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Differentiation of Isolated Populations: Two Giant Salamander Species (*Dicamptodon*) East of the Oregon Cascade Mountain Crest, USA

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***Abstract.*—Isolated populations of Cope's (*Dicamptodon copei*) and Coastal (*D. tenebrosus*) Giant Salamanders occur 30–50 km east of the Cascade Mountain crest in northern Oregon, USA. To date, only *D. copei* have been found in the White River basin that emanates from the southern flanks of Mount Hood. At 7.6–11.0 km east of *D. copei*, *D. tenebrosus* only occurs at two localities along the steep and xeric slopes of the Deschutes River canyon: Oak Springs and 4–5 km upriver at Maupin Spring. During surveys conducted from 28 July 2013 to 20 August 2015, we found *D. tenebrosus* at Oak Springs, but not at Maupin Spring or 12 additional sites in the Deschutes River basin. At Oak Springs, larval *D. tenebrosus* were described previously as having unique coloration. The dorsum of older larvae was light tan-brown with "peculiar" scattered yellow dots. We provide the first photographs and measurements of larval *D. tenebrosus* from Oak Springs. Dorsolateral coloration of three large larvae was reddish-brown with cream-yellowish flecks and small blotches that were most prevalent anterior on the dorsum. A large transformed adult was melanistic but had a marbled pattern beneath the outermost dermal layer. Unlike *D. tenebrosus* elsewhere, Oak Springs and Maupin Spring specimens had low fin height, similar to that typical of *D. copei*. The origins of these isolated populations of *D. copei* and *D. tenebrosus* are unknown. They appear to be distinct groups occurring in disjunct, small geographic areas. Their distinctive morphological characters indicate prolonged isolation and they merit conservation action.**

Key Words.—Coastal Giant Salamander; Cope's Giant Salamander; Deschutes River; *Dicamptodon copei*; *Dicamptodon tenebrosus*; White River

Introduction

The Coastal Giant Salamander, *Dicamptodon tenebrosus*, and Cope's Giant Salamander, *D. copei*, occur in coniferous forests in the Pacific Northwest of the United States (Petranka 1998), where they can be major predators in streams (Parker 1994). Larvae and neotenic adults of these two species are similar in appearance in the field (Fig. 1). These species are principally distributed west of the crest of the Cascade Mountains (Fig. 2), although Storm (1966) suggested that *Dicamptodon* may have dispersed eastward from the Cascade Mountain range through the Columbia River gorge and established populations on eastern side of the Oregon Cascades. Nussbaum (1976) reported on populations of *D. tenebrosus* east of the Cascade crest in Oregon at a few sites located in continuously forested areas of the north and northeast slopes of Mount Hood, just south of the Columbia River. In northern Oregon, *D. tenebrosus* occurs at Oak Springs (sometimes called Oak Creek and associated seeps), which are approximately 53 km east of the Cascade crest, Wasco County, Oregon, USA (Fig. 3), and 70 km southeast of known records in the Columbia River gorge (Nussbaum 1976: Nussbaum et al. 1983).

Oak Springs and adjacent headwaters are ≤ 1 km from the Deschutes River (a major tributary of the Columbia River) and flow through a > 200-m wide strip of riparian vegetation (Fig. 4), which is dominated by White Alder (*Alnus rhombifolia*) and Oregon White Oak (*Quercus garryana*) (Nussbaum 1976). The relative oasis of Oak Springs contrasts sharply with adjacent basalt talus in the Deschutes River canyon and upland plains (Fig. 4), which is dominated by Great Basin Sagebrush (*Artemisia tridentata*) and Western Juniper (*Juniperus occidentalis*). Several other isolated seeps and streams emanate nearby within the canyon of the Deschutes River (Fig. 2).

Figure 1. Top: Comparison of live neotenic *Dicamptodon tenebrosus* (Coastal Giant Salamander; left) from Oak Springs Fish Hatchery and *D. copei* (Cope's Giant Salamander; right) from Forest Creek in White River basin, Wasco County, Oregon, USA. Bottom: Dorsal view of same *D. tenebrosus* showing flecking on dorsum. (Photographed by Nick D. Waters).

