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## California Records of the Oarfish, *Regalecus russelii* (Cuvier, 1816) (Actinopterygii: Regalecidae)

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Recent oarfish strandings in California have generated enormous interest. Oarfishes are iconic and have been feared as ‘sea monsters or serpents’ in the past and ‘harbingers of earthquakes’ more recently. The amount of media coverage and subsequent misconceptions has motivated us to document the California stranding records as best we can based on the most reliable information.

Most accounts over the last century have regarded *Regalecus* as monotypic, as *R. glesne* (Heemstra 1986; Olney 2002; Horn et al. 2006; Nelson 2006; Page et al. 2013; Kells et al. 2016). Historically, and more recently, a second species, *R. russelii* or with a modified species spelling as *russellii* [as *russelii* (Cuvier 1816 (ex Shaw)) by Eschmeyer et al. 2017], has been recognized (Jordan 1902, 1907; Jordan and Starks 1907; Fujii 1984; Hayashi 2002; Roberts 2012, 2016; Angulo and López-Sánchez 2017). Both species have circumglobal, but not entirely overlapping, distributions. However, only *R. russelii* has been found, so far, in the northeastern Pacific, including Mexico, Costa Rica, and central and southern California.

Morphologically, *Regalecus russelii* is characterized by 3–6 rays in the first dorsal crest and a single ray in the second dorsal crest, not connected with a membrane to the other. *Regalecus glesne* has 6–8 rays in the first crest and 5–11 rays in the second crest (Roberts 2012). The total number of dorsal rays, vertebrae and gill rakers are also diagnostic. Mitochondrial DNA sequences indicate distinct separation between these species (Roberts 2012).

We have attempted to access all sources of information related to oarfish strandings off California, including newspaper articles, natural history museum records, published accounts, and the files and correspondence of Boyd Walker, John Fitch, Vladimir Walters, and other ichthyologists interested in early oarfish strandings. We have examined all California specimens at The Natural History Museum of Los Angeles County (LACM), Santa Barbara Museum of Natural History (SBMNH), Scripps Institution of Oceanography (SIO), and University of California Los Angeles (UCLA, now transferred to SIO). We have also searched VertNet (<http://www.vertnet.org>) and iDigBio (<https://www.idigbio.org/>) records.

Length measurements are total lengths. In eight cases we feel the original measurements were by metric tape (numbers 3, 5, 7, 9, 10, 12, 13 and 18), one by John Fitch, two by LACM staff, one by scientists at the USC Wrigley Marine Science Center at Santa Catalina Island, one at the Catalina Island Marine Institute, one by researchers at California State University Fullerton, and two San Diego County specimens by researchers at Scripps Institution of Oceanography and the Southwest Fisheries Science Center, La Jolla.

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*California records.*—We have verified a total of nineteen oarfish strandings and sightings along the California coast, since 1901, all from southern California with the exception of one sighting slightly north of the Point Conception boundary, plus several unverified and extralimital records.

1) 22 February 1901. The first recorded oarfish (Fig. 1A) from California was found “about one mile up the coast” from Newport Beach (Jordan 1902, Jordan 1907, Jordan and Starks 1907, Fitch 1951, Los Angeles Times 24 Feb 1901, Los Angeles Herald 26 Feb. 1901). It was 6.71 m (22 ft) long and weighed an estimated 500-600 lbs. (Jordan and Starks 1907). Jordan (1907) also mentions Santa Catalina Island where “during the past few years I have seen one oarfish (*Regalecus russelli*) alive, while another was brought to me dead,” indicating that there may have been a few more unconfirmed sightings at Catalina Island during this time.

2) 29 March 1950. A 3.20 m (10.5 ft) oarfish was sighted by Thomas DeGarmo “swimming feebly just off a point of rocks” at Cabrillo Museum, near San Pedro (Fig. 1B) (Fitch 1951, Fitch and Lavenberg 1968). The head was badly damaged, a few feet of the tail were missing and the weight was estimated at 113.4 kg (250 lbs). A cast was made and the specimen was donated to Scripps Institution of Oceanography and given the catalog number SIO 50-115. Tom Deméré (San Diego Natural History Museum) discovered that the SDNHM model has a label indicating it is a “cast made from a fish taken near San Pedro in 1950.” The number of rays in the crest of the model match *R. glesne* and may be incorrectly added due to the damaged condition of the specimen’s head.

