

## **Geographic range and biology of Spinyeye Rockfish (*Sebastes spinorbis* Chen, 1975), an endemic species to the Gulf of California, Mexico**

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The genus *Sebastes* is composed of 110 species that inhabit marine waters from the intertidal zone to depths greater than 1000 m (Haldorson and Love 1991, Love et al. 2002, Hyde and Vetter 2007). Members of this genus (99 species) are distributed throughout the North Pacific with at least four in the North Atlantic and two in the southern hemisphere (Hyde and Vetter 2007). Seven species of the genus *Sebastes*, including the Spinyeye Rockfish (*Sebastes spinorbis*), are found in the Gulf of California and six of these are endemic to the Gulf (Love et al. 2002, Hyde and Vetter 2007, Palacios-Salgado et al. 2012). The Spinyeye Rockfish differs from other members of the genus by the presence of a spine on the lateral surface of the corner of the eye and/or the orbital border of the first and second suborbital (Chen 1975). Adults are pink to red with some orange shading; they have six pale dorsal spots and can reach 344 mm total length (TL) (Love et al. 2002, Robertson and Allen 2015). Little information is available about the bathymetric and geographic distribution of this species. Its previously known geographic range was reported associated with rocky bottoms in the vicinity of Bahía de Los Angeles and Ángel de la Guarda Island in the central region of the Gulf of California, primarily on the continental external shelf at depths from 130–200 m (Castro-Aguirre and Balart 1996, Castro-Aguirre et al. 2005). Nevertheless, Acevedo-Cervantes et al. (2009) have reported this species recently at depths of 200–540 m.

At present, Spinyeye Rockfish is not a fishing target, and it is not considered a species of conservation concern. Little information is available on its biology (Castro-Aguirre et al. 2005) because it inhabits deep waters and is absent in commercial and recreational fisheries (Castro-Aguirre and Balart 1996, Love et al. 2002). Therefore, this research provides basic information on latitudinal and bathymetric distribution, sizes and reproductive biology of Spinyeye Rockfish in the Gulf of California. The study documents an expansion of the current range to the central Gulf region where it had not been historically recorded. Finally, the presence of Spinyeye Rockfish has now been documented over soft bottoms, contrasting with previous studies reporting that it was only associated with rocky bottoms.

## MATERIAL AND METHODS

Specimens were obtained from three research cruises on board the R/V BIP XII, during September 2004 and February and May 2005. The primary purpose of these cruises was shrimp species exploration in waters greater than 80 m deep. Fishing trawl tows were performed on soft bottoms from Puerto Peñasco, Sonora (31°N) to Topolobampo, Sinaloa (25°N) at depths from 90–540 m in the eastern coast (Figure 1). The fishing equipment used was a bottom polyethylene trawl 38 m long, 68 m mouth perimeter, 38 m headline, 2.54 cm mesh size and operated astern.

After one hour of effective trawling (fishing haul time average, 2.0 knots average velocity), a sample (20 kg) was taken from the total catch at each station and frozen on