Nussbaum (1976) described older larvae of *D. tenebrosus* at Oak Springs as plain tan-brown with scattered yellow dots on the back and sides, a unique coloration for the species. Further, Nussbaum (1976) mentioned that some metamorphosed individuals from Oak Springs had a dorsal marbled pattern similar to that of *D. tenebrosus* from the northern portion of the Cascade Range in Washington State. We assume these descriptions of color patterns were based on examination of live salamanders because preserved specimens seldom retain either color or patterns. To our knowledge, neither photographs nor measurements exist of larva or adults from the Oak Springs area; consequently, comparisons of these individuals to other populations in an extensive effort (Nussbaum 1976) are not possible. Recently, Steele and Storfer (2006) found genetic variation in mitochondrial DNA (mtDNA) in *D. tenebrosus*, and identified a Northern Clade consisting of the isolated Oak Springs site, Oregon, and others in the Columbia River gorge and north into Washington State.

Cope's Giant Salamander, *D. copei*, occurs in western Washington, the southern Washington Cascade Mountains, and the northernmost portions of western Oregon (Nussbaum et al. 1983; Foster et al. 2015). Nussbaum (1970) described color in larvae as yellowish tan patches on the dorsum and sides (faint patches of yellowish tan can occur in young *D. tenebrosus* but are more difficult to discern in older larvae). The extensive number of light patches is distinct on the plain ground color in *D. copei* (see Foster et al. 2015). Recently, Steele and Storfer (2007) analyzed mtDNA variation in *D. copei*, including some from the Columbia River gorge and a few from Still Creek, Clackamas County (on the northeast side of Mount Hood) and Boulder Creek, Wasco County, Oregon (on the southeast side of Mount Hood). Although not discussed, the Boulder Creek site is the first published record of *D. copei* appreciably east (approximately 30 km) of the Cascade crest. Recently, Bury et al. (2014) extended the range of *D. copei* another 20 km downstream (to Justensen Ranch) from Boulder Creek. Both sites are tributaries of the White River, a perennial lahar channel that headwaters at Mount Hood. The lower White River flows through a steep canyon (Fig. 3), most of which is public land managed by the BLM. Private ranches

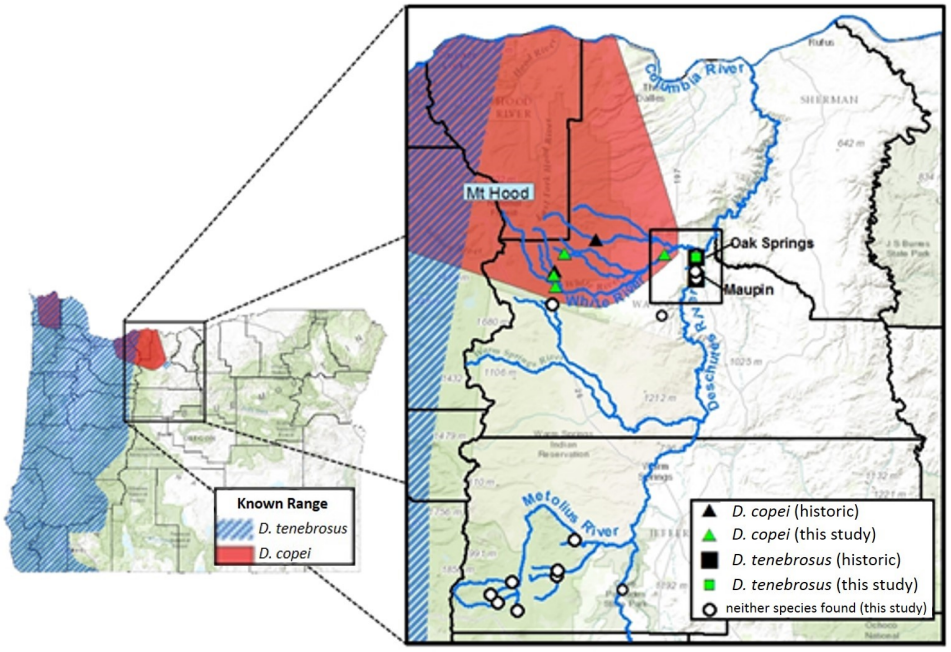

Figure 2. Geographic ranges of the Coastal Giant salamander (*Dicamptodon tenebrosus*) and Cope's Giant Salamander (*D. copei*) in western Oregon, USA. Expanded view shows sampling sites east of the Cascade Mountains. The Deschutes River flows north and empties into the Columbia River. The White, Warm Springs, and Metolius rivers flow in easterly directions into the Deschutes River. Just south of the mouth of the Metolius River, the Crooked River drains a basin east of the Deschutes River.