3) 7 February 1958. A 1.76 m (5.8 ft) oarfish was picked up by Linc Foster at 11 AM on a beach in Santa Monica Bay, just south of Topanga Canyon (Fig. 1C) (From John Fitch correspondence to Vladimir Walters, 25 February 1958). The specimen was found on the beach while it was still barely alive. The body broke in half as it was lifted. It was turned over to Dr. Kenneth Norris at Marineland of the Pacific and the above data recorded in their field notebook under MLP58-2. An additional maximum of 110 mm of the tail was estimated to be missing by Fitch, possibly making it about 1.87 m. in length. Subsequently, it was cataloged at the University of California Los Angeles (W58-267) and now resides at the Scripps Institution of Oceanography (D. Buth, UCLA, per. com. 2013). The SIO 15-113 label has 1,750 mm written as the length. Fitch counted six rays in the dorsal crests (nuchal pendants).

4) 24 September 1963. A 4.12 m (13.5 ft) fish was stranded 3.2 km (2 mi) west of Malibu pier (Los Angeles Times, 27 Sept. 1963, Roberts 2012). Vladimir Walters and Boyd Walker (UCLA) estimated that about 1.5 m (5 ft) of the tail were missing, making the complete fish about 5.64 m (18.5 ft) long. A subsequent Los Angeles Times article (1 October 1963) stated “...an 18½-ft oar fish, will be on display outside the Life Science Building at UCLA.” Fitch and Lavenberg (1968) mention a “19-footer from near Topanga Canyon.” We assume it is the same fish. They said it was preserved in the fish collections at the Los Angeles County Museum of Natural History. An inventory of wooden tanks at the Museum’s Marine Mammal Warehouse listed an uncataloged “Oarfish (dried formalin)” in WT-17. This specimen was discarded in 2006. No picture is available.

5) 25 January 1970. A 4.39 m (14.4 ft) specimen (Fig. 1D) was found dying in the surf by Foster and Francis Phelps, 2.4 km (1.5 mi) northwest of the Ventura-Los Angeles County line. Roberts (2012) has the locality as Malibu, Leo Carrillo State Beach, 4.1 m, stranded. It originally went to Marineland of the Pacific and then was deposited at the Natural History Museum of Los Angeles County (LACM 31697-1) about a year later. Camm Swift