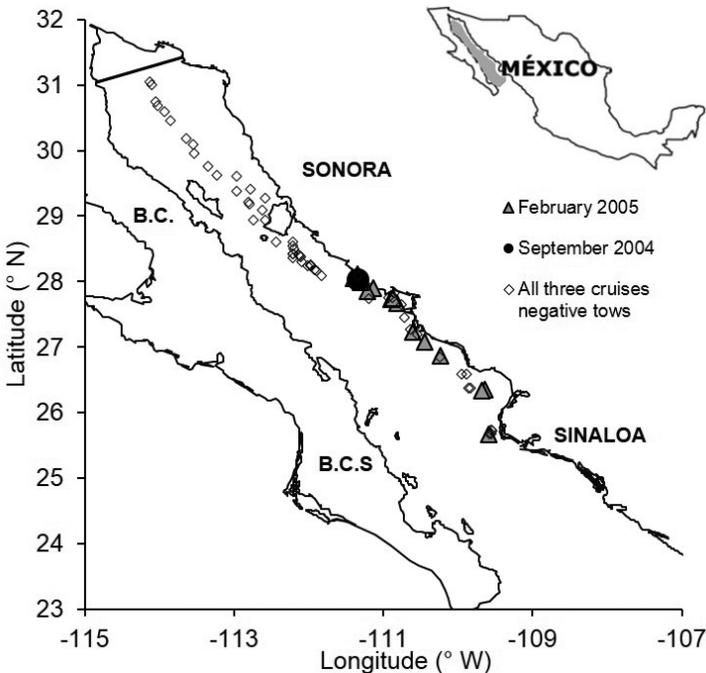


FIGURE 1.—Geographical location of *Sebastes spinorbus* collected in the Gulf of California in September 2004 and February 2005. All cruises negative tows are also shown.

board until it was processed at CIBNOR Fisheries Laboratory at Guaymas, Sonora. The depth and vessel position of each trawl haul was recorded with an echo sounder and GPS. Water temperature and dissolved oxygen in the water column were measured with CTD-SD204 at every station.

In the laboratory, the *Sebastes* specimens were separated and identified following Chen (1975) and Love et al. (2002). Each specimen was measured for standard length (SL) (mm) using a conventional ichthyometer to 1 mm precision and total weight (g) with a conventional Ohaus balance to 0.1 g precision. The length/weight relationship for Spinyeye Rockfish was calculated using the equation  $W = a L^{*b}$ . In addition, the gonad maturity stage from females and males was recorded visually according to Nikolsky (1963) morph-chromatic scale, which is based on colour and gonad texture, as well as its space in the abdominal cavity. The specimens in stages I–II were considered immature (gonads flaccid, transparent and less than one half of the space in the abdominal cavity); those in stages III–V were considered mature (gonads coloured and more than one half of the space in the abdominal cavity). According to the depth in which specimens of Spinyeye Rockfish were caught, the relationship between depth and fish size was explored.

## RESULTS

A total of 392 Spinyeye Rockfish were collected during the three cruises (71 trawl tows). Eighteen individuals were caught in September 2004, 374 in February 2005, and none in May 2005. Capture depth of Spinyeye Rockfish ranged from 95 to 482 m (Figure 1).

The observed sizes for Spinyeye Rockfish ranged from 68 to 268 mm with two modal frequencies at 130 and 200 mm SL (Figure 2). No difference by sex in sizes (Figure 2) and evident relationship between size and capture depth were observed. The length/weight relationship for the sampled size interval showed a coefficient of allometry  $b$  of 2.9787 (Limits: lower 2.92–3.03 upper, 95% confidentiality) and  $a$  value of 0.00002.

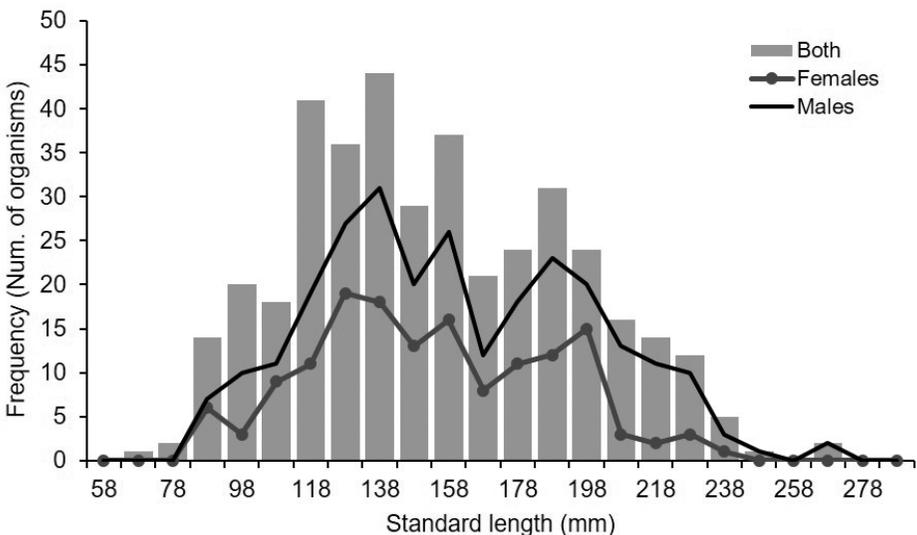


FIGURE 2.—Size frequency by sex of *Sebastes spinorbis* caught in the Gulf of California in September 2004 and February 2005.