occur on adjacent open, dry plains or irrigated fields. This new site is only 7.6 km west of Oak Springs, which reportedly has *D. tenebrosus*. Current knowledge of the isolated populations of *Dicamptodon* east of the Cascade crest is based on minimal information of their distribution and distinctiveness. Thus, our objectives are to: (1) summarize the locations of known records, unpublished reports, and new range extensions; (2) identify new material based on known key diagnostic features; and (3) compare their morphology and color.

Materials and Methods

We explored 16 creeks on the east side of the Oregon Cascades and upstream from known sites on the White and Deschutes rivers. We perused topographic, U.S. Forest Service, Bureau of Land Management (BLM) and Google maps for potential waters that were crossed by roads. Fisheries biologists have reported netting one salamander (unknown species) at each of four sites in the Metolius River Recreation Area in the upper Deschutes River basin, approximately 70 km south of Oak Springs (Simon Wray, pers. comm.). These salamander captures were listed in an unpublished report showing capture of > 4,000 fishes by electroshocking techniques. Identification may be suspect because Long-toed Salamanders (*Ambystoma macrodactylum*) and Rough-Skinned Newts (*Taricha granulosa*) occur in the area.

To locate and capture salamanders, we used basic sampling techniques of proven protocols (Bury and Corn 1989). We attempted to search at least one person-hour per site. We measured and photographed each salamander in the field, and we took tissue for genetic analyses (to be reported elsewhere). We employed hand searching with a long-handled dip net placed downstream from a rock or boulder (often in a riffle), and then we moved or lifted the stone so that the current would push uncovered salamanders into the net (Bury and Corn 1989). In shallows, we held pieces (approximately 26 × 40 cm) of hardware cloth with 0.6 cm mesh downstream from turned objects. In quiet pools, one of us (NDW) fished for salamander using a snell-less hook with annelid bait. The snell-less hook allows the salamander to be removed without tearing and poses less risk of esophageal trauma. Typically, a salamander will grab the bait and then can be carefully brought to shore, where it usually releases its hold on the bait without being harmed.

We retained representative vouchers (those salamanders > 65 mm SVL) and deposited most of these at Oregon State University: Museum of Natural History (OSUMNH) and Stevan J. Arnold (SJA) collections. To prepare specimens, we relaxed salamanders in MS222 and placed them in flat containers where they were preserved in 10% formalin (buffered) for 1–2 d. We rinsed the formalin-preserved specimens in water and then transferred them to 70% ethanol for permanent storage.

To identify salamanders, we employed several characters and ratios defined by Nussbaum (1976)