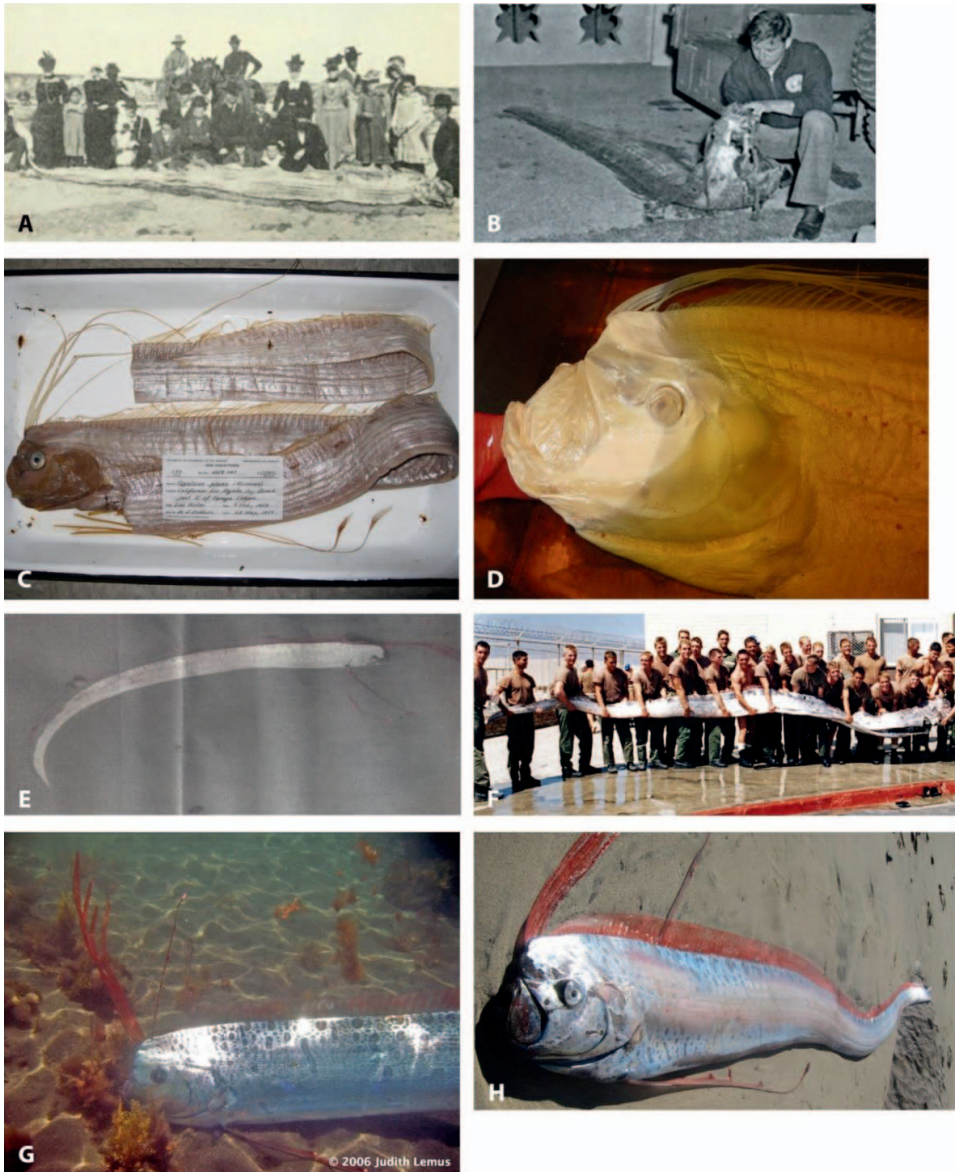


Fig. 1. **A** Newport Beach oarfish, February, 1901, from Jordan (1907). **B** Cabrillo Museum oarfish and John Olguin, 1950, courtesy of J. Passarelli. **C** Santa Monica Bay oarfish, 1958, SIO 15-113, image by R.F. **D** County Line specimen (LACM 31697-1) by E. Hernandez. **E** County Line oarfish number two, 20 July 1992, by Steve Wallace. **F** Coronado oarfish, 1996, by W. Leo Smith. **G** Santa Catalina Is. oarfish, 2006, by Judy Lemus. **H** Malibu oarfish, 2010, by Darrell Rae.

re-measured the specimen as 4.39 m (14.4 ft.). Part of the tail was missing, assumed to be bitten off. The specimen was on display in the Foyer at the LACM for many years until being replaced by the 2006 Catalina fish in 2007. The specimen was cast and a model made for display in the Marine Hall (Emboden 1974), with a relatively large, fan-shaped,

dorsally-directed tail fin added (inaccurate because it resembles the upper lobe of the caudal fin of a ribbonfish, Trachipteridae). The model is on display in the Discovery Hall on the second floor. An otolith in the John Fitch Otolith Collection is labeled "Jan 1970  $\pm$  18 ft." We think it is likely from this specimen. Fitch was probably estimating how long the fish was if the tail was intact.

6) 12 July 1992. An oarfish was observed "undulating in the surf" and photographed by Steve Wallace (Fig. 1E) on the beach, near Malibu at Ventura County line. (Bill Beebe, Los Angeles Times, 24 July 1992). Beebe stated the sighting took place two Sundays prior to his article. Records at LACM had date as July 20. "It looked like a sea serpent about six or eight feet long. It had a head like a dorado (dolphin fish) and shaped like an eel." Wallace indicated that the fish was washed back out to sea while he was there.

7) 19 September 1996. An oarfish estimated as 7.0 to 7.3 m (23 to 24 ft) was found on the beach at Coronado, near the Coronado U.S. Naval Special Warfare Command Center, by Scott Vogt and other U.S. Navy SEALs (Fig. 1F) and reported to the Birch Aquarium at Scripps Institution of Oceanography (The San Diego Union-Tribune 27 Sept. 1996; Smith 1996; Roberts 2012). The specimen was measured and dissected by H.J. Walker, Cindy Klepadlo and Leo Smith of Scripps Institution of Oceanography on Coronado at the Naval Center. They measured it at "just over seven meters" but estimated it to be 23 to 24 feet because the tip of the tail was missing (Smith 1996). SIO field notes have the "estimated" length as 7.3 m. Following examination of the whole fish the head and a portion of the tail were removed and are now accessioned at the Marine Vertebrate Collection (SIO 96-82) along with a DNA tissue sample. Dorsal crests fin rays total 6; gill rakers  $13+39 = 52$ . The Navy buried the remaining parts of the specimen.

8) 26 October 1997. A 5.0 m (16.4 ft) specimen (SIO 97-226) was caught by a commercial fisherman with a gill net off San Diego, ca. 17 mi. W of Point Loma. Tissue analysis confirmed it was *R. russelii* (Roberts 2012). The head and tail were saved. No picture.

