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First report of axanthism in a wild Rough-skinned Newt, *Taricha granulosa* (Skilton, 1849), from northern California

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Colouration is one of the most obvious and important aspects of an animal's phenotype, playing key roles in fitness and survival. Colouration can determine whether an animal is detected, recognised, and approached by predators, or conversely, colouration can advertise unpalatability or danger (aposematism) to potential predators (Caro, 2005; Rudh, 2013; Jablonski et al., 2014; Ruxton et al., 2018). Colouration can also be crucial in intraspecific communication, whether in mate choice, territorial displays, or other forms of social signalling (Korzan and Fernald, 2006; Dreher et al., 2017). As such, animal colouration is thought to be under intense natural and sexual selection (Pérez i de Lanuza et al., 2013; Simpson et al., 2020). Nevertheless, colour abnormalities (atypical colours or patterns for a species) frequently arise in natural populations of wild vertebrates (Kolenda et al., 2017; Allain et al., 2023; van Buchem et al., 2025). For example, albinism (absence of all colour pigments) has been reported from nearly every vertebrate group, ranging from frogs to opossums to sea turtles (Corn, 1986; Perrault and Coppenrath, 2019; Fuentes et al., 2024). Sometimes these colour abnormalities affect only part of an individual's phenotype instead of the whole, such as partial amelanism (lack of the dark pigment melanin) or piebaldism (localised patches of no pigmentation) (Davis, 2007; Lopez and Mora, 2025).

Axanthism is an abnormal colour variant characterised by the reduction or absence of xanthophores, the pigment cells responsible for yellow colouration, preventing the normal expression of yellow and orange colours (Bagnara et al., 1968; Jablonski et al., 2014; Allain et al., 2023). In the absence of yellow pigments, axanthic animals are often characterised by blue colouration, particularly in amphibians that normally display a green background colour (Bagnara et al., 2007; Allain et al., 2023), but axanthic amphibians may also be grey, or grey-black (Bagnara et al., 2007; Jablonski et al., 2014). Of the various colour aberrations, axanthism is among the most uncommon (Jablonski et al., 2014), and is rare in anurans and seldom seen in caudates (Jablonski et al., 2014; Luchinni and Pizzigalli, 2020; Allain et al., 2023).

Pacific Newts (*Taricha* spp.) are robust salamandrids of forest, woodland, and chaparral communities of western North America (Stebbins, 1951, 2003). They are characterised by a dark dorsum that ranges from near black to a light chocolate brown, and that stands in stark contrast to a bright ventrum of yellow, orange, or red colouration that extends from the base of the tail, across the belly and through to the chin (Storer, 1925; Reimer, 1958; Twitty, 1966; Stebbins, 2003). When confronted by predators, newts may strike the "Unken pose", arching neck and tail skyward to suddenly reveal their vivid ventral colours (Johnson and Brodie, 1975; Stebbins and Cohen, 1995), advertising the deadly neurotoxin (tetrodotoxin) they possess (Brodie, 1968; Brodie et al., 1974; Hanifin et al., 1999). These ventral colours are conspicuous to sympatric predators (Moniz et al., 2023), appear to be easily learned (Johnson and Brodie, 1975) and reduce attack rates by some (avian) predators (Kuchta et al., 2008). Thus, colouration in *Taricha* appears to function as a reliable aposematic signal (Johnson and Brodie, 1975; Stebbins and Cohen, 1995; Kuchta et al., 2008; Moniz et al., 2023). Indeed, colour variation in *Taricha* appears rare, which is consistent with the hypothesis that selection from the community of newt predators maintains a consistent colour pattern. Here we report the first observation of axanthism in a wild Rough-skinned Newt, *T. granulosa* (Skilton, 1849).

While sampling newts with a dip net at Bonnie's Pond (38.3300ºN, 122.5817ºW, elevation 683 m; Fig. 1), Mitsui Ranch Preserve, Sonoma County, California,

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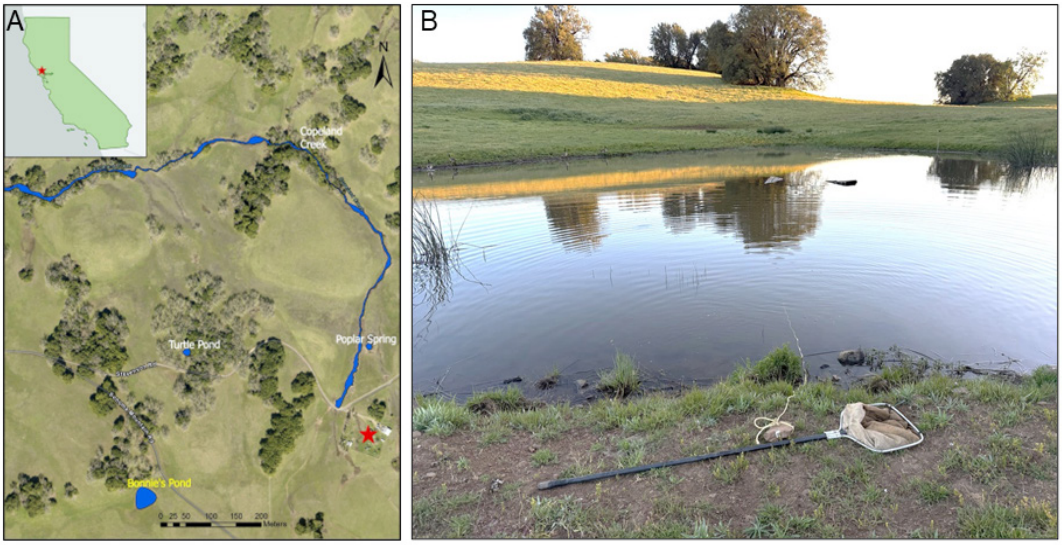