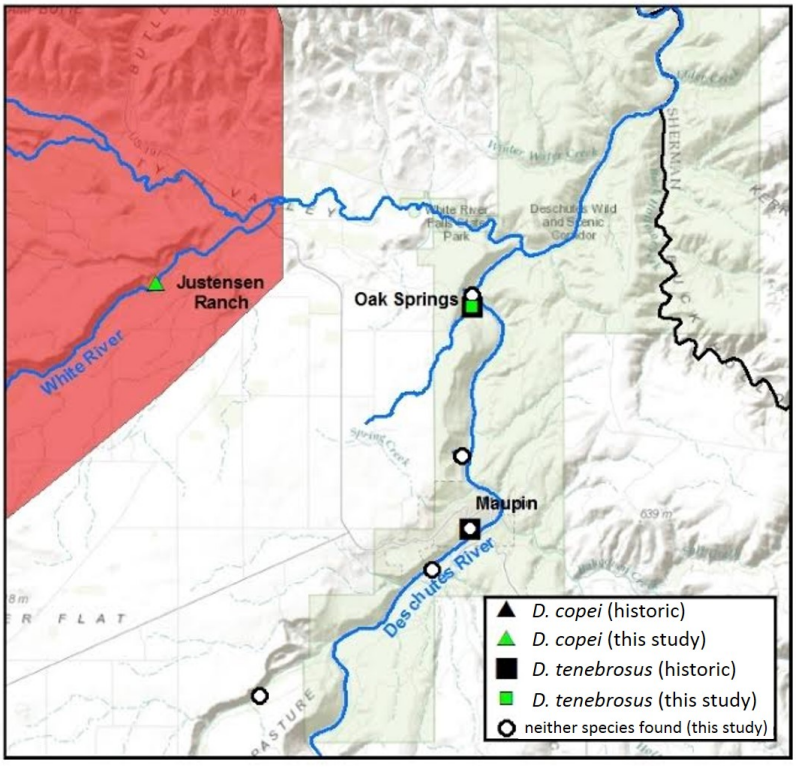

Figure 3. *Dicamptodon copei* (Cope's Giant Salamander) and *D. tenebrosus* (Coastal Giant Salamander) occur in close geographic proximity to each other at the easternmost portion of their ranges: *D. copei* is at Justensen Ranch along the White River (triangle) and *D. tenebrosus* at Oak Springs and Maupin Spring (squares), Oregon, USA.

who analyzed range-wide variation in *D. tenebrosus* (Nussbaum 1970) in support of the description of *D. copei* as a new species. To avoid overlap or similar proportions of ratios in small larvae, Nussbaum (1970) only compared morphology of preserved salamanders with a snout-vent length (SVL, at anterior vent edge) ≥ 65 mm. Besides our material, we examined specimens from the same region at the OSUMNH herpetological collection. Also, we evaluated observations or captures in regional reports by State and Federal agencies (including follow-up interviews with authors) and discussions with local residents.

Results

***Dicamptodon copei* east of the Cascade Mountains**.—In July 2013, we caught eight larvae in a spring and creek (0.4-m wide) on the south side of the White River (see Bury et al. 2014). This is part of the Justensen Ranch, in the lower section of the White River (Fig. 5A). There is one larval specimen (OSUMNH 11508) collected in 1973 from Badger Creek, which flows to the southeast off Mount Hood, and into the White River. Although collected in July 1973, it does not appear to be reported in the literature. Badger Creek is north and somewhat parallel (3 km or more) to the White River. It joins Tygh Creek, and then runs to the White River downstream of the Justensen Ranch. Although cataloged as *D. tenebrosus*, we identify it as *D. copei* based on key features (Table 1). In July 2013, we collected nine larval *Dicamptodon* sp. from three sites in the upper portion of the White River basin (Table 2; Fig. 2): Forest Creek, main stem of the White River, and Gate Creek. All larvae had ratios characteristic of *D. copei* (Table 1) except for one feature (Tail height/SVL) of a single salamander at Justensen Ranch creek.

***Dicamptodon tenebrosus* along Lower Deschutes River**.—Earlier workers collected specimens at Oak Springs on 9 May 1953 (OSUMNH 8504–510). Apparently, Nussbaum (1976) did not include them in his range-wide comparison of variation in the species because of the small size of most specimens. We found only one larvae in this series (OSUMNH 8504) and another (OSUMNH 7225) in a separate group, to be ≥ 65 mm SVL (Table 1).

There is also a series of 14 larvae (MVZ 189440–448; MVZ 192662–666) collected in 1983 (see Good 1989). In July 2013, we caught four larvae at Oak Creek (Fig. 5B), including three large neotenes (SJA 54847-849) that have wide heads characteristic of *D. tenebrosus* (Table 1). We caught these by fishing in a small pool (4 × 6 m) dammed up for water intake to the hatchery). Hand searching of Oak Springs yielded one small individual

Figure 4. View of Deschutes River canyon looking downstream (north), Wasco County, Oregon, USA. Oak Springs Fish Hatchery is on west side (left), where seeps and a small creek flow out of lava basalt deposits to create a large riparian zone. Around the cliff in background (west) is the mouth of White River that originates on Mount Hood. (Photographed by Jason Bracken).