9) 16 August 2006. A 4.46 m (14.6 ft) oarfish (Fig. 1G) appeared in Big Fisherman Cove, near the USC Wrigley Marine Science Center, Santa Catalina Island (Museum records; Pete Thomas, Los Angeles Times, 26 Aug 2006). Judy Lemus and many others at the Marine Science Center observed the fish alive, but feeble, in Big Fisherman Cove for about a day until it beached itself. Kevin O'Connor took a video of it swimming underwater (LACM files). Gerry M. Smith and Judy Lemus froze the specimen and contacted the Natural History Museum of Los Angeles County. The specimen was kept frozen at the Museum until 31 May 2007 when a stainless steel tank, ordered specifically for this fish, was ready. The specimen was examined, dissected and cataloged as LACM 56478-1. Tissues (T-000847) were frozen. The specimen was fixed in formalin and then moved to 70% ethanol when put on display in the Foyer of the Museum in 2007. There were two dorsal crests with  $5+1$  rays, plus 173 rays = 179 total dorsal rays;  $5+1+62$  dorsal rays to vertical at vent. Gill rakers 14 upper + 37 lower. Tissue was sent to Tyson Roberts at Smithsonian Tropical Research Institute on 4 Dec 2008.

10) 28 November 2010. Darrell Rae observed a 3.28 m (10.8 ft) oarfish swimming a few feet from shore before it washed up at the Malibu Colony, just west of Malibu Lagoon (Fig. 1H) (Malibu Times, Carly Erickson, 1 December 2010; Los Angeles Times, Tony Barbosa, 3 December 2010). Jeff Hall from the California Wildlife Center collected the specimen and it was transferred to the Natural History Museum of Los Angeles County. Tissue was taken (T-001206) and the fish was cataloged as LACM 57292-1. The dorsal

crests numbered 5+1. In 2016 reproductive tissue was sampled by Kristy Forsgren of California State University Fullerton (Forsgren et al. 2017).

11) 7 February 2011. A 4.3 m (14 ft) specimen was stranded at Surf Beach, just south of Ocean Beach County Park, near Lompoc (email to RF from Kristi Birney, Environmental Defense Center, Santa Barbara, CA) (Fig. 2A-B). It was photographed by John Downs in the late afternoon, but not collected; it apparently washed back to sea at high tide that night. It appears there were six rays in the dorsal crests. Surf Beach is ca. 35 km north of Point Conception and ca. 13 miles north of Point Arguello. It represents the northernmost record of *Regalecus* in the eastern Pacific.

12) 13 October 2013. Jasmine Santana, of the Catalina Island Marine Institute, saw a dead 5.27 m (17.3 ft) long oarfish (Fig. 2C) lying on the bottom at about 5 m, while snorkeling in Toyon Bay, Santa Catalina Island. She grabbed it by the tail and swam it to shore, estimating it weighed about 181 kg (400 lbs). It was well-publicized by local media (Los Angeles Times, 16 October 2013). Dissection determined that it was probably a male. The stomach was empty. Taylor Sakmar of CIMI contacted the LACM about the specimen. Tissue samples (T-001236 to T-001248), gill samples, dorsal and pectoral fin ray samples, heart, liver, kidney, kidney blood, gonads, tip of tail, and muscle from the abdominal wall were given to the Natural History Museum (LACM 58180-1) via David Work. The gall bladder, parts of the gills, stomach, spleen, part of the intestine, and gastric caecum went to the Ecological Parasitology Lab, University of California, Santa Barbara. They found several types of larval and juvenile parasitic tapeworms and nematodes. Oarfish may act as intermediate hosts for adult parasites of the same taxa found in Shortfin Mako and Sperm Whales (Kuris et al. 2015). Also, an otolith, dorsal ray and pelvic ray were sampled for ageing (Midway and Wagner 2016).

13) 18 October 2013. A 4.45 m (14.6 ft) oarfish was discovered on the beach at Oceanside (33°12'N, 117°23'W), near the harbor breakwater (Fig. 2D). The specimen was analyzed by scientists from the NOAA Southwest Fisheries Science Center, La Jolla. The head was damaged. It was determined to be a female with eggs. Some tissues and parts went to the Scripps Institution of Oceanography, Marine Vertebrate Collection (SIO 13-259). Remaining tissues went to California State University Fullerton, frozen, and later CT-scanned at UCLA; hyperostotic dorsal pterygiophores were present (Paig-Tran et al. 2016).

14) 9 August 2014. Patricia Malone and party photographed an estimated 4.6 m (15 ft) oarfish on Santa Rosa Island, between Skunk Point and Torrey Pines, on Bechers Bay (approx. 33°59'N, 120°0'W) (Fig. 2E-F). She said it was freshly dead with little decomposition but the eyes were missing. The lens of the eye showing in Fig. 2F does appear to be missing, possibly due to scavenging by birds. There was a small bite in the midsection, the tail was missing and the dorsal fin was buried in the sand. No tissues or parts were kept.