Figure 1. (A) Map and (B) photos of study site, Bonnie's Pond, Mitsui Ranch Preserve, Sonoma Mountain, Sonoma Co., California. We found the axanthic Rough-skinned Newt (*T. granulosa*) in Bonnie's Pond, where we captured, photographed, and released the individual back at capture site. Map courtesy of Jennaca A. Hajek; photo by Ryan K. Murphy.

USA (at 14:15 on 5 May 2025), we captured an adult male *T. granulosa* exhibiting axanthism (Fig. 2). We determined the newt to be a breeding adult male based on large overall body size, smooth dorsal skin texture, the presence of a highly keeled tail, and a swollen vent (Houck and Sever, 1994; Stebbins, 2003). Bonnie's Pond hosts populations of two newt species: *T. granulosa,* and *T. torosa* (California Newt). We determined this individual as a *T. granulosa* based on the diagnostic features described by Reimer (1958): the ventral colour did not make contact with the lower eyelids; and upper eyelids were uniformly dark; the ventral colour does not extend between the nostrils; and an extremely sharp boundary is maintained between the dorsal and ventral pigments along the entire lateral view. Further, the cornea of the eye remains inside the margin (contour) of the head (Stebbins, 1951). Though we did not record size (snout vent length) or mass, the newt seemed well within the range of normal adult male *T. granulosa* at Mitsui Ranch Preserve (Wilcox, unpubl. data). In fact, the newt was robust and looked vital and healthy. However, the ventral surface of the newt stood out immediately as exceptionally pale, and seemed to lack any of the yellow and orange colours that characterise Pacific Newts, instead appearing almost a pastel pink. Additionally, the dorsum appeared darker and greyer than the dorsal surface of other conspecifics, lacking the usual warm tones. After we briefly handled and photographed the newt, we released it at the point of capture.

Little was known about the underlying phenomena causing axanthism until the dermal chromatophore unit of pigment cells in amphibian skin was described by Bagnara et al. (1968). In amphibians, three general types of cells (and possibly more) produce colour: melanophores which contain melanin pigments to produce dark colours; xanthophores which contain pteridine and carotenoid pigments to produce red and yellow colours; iridophores that contain stacked guanine crystals that scatter light to produce structural colours such as green and blue (Gur et al., 2017). Light passes through the xanthophores first, then through the directly apposed iridophores, and finally to the melanophores at the bottom of the dermis. We suspect this newt was axanthic, lacking the red and yellow pigments needed to produce the normally vibrant ventral colours of Pacific Newts. It is also possible that this newt was deficient in iridophores. If iridophores were present, the dorsum should have possessed a blue-grey colour (Jablonski et al., 2014) because iridophores usually refract light into shorter, blue wavelengths (Bagnara et al., 2007).

Colour aberrations in *Taricha* are uncommon, and we are aware of just four other populations of *T. granulosa* with colour abnormalities, all of which include increased melanin (Garber and Garber, 1978). There are two populations of Rough-skinned Newts:

Figure 2. Photos of the axanthic *T. granulosa* from Bonnie's Pond. Photos show the adult male was in reproductive condition. Photos display (A) ventral, (B) dorsal, and (C–D) lateral surfaces, including (E) tail and vent region, and (F) contrasts between the axanthic newt (left) with a typical adult *T. granulosa* (right) from the same pond. Photos by Jeffery T. Wilcox (A–C) and Ryan K. Murphy (D–F).

one in southeastern Alaska; the other in Crater Lake, Oregon (often referred to as the Mazama Newt, T. g. mazamae), where the dark dorsal colouration permeated the ventrum, giving the belly a dark-spotted and marbled appearance (Myers, 1942; Riemer, 1958; Ray et al., 2022). Two other populations of *T. granulosa* also possess patches of dark spots or marbling, but on the dorsum. One population of dark-spotted newts is known from a site in the Cascade Ranges of northern Oregon, and another population is known from the Siskiyou Mountains of northwestern California (Livezey and Wylie, 1961; Garber and Garber, 1978). Our account differs because we observed just a single aberrant newt (after 15 years of sampling the ponds at Mitsui Ranch Preserve), rather than a population of newts with phenotypic variation among individuals. Furthermore, our newt displays a completely different phenotype than the variation previously recorded for *Taricha*. It will be interesting to see if this male persists, and if the genetic mutation(s) he bears will be passed down to other newts in the population.

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