(54 mm SVL) that was not analyzed (tail tip taken and then released alive where found). We searched waters again during August 2013 and June 2014, finding no *Dicamptodon* but observed adult Rough-skinned Newts, Taricha granulosa in ditches at the base of the slopes near rail road tracks (Table 2). During summer of 2014, the biologists at the Oak Springs Fish Hatchery caught and took tissue samples from five larvae for a separate study on genetic variation. All those kept in captivity at the hatchery were in water from Oak Springs and were released where found.

During late August 2013, biologists at Oak Springs Fish Hatchery found an adult *Dicamptodon* on a dirt road next to Oak Springs after a large thunderstorm. They transported the adult to a laboratory for photographs (Fig. 6) and then released it where found. This adult was 330 mm total length (TL). Its dark color lacked any yellow flecking and appears to be a result of melanism as a more typical pattern was visible beneath when lightened digitially (Fig. 6).

About 5 y earlier, another large metamorphosed individual was found by Lyle Curtis (pers. comm.), a biologist at Oak Springs Fish Hatchery, in a braided side-channel (about 2 m wide) of the Deschutes River at the lower (downstream) part of the hatchery grounds. The braid is east of rail road tracks along the lower banks. This adult was under a small log at the edge of the water. It was grabbed and tossed onto shore but flipped back into the water and swam away. No color was noted.

There is a large neotene (OSUMNH 6046) from Maupin, Oregon, which is about 5 km upriver from Oak Springs (Fig. 2). It is 143 mm SVL and 245 mm total length TL. Nussbaum (1976) briefly mentions this specimen along with others from Oak Springs.

Table 1. Ratio of selected morphological characters in preserved *Dicamptodon* sp. from Nussbaum (1970, 1976) compared to our five sites of Cope's Giant Salamander (*D. copei*) in the White River basin, and two sites of Coastal Giant Salamander (*D. tenebrosus*) along the Deschutes River, Wasco County, Oregon, USA. Abbreviations are SVL = Snout-Vent Length (from anterior angle of vent). Body Length = SVL minus Head length. An asterisk (*) indicates the measurement is not in reported range for species (see Nussbaum 1976). All specimens deposited at Oregon State University Herpetological Collection (under two series: OSUMNH and SJA).

Source or Specimen Number		SVL (mm)	Head Width/SVL	Head Length/Body Length	Tail Height/SVL
Nussbaum (1970) *D. copei*		>65	0.18–0.21	0.39–0.49	0.13–0.23
Justensen Ranch	SJA 54835	67	0.18	0.36	0.12
	SJA 54836	63	0.20	0.40	0.13
	SJA 54837	65	0.19	0.39	0.16
White River	SJA 54840	77	0.17	0.41	0.17
Forest Creek	SJA 54843	100	0.18	0.37	0.18
	SJA 54844	64	0.18	0.37	0.14
Gate Creek	SJA 54845	76	0.19	0.43	0.15
	SJA 54846	79	0.20	--	0.19
Badger Creek	OSUMNH 11508	81	0.21	0.42	0.18
Nussbaum (1976) *D. enebrosus*		>65	0.21–0.22	0.46–0.55	0.21–0.27
Oak Springs	SJA 54847	127	0.23	0.43*	0.15*
	SJA 54848	134	0.22	0.38*	0.14*
	SJA 54849	120	0.23	0.41*	0.17*
	OSUMNH 7225	80	0.22	0.53	--
	OSUMNH 8504	98	0.21	0.44*	0.16*
Maupin	OSUMNH 6046	152	0.23	0.46	0.18*

Figure 5. Representative habitats of *Dicamptodon* (Giant Salamanders) on east side of the Cascade Mountains in Wasco County, Oregon, USA. A) Tributary of White River (at Justensen Ranch), which has *D. copei* (Cope's Giant Salamander). B) Oak Springs, which has *D. tenebrosus* (Coastal Giant Salamander). (Photographed by Christina L. Baggett).