15) 1 June 2015. Tyler Dvorak and Amy Catalano discovered an estimated 4.32 m (14.2 ft) oarfish on Santa Catalina Island, stranded along Emerald Bay (Fig. 2G). The fish was reported to Catalina Island Conservancy, necropsied, and shipped to California State University, Fullerton, for further study and CT scanning at UCLA (Paig-Tran et al. 2016). Muscle tissue is frozen at the LACM (T-001252). Reproductive tissue indicated it was a female (Forsgren et al. 2017).

16) 30 June 2015. An oarfish was snagged with rod and reel and brought to the surface on the fishing boat *Fortune*, off Salta Verde Point at Santa Catalina Island over 9 m depth (Fig. 2H). It was estimated to be about 6.1 m (20 ft). The captain, Bruce Smith, said it may have been alive at the time. The fish was gaffed but its flesh started to tear so it was released and not seen again after that.

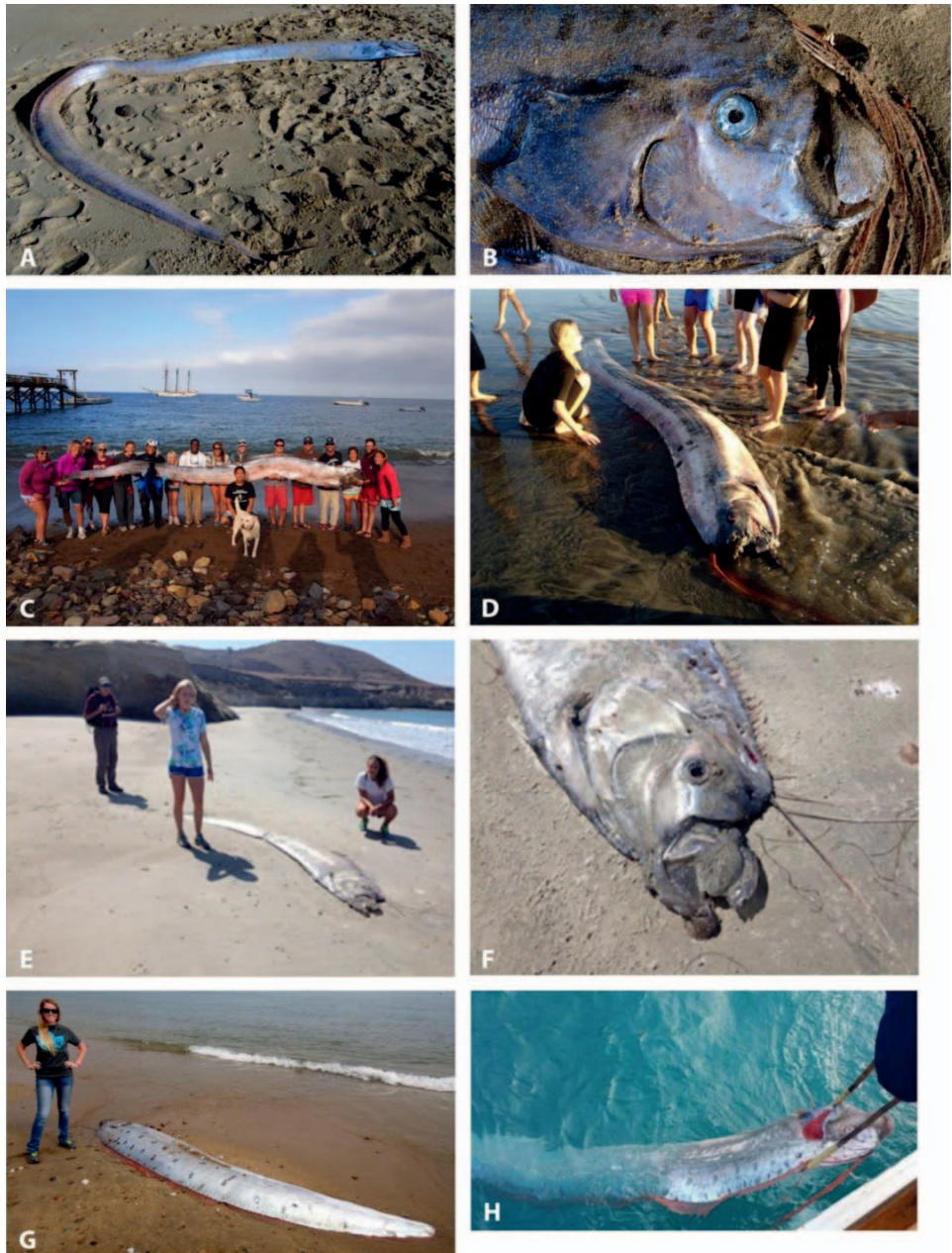


Fig. 2. **A** Oarfish at Surf Beach, Lompoc, 2011. **B** head, image by John Downs. **C** Santa Catalina oarfish, Toyon Bay, 2013, courtesy of CIMI. **D** Oceanside oarfish, 2013, by Mark Bussey, Associated Press, LA Times, 22 October 2013. **E** Santa Rosa Is. oarfish, 2014, **F** head, by Patricia Malone. **G** Amy Catalano and oarfish, June 2015, Catalina Is, by Tyler Dvorak, courtesy of Catalina Is. Conservancy. **H** Salta Verde Point, Santa Catalina Island, June 2015, by Bruce Smith.

