate males					
Combined dwarf morph	61	168–229[a]	202.2	3.9–7.7	5.8
Hyatt Lake large morph	105	197–254[a,b]	233.8	4.9–9.8	7.2
NW Oregon large morph	576	191–309[a,c]	256	4.2–14.6	8.1
Mt. St. Helena Region	17	184–248[a]	204.2	3.8–7.7	5.9
Neonate females					
Combined dwarf morph	71	171–222[a]	202.8	4.0–7.4	5.8
Hyatt Lake large morph	90	197–260[a,b]	236.7	4.4–10.6	7.3
NW Oregon large morph	685	197–302[a,c]	256.8	4.2–16.1	8.2
Mt. St. Helena region	9	191–235[a]	213.9	5.3–7.3	6.2

[a] Statistical significance, $P < 0.05$.
[b] Includes two groups that were identified in the Tukey test.
[c] Includes three groups that were identified in the Tukey test.

significance. The smallest female sizes come from the southern Kern Plateau, San Bernardino Mountains, and Breckenridge Mountains. The largest female sizes come from the Tehachapi Mountains and the combined Mount Pinos, Scodie Mountains, and southern Greenhorn Mountains (Table 4).

We compared the combined mean lengths and weights of neonates from all seven dwarf-morph populations ($n = 37$) with the same data for the large-morph populations from Hyatt Lake ($n = 57$) and northwestern Oregon ($n = 378$; Hoyer and Storm, 1992). Similar to adult populations, the southern California neonates are the smallest sized populations, followed by Hyatt Lake, and the largest sizes are in northwestern Oregon (Table 5).

In the Mount Saint Helena region, from a sample of 11 males and 3 females, the largest male from that population measured 508 mm and 2 females measured 578 and 594 mm, all being somewhat larger than the maximum lengths recorded for males and females of all dwarf-morph populations. Neonates from seven litters derived from two females from the Mount Saint Helena region had a mean length of 207.5 mm ($n = 26$). The lengths of 22 neonates fall within the range of dwarf morph neonates; however, four neonates of 235, 235, 237, and 248 mm are larger than the largest recorded dwarf neonate of 229 mm ($n = 129$).

DISCUSSION—The original perception of southern rubber boa rarity was based on the paucity of encounters in the field and few vouchers in institutional collections (G. Stewart, pers. comm.). The evidence does not support the notion that southern rubber boas or other populations of the species are rare. The frequency of encounters in our own study, as well as support from other studies (Ross, 1931; Lewis, 1946; Cunningham, 1966; Hoyer, 1974, 2015; Hoyer and Storm, 1992; G. Keasler, in litt.) strongly indicates that rubber boas are common throughout their range. Because researchers know perceptions and opinions to be unreliable and that they cannot be construed as if factual, the use of such subjective information in research and related endeavors is neither professional nor ethical (Hoyer, 2007).

Our current knowledge at the present time suggests that the large morph occurs throughout the remainder of the species' distribution in North America. The lengths of adult boas in large-morph populations significantly exceed the maximum lengths of the dwarf-morph populations. For instance, we have recorded females in excess of 660 mm for almost all large-morph boa populations (R.F.H., pers. observ.) from vouchered and live females. The exception is the boa population that occurs in the Mount Saint Helena region (Fig. 1). The lengths of adults and neonates from that region suggest that we might consider the population as semi-dwarf or a small race of the large morph.

The discovery of several populations of this dwarf rubber boa form, all clustered in southern California, has taxonomic implications. With populations of the dwarf morph all clustered together in southern California, Hoyer (2015) has suggested that the two size morph populations might represent subspecies but, despite distinct differences between the two size morphs, they should not be considered separate species. The dwarf phenotype occurs in both the northern and southern clades (Rodriguez-Robles et al., 2001; Toshima, 2011) and all rubber boas are superficially identical in physical appearance throughout the species' distribution (Nussbaum et al., 1983; St. John, 2002; Stebbins, 2003). Boas of any population intergrade readily in captivity, suggesting the absence of any reproductive isolation. Thus, the two size morphs probably intergrade in the Sierra Nevada Mountains (Greenhorn Mountains and southern Kern Plateau) where continuous suitable habitat occurs unbroken between their constituent populations. Additionally,