The one Maupin specimen has a wide and long head characteristic of *D. tenebrosus* but the tail fin height is low (Fig. 7; Table 1). Museum data shows that W. Troutman and R. Gerity collected the salamander on 13 July 1951 from "A.E. Troutman's pond." In 1980, a second *Dicamptodon* was collected and released from Maupin Spring during an aquatic survey of tributaries of the lower Deschutes River canyon (Titus and Rahr 1984). A photograph was taken but cannot be located (Thomas Titus, pers. comm.). Both of the surveyors are biologists familiar with the region and its herpetofauna, so we accept the identification as valid. In summer of 2013, we searched about 100 m of the lower portion of the Maupin Spring above and below the railroad tracks, including a side channel of the Deschutes River. We found no salamanders (Table 2). Crayfish (Arthropoda: Malacostraca) were common.

A few residents told us that they observed a salamander matching the description of *Dicamptodon* in Maupin Spring or, earlier, a dammed up pool. However, no one had photographs or other evidence. Mike Miles, Chief of Public Works for Maupin, removed a large salamander on the intake grate of the city water supply approximately 5 y ago. He directed us to the owner of a ranch immediately north of town that reportedly had salamanders and, in July 2013, we were allowed to search three small (< 0.5 m wide), steep creeks (Table 2). The habitat appeared suitable with fast waters, many cobble-sized or larger rocks, and dense riparian vegetation, but we did not find any salamanders. However, we do not know if the recent sightings at Maupin were *Dicamptodon* or other salamanders (*Taricha granulosa*, *Ambystoma macrodactylum*) that also occur in the region. All springs near Maupin had side slopes overgrown with non-native Himalaya berry (*Rubus* spp.).

Other sites in the Deschutes River basin.—To our knowledge, there are no published records of *Dicamptodon* in the tributaries of the Deschutes River upstream of Oak Springs and Maupin Spring. We searched three new sites in the White River area and 11 more in the upper tributaries of the Deschutes River (Table 2). We gained access to Opal Springs at the base of the Crooked River, just upstream from Billy Chinook Reservoir dam on the Deschutes River (Fig. 2). Water discharges at high flow (380,000 l/min) and has a short run (approximately 50 m) from the base of steep canyon walls and the river. Warm Springs River is another upper tributary of the Deschutes River and also drains the east side of the Oregon Cascade Range. Public access is restricted in the Warm Springs Reservation but its fisheries biologist, Douglas Calvin, told us that he has not seen any *Dicamptodon* in the area during more than 15 y of aquatic surveys. We searched one site just north of the reservation (Fig. 1) without success.

Discussion

***Dicamptodon copei* east of the Cascade Mountains**.—This species occurs in the upper (Foster et al. 2015) and lower portions of the White River (Bury et al. 2014) to approximately 7.6 km west of Oak Springs along the Deschutes River, where *D. tenebrosus* occurs (Nussbaum 1976). There are other records of *D. copei* in the White River basin. Steele and Storfer (2007) analyzed mtDNA of *D. copei* at Boulder Creek (on the southeast side of Mount Hood), which empties into the White River approximately 20 km upstream from Justensen Ranch creek. With samples from Still Creek, Clackamas County, Oregon, on the west side of Mount Hood, they report a genetic clade distinct from those across the Columbia River in Washington as well

Table 2. Locations, dates and times of searches in Wasco County, Oregon, USA: White, Lower Deschutes, and Wind Rivers, Jefferson County, Oregon, USA: Upper Deschutes and Metolius rivers. Water width is in meters and Time is person-hours spent searching. Species acronyms are DITE = *Dicamptodon tenebrosus*; DICO = *D. copei*; TAGR = *Taricha granulosa*.