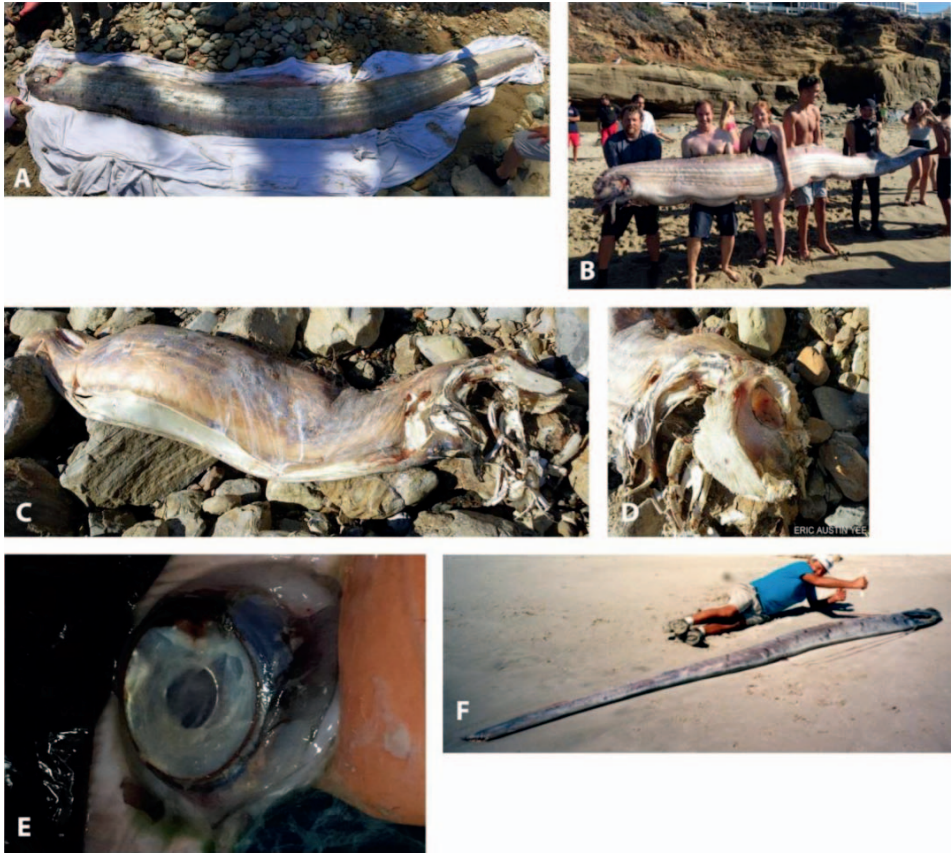


Fig. 3. **A** Specimen stranded near Avalon, Santa Catalina Island, August 2015, by Charles Kelly. **B** La Jolla, September 2015, image from Nick Wegner, SFSC. **C** Carcass at Palos Verdes, November 2015. **D** Close-up of head, by Eric Austin Lee. **E** Eye when fresh, image from Erin Paig-Tran. **F** Oarfish stranded on Ensenada de los Muertos, Baja California Sur, 1995, image by Sandra Frederickson.

17) 17 August 2015. An estimated 4.3 m (14.1 ft) long oarfish was discovered at Pebble Beach, near Avalon, Santa Catalina Island, by an employee of Mountain and Sea Adventures (Fig. 3A). It was freshly dead with little decay; however, the tail was missing. There was krill in its stomach (per. com. Erin Paig-Tran of California State University, Fullerton. Tissues and parts (California State University at Fullerton) were retained and scanned. It was determined to be a male (Forsgren et al. 2017). Samples are being examined for parasites by the Ecological Parasitology Lab at the University of California, Santa Barbara.