Fig. 2—Search areas for rubber boas in southern California. The known range, including the San Bernardino and San Jacinto mountains, indicates areas we already knew to have southern rubber boas. The extended range from the San Emigdio Mountains to the Kern Plateau indicates where we found rubber boas for this study. We searched the darker possible range, encompassing the Sawtooth and San Gabriel mountains, but found no boas.

adult rubber boas in all populations exhibit a high incidence of tail tip scarring that mostly occurs when female small mammals trying to defend their young attack these snakes (Hoyer, 1974; Hoyer and Stewart, 2000*a*). This indicates that behavioral traits are also uniform across the entire distribution.

The populations where researchers have confirmed the dwarf morph to occur in the San Bernardino Mountains, Mount Pinos, the Tehachapi Mountains, and Breckenridge Mountain exist on "sky islands." They are isolated by habitat at lower elevations that is not suitable for the species' survival. That also pertains to the suspected dwarf-morph populations in the San Jacinto Mountains, Piute Mountains, Scodie Mountains, and Frazier Mountain. Continuous suitable habitat exists between Mount Pinos and Mount Abel but that group of peaks is isolated as well. Only in the Sierra Nevada Mountains is suitable boa habitat continuous from south to north. Those regions are the Greenhorn Mountains that represent the western edge of the Sierras and the broad Kern Plateau to the east of the Greenhorn Mountains across the North Fork Kern River gorge.

So, where a suspected dwarf-morph population occurs south of Alta Sierra in the southern Greenhorn Mountains, there is continuous boa habitat north of Alta Sierra into the main Sierras where researchers know the large morph to occur. The same situation applies to the Kern Plateau, where a dwarf-morph population occurs in the southern part of the Kern Plateau (Fig. 2). From that region northward in the Sierras to Oregon and beyond, there is continuous boa habitat. Somewhere in Tulare County, and in Inyo County on the eastern slopes of the Sierras, the two size morphs must meet.

Because suitable habitat for the species is continuous in the main Sierras from south to north, one size morph might be displacing the other. If the constituent populations are static, what genetic factors have retained the integrity of the two size morphs? Future studies could address which of the two size morphs is ancestral or if they arose from a common ancestor, now extinct, and what factors selected for, and perpetuated, the difference in size. Where the two size morphs do occur in the Sierra Nevada Mountains, the populations might be parapatric or sympatric. What genetic factors have kept the two size morphs distinct? Specific selective advantages probably exist for each size morph, such as climate or topography, given the geographical gradient of dwarf morphs. We do not know if the dwarf-morph populations belonging to the southern and northern clades are because of the same or different genes. The mutations producing the dwarf phenotype might have occurred more than once.

To possibly determine the northern extent of the dwarf morph in the Greenhorn Mountains, we recorded data on 2 boas found west of Johnsondale and 14 boas found north of Alta Sierra (Fig. 1; Table 1). Some of the lengths and scalation features indicate those boas are either members of the large-morph phenotype or represent intergrades between the two size morphs. The midbody dorsal scale counts mostly align with the northern rubber boa large-morph subspecies and two adult females exceed the largest dwarf population female by 25 and 26 mm. Although this article does not cover scalation patterns, there is a need for a study that focuses on these patterns to identify possible range movements. This unpublished scalation pattern strongly suggests that the morphological traits used to separate northern and southern subspecies are invalid (R.F.H., pers. observ.) and, with the identification of new dwarf populations, the mtDNA studies

(Rodriguez-Robles et al., 2001; Toshima, 2011) might need revisions.

The identification of several dwarf populations of rubber boa has elucidated abundance and distribution data for an enigmatic species. The rubber boa in southern California is far more abundant and widespread than previously thought (Klauber, 1943). Dwarf phenotypes are not restricted to southern or northern clades but are relatively distinct from large-morph populations, casting doubt on previous designations of northern and southern subspecies. Future research on the taxonomy of rubber boas remains pertinent.

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