River/Site	Latitude/Longitude	Water Width	Date	Time	Amphibian species DITE	DICO	TAGR
White River							
Justensen Ranch	45.225419, -121.181099	0.5	28 July 2013	3		8	
Upper Main stem	45.154662, -121.519477	3	28 July 2013	1		1	
Forest Creek	45.179857, -121.524181	1-2	28 July 2013	2		4	
Gate Creek	45.226915, -121.491352	1.5	1 August 2013	2		4	
Lower Deschutes River							
Maupin spring/creek	45.171664, -121.083094	2	28 July 2013	3			
Maupin spring/creek	45.171664, -121.083094	2	30 July 2013	2			
Springs/creeks N of Maupin	45.187681, -121.085723	<0.5	30 July 2013	3			
Oak Springs	45.220422, -121.082384	1-3	30 July 2013	5	4		
Oak Springs, lower	45.222878, -121.082406	1-3	1 August 2013	2			2
Oak Springs, lower (ditch)	45.222878, -121.082406	1-3	1 June 2014	1			4
Wind River							
Beaver Butte Rd	45.11611, -121.53018	1-2	1 August 2013	1			
Crooked River							
Opal Creek	44.49240, -121.2983	2-3	20 August 2015	6			
Upper Deschutes/Metolius							
Head of the Metolius River	44.441488, -121.641110	3-4	31 July 2013	2			
First Creek	44.459390, -121.699616	2	31 July 2013	1			
Heart of Jack Creek	44.476210, -121.723383	3	31 July 2013	2			
Canyon Creek, Road FS12	44.503824, -121.654761	2	31 July 2013	1.5			
Six Creek, Road NF11	44.51827, -121.51593	0.5	20 June 2014	1			
Farm Creek, Road NF11	44.53041, -121.51282	0.3	20 June 2014	1			
Street Creek	44.59682, -121.460896	1-2	20 June 2014	1.5			

as downstream along north-facing walls of the Columbia River gorge (west of Mount Hood). Currently, all salamanders in the White River basin appear to be *D. copei*. Further study is needed on meristic and genetic variation of samples in the White River and other slopes of Mount Hood to define limits of its distribution and taxonomic status.

Badger Creek is an important locality because it appears to be north of and near Justensen Ranch creek where we found *D. copei*. However, it is unclear where this individual was taken along Badger Creek. Currently, *D. copei* is reported from >30 creeks in the Mount Hood National Forest, Oregon (Foster et al. 2015; Char Corkrun, pers. comm.), with most records from higher elevations (500–1000 m) in forested stands. Several records are from upper tributaries of the White River. However, there is no study available on the morphological differences, if any, of *D. copei* in northern Oregon.

***Dicamptodon tenebrosus* along Lower Deschutes River**—At Oak Springs, we found the unique basic pattern (tan-brown with yellow dots) of larval individuals as earlier reported by Nussbaum (1976) at this locality. Apparently, Nussbaum (1976) did not include Oak Springs material in his range-wide comparison of variation in the species because of the small size of most specimens. However, three large neotenes that we caught were reddish-brown (alive) with yellowish flecks and small blotches on the top of the head and dorsum, especially anteriorly. Further, the captured melanistic adult is of large girth and exceptional size (330 mm TL). The record is for an unnumbered specimen (University of Washington collection) from Renton, King County, Washington, at 333 mm TL preserved and it was likely 345 mm in life (Nussbaum 1976).

Good (1989) reported the isolated Oak Springs population as one of three clear geographic clusters within *D. tenebrosus*. Steele and Storfer (2006) used

Figure 6. Adult *Dicamptodon tenebrosus* (Coastal Giant Salamanders) from Oak Springs Fish Hatchery, Wasco County, Oregon, USA, August 2013. Top: Melanistic coloration (Photographed by Lyle Curtis). Bottom: Computer enhanced view with background removed and photo lightened. (Photographed by Nick D. Waters).

tissues from these and other sites to analyze mtDNA variation across the range of *D. tenebrosus*. They report that *Dicamptodon* at Oak Springs are *D. tenebrosus*, and that this population is a sister clade to a northern group (Columbia River gorge, Washington Cascades, western Washington).

To our knowledge, the Oak Springs and Maupin salamanders here provide the first measurements and photographs of larval, neotenic or adult *D. tenebrosus* from the east side of the Cascade Mountains. We identify all these specimens as *D. tenebrosus* based on body ratios and especially their wide heads. However, all had low tail fin heights that were in the range of *D. copei*. The tail fin reduction may be an adaptation (Fitzpatrick et al. 2003) to steep, rocky springs (i.e., tail fin height increases in quiet waters). Two of three large neotenes also had low ratio of head length/body length.