18) 14 September 2015. An oarfish washed ashore in La Jolla at Shell Beach (Fig. 3B). It was 5.21 m (17.1 ft) long. National Marine Fisheries Service staff from the Southwest Fisheries Science Center retrieved it. Tissues, photographs, and records are at Scripps Institution of Oceanography (SIO 15-37) per. com. Phil Hastings, Curator, Marine Vertebrate Collection. Samples were CT scanned for hyperostosis (Paig-Tran et al. 2016) and reproductive tissues indicated it was a female (Forsgren et al. 2017).



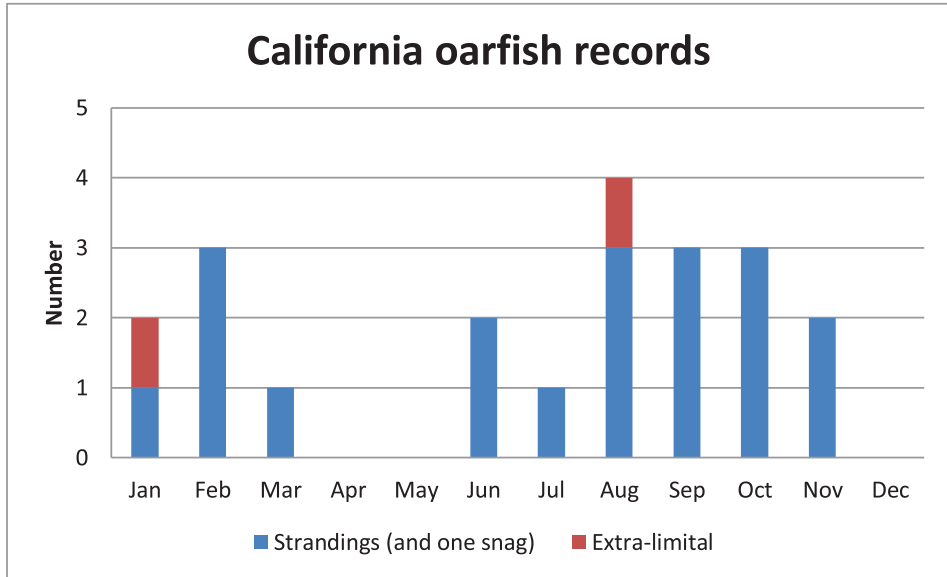


Fig. 4. Oarfish records by month.

19) 3 November 2015. An oarfish was discovered by tourists at Rancho Palos Verdes, right below the Trump National Golf Course (per. com. Erin Paig-Tran, California State University at Fullerton, Fig. 3C-E). Dr. Paig-Tran's students dissected it and took samples the next day. They recorded the fresh length as 4.1 m (13.4 ft) and reported it still had red fins and silver skin. Samples were CT scanned for hyperostosis (Paig-Tran et al. 2016) and it was a male (Forsgren et al. 2017). The dried carcass remaining on the beach was then examined by Eric Austin Lee on November 6th. He estimated the dried length at about 2.1 m (7 ft) and kept the badly decomposed head for the Aquarium of the Pacific, Long Beach, CA. Samples are being examined by the Ecological Parasitology Lab, University of California, Santa Barbara.

*Records with limited data.*—A smaller 2.2 m (7.2 ft) oarfish was on display with the larger 1970 oarfish for years in the Museum Foyer. Robert J. Lavenberg (per. com.) recalls Boyd Walker (University of California, Los Angeles) received it from lifeguards in Santa Monica Bay in good shape and then donated it to the LACM. We have no other data (LACM 58185-1). Dirk Nolf (1985, fig. 56E) illustrates a *Regalecus* 1.4 mm otolith that matches a 1.4 mm otolith in the Fitch Collection that has ">244 cm" written on the capsule. It may be the same fish since the body lengths are similar.

An oarfish skeleton is cataloged at the Santa Barbara Museum of Natural History (SBMNH OS 4904) collected in 1996 but with no specific locality. It is possibly from Santa Barbara County. The preopercle is 120 mm in length, vertebrae about 35 mm and the longest dorsal ray is about 700 mm long, indicating a large fish, likely 3-4 meters in length.

*Extra-limital records (taken at sea or off northern Baja California).*—A 7 August 1961. An oarfish estimated as ca. 4.6 m (15 ft) was encountered by the sportfishing vessel Beverly 80 mi. SW of San Diego (off Baja California, Mexico). The oarfish was noted by the vessel Captain, E. Galvin, as being under attack by sharks at the surface prior to being gaffed. The head, in a battered condition, and a 1 m section of the tail from near the caudal were salvaged. Parts of the specimen were donated to Scripps; the cranium went to

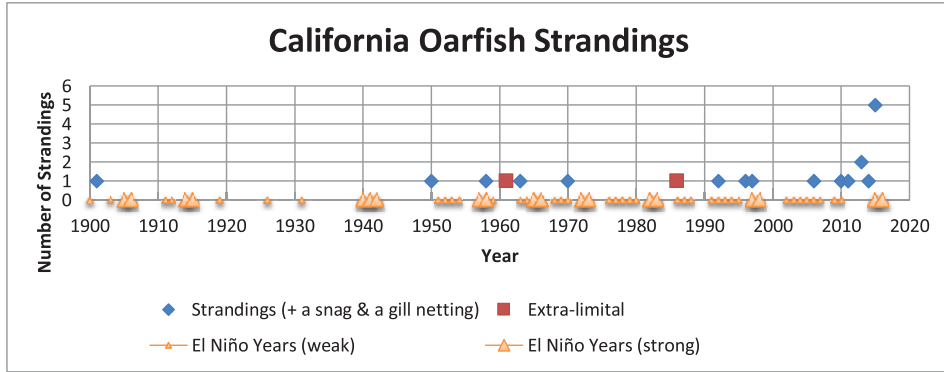


Fig. 5. Oarfish strandings by year, with El Niño years based on <http://www.bom.gov.au/climate/enso/enlist/> [https://www.esrl.noaa.gov/psd/enso/past\\_events.html](https://www.esrl.noaa.gov/psd/enso/past_events.html).

J. E. Fitch, California Department of Fish and Game, and the brain was sent to Vladimir Walters, UCLA. SIO 61-389.

B) 24 January 1986. A 4330 mm (14.2 ft) specimen was caught south of San Juan Seamount, over “1830 Bank,” 32°30.0’N 121°0.0’W. The oarfish (SIO 86-1) was taken by the F/V Temptation with a drift gill net.

*Summary.*—There are no known records of *Regalecus* north of Central California in the northeastern Pacific. All of the California records are from strandings, except one that was caught in a gill net and one that was snagged by hook and line. The extra-limital specimens were caught offshore in trawls or were gaffed. The peak months were August and February (Fig. 4) in a bimodal pattern. No strandings occurred in April, May, and December.

In 1901 there was a stranding near Newport Beach and then none reported until 1950. More strandings have been seen recently (Fig. 5). In the fall of 2013 there were two strandings that coincided with the appearance of a warm water “blob” in the North Pacific (Bond et al. 2015; Kintisch 2015). In 2015 that dramatically increased to five strandings. California experienced a strong El Niño event starting in 2015, lasting into 2016, with warm water, and the appearance of tropical fishes such as Blue Marlin, Wahoo, Yellowtail Jack and Bigeye Scad (Feeney and Lea 2016; Love et al. 2015). No California sightings of oarfish occurred in 2016 or as yet in 2017.

Most northeastern Pacific records of *Regalecus* are from Mexico and Central America, numbering 45 records between 1979 and 2014 (Galván-Magaña, et al. 1999; Salazar-Hermoso 1999; Roberts 2012, Angulo and López-Sánchez 2017), including two sightings since 2012, and one unpublished record from 1995 in the LACM files.<sup>1</sup> There are no records from 2015 to June, 2017 south of California. Multiple occurrences are common to the south; in 1991 there were seven occurrences in Mexico. In 1995 there were six records of oarfish in Mexico and Costa Rica. The most frequent months of the strandings also had

<sup>1</sup> On 24 March 1995, according to the files at the LACM, a 4.9 m (16 ft) specimen was stranded on Ensenada de los Muertos, Baja California Sur, Highway 286, 21.6 km from Los Planes. It was photographed by Sandra Frederickson and party (Fig. 3F). The tail was missing. The pictures, negatives and a letter were sent from Ms. Frederickson to the LACM on 10 April 1995. The date and locality do not match any record listed in published references relating to Sea of Cortez strandings (Galván-Magaña et al. 1999; Salazar-Hermoso 1999; Roberts 2012).

a bimodal pattern, with a peak from March to September and again from December to January; no oarfish are reported in February or November. The recent numbers in both Mexico and California in the eastern Pacific indicate an increasing trend in sightings. Not all past sightings coincided with an El Niño event (Fig. 5). There is, however, an increasing trend in sea surface temperatures during 1900–2012 of about 0.5–1.0°C (Johnstone and Mantua 2014).

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