Although the Maupin neotene is large, other individuals (Nussbaum 1976) are >40 mm larger: 286 mm TL (Clackamus County, on the west side of the Oregon Cascade Mountains) and 205 mm SVL and 351 mm TL (Multnomah County, Oregon, in the Columbia River gorge). These sites are within approximately 80 km of Maupin. In July 2013, Thomas Troutman of Maupin, Oregon, told us that this was a pond of his uncle. Apparently, the pond behind a man-made small dam is now gone (currently not visible from a nearby road or publicly available satellite maps). Thomas Troutman said he had seen large salamanders in this spring area but not in recent years (no dates provided).

Because of the isolated nature of creeks and seeps in the semi-arid east side of the Cascade Mountains, we consider the one specimen and other reports at Maupin to represent a second site for *D. tenebrosus* along the Deschutes River. We did not observe *D. tenebrosus* despite hours of effort extending along parts of the outflow creek down the slopes of the Deschutes River canyon, along a side channel of the river, and three small creeks just north of town. Still, we urge additional sampling effort to determine if *Dicamptodon* persist at Maupin Spring.

Overall, our access to habitat was limited or searches difficult to perform. The larger waters were 2–4 m wide, deep (e.g., > 0.5 m), and swift; thus, our sampling (with dip nets) was limited to shoreline areas. However, techniques such as electroshocking or fishing (with baited snell-less hooks) may be better suited than hand-held nets for larger waters. To date, fisheries biologists are either not finding salamanders or ignoring them when found. Capture in hand and photographs are needed to ensure identification. Several small creeks appeared ephemeral (e.g., we searched them during June and they may dry up later in the summer). We found no *Dicamptodon* in the upper Deschutes River basin. Still, we encourage further search because many waters remain unchecked in the region and population

Figure 7. Comparison of neotenic *Dicamptodon*. Top to Bottom: *D. tenebrosus* (Coastal Giant Salamanders) from Maupin (OSUMNH 6046), and from Oak Springs (RWN 133342-33), Wasco County, Oregon, USA; and *D. copei* (Cope's Giant Salamander; OSUMNH 54825) from Washington State. All are specimens at the herpetological collection, Oregon State University, Corvallis, Oregon, USA. (Photographed by Christina L. Baggett).

sizes may be small. The Deschutes River and its side-channels may support *D. tenebrosus* but further sampling is necessary.

Management and conservation.—All the waters of Oak Springs are managed as a fish hatchery by the Oregon Department of Fish and Wildlife and are protected. The headwaters are free flowing except for two small check dams. Salamander habitat is mostly intact. However, most water is collected (usually near lower parts of the steep slopes) and sent to fish-rearing ponds. Grates are installed over intake pipes but an improvement may be to employ nested layers of smaller mesh to reduce intake of larval salamanders in the pipes that send water to fish-rearing ponds. *Dicamptodon* has no special state protection because it is common elsewhere in its range. In isolated populations, however, some protection may be helpful (e.g., design a more effective grate over intake pipes). Hatchery biologists are aware of this unique salamander population and, when found, they release them unharmed where found.

During the early 1950s, one neotenic *Dicamptodon* was taken in Maupin Spring. A few salamanders have been reported since then. We were unable to detect them. Canopy cover is scarce. The immediate area is partly surrounded by rural housing and it appears to have a dirt road that is around half of a new pond (Google Maps; 7 July 2016). We also searched three small creeks north of town but we found no salamanders. Stream conditions of the springs near Maupin appear degraded and differ sharply from the relatively undisturbed vegetation at Oak Springs.

A side creek with *D. copei* occurs on the Justensen Ranch (lower White River) and appears to be perennial. Some water is diverted for irrigation. The area has low use by people and no other developments are nearby. The canyon upstream from the site is steep and is mostly in public ownership, but adjacent uplands are used for grazing and irrigated fields (Lamson, K., and J.S. Clark. 2004. White River Watershed Assessment. Unpublished report to Wasco County Soil and Conservation District, The Dalles, Oregon. Available at: http://www.wascoswcd.org/linked/wrws_assessment.pdf. [Accessed 12 March 2017]). It lacks any roads or structures until about 20 km upstream (some logging roads cross the White River). Thus, there appears to be no imminent threats to the population. Still, further search effort is needed in the lower portions of White River and its tributaries to denote its current distribution and status.

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