Of the 392 fish analysed on September 2004 and February 2005, 40% were females, 31% males (M/F ratio 1:1.35) and 29% were undetermined. Five gonadal maturity stages were recorded in females, of which 33% were in process to maturity (stages I and II) and 67% sexually mature (stages III to V). Four gonadal maturity stages were recorded in males, 57% were in process to maturity (stage II) and 43% sexually mature (stages III to V).

The temperature and dissolved oxygen profiles in the water column of one station where Spinyeye Rockfish was collected (February 2005- 400 m deep) showed a rapid fall starting from 70 m in depth, reaching temperatures of less than 10°C and levels of almost anoxia at 400 m (Figure 3).

## DISCUSSION

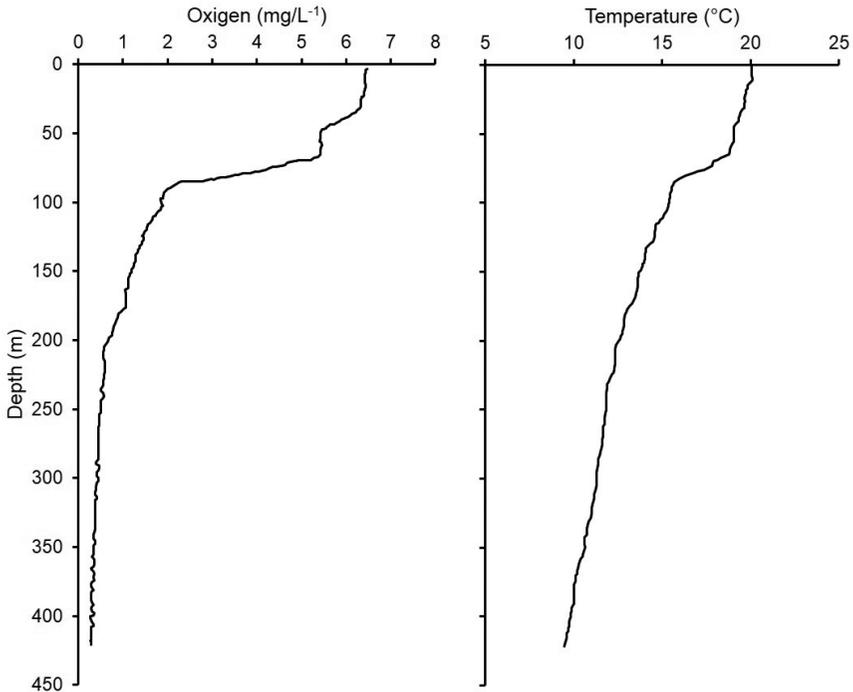


FIGURE 3.—Vertical distribution of the temperature and oxygen concentration, recorded during a positive tow in the Gulf of California.

This work shows an expansion of the documented distribution for Spinyeye Rockfish of approximately 3° in latitude (500 km) from Bahía de Los Ángeles and Isla Ángel de la Guarda in the Gulf of California southward to Topolobampo, Sinaloa (Figure 1). This report also confirms the depth record established for the species by Acevedo-Cervantes et al. (2009) of 480 m in contrast to Love et al. (2002), Castro-Aguirre et al. (2005) and Robertson and Allen (2015) who documented the presence of this species to a depth of 200 m. In this study Spinyeye Rockfish were caught on soft bottoms, contrasting also with the reports that it had been associated only with rocky bottoms.

The wide bathymetric distribution of this species suggests substantial environmental plasticity and perhaps the ability to tolerate low temperatures and anoxic conditions in the Gulf of California (Figure 3). These extreme conditions in the central Gulf of California had already been reported by Hendrickx and Serrano (2010) and Acevedo-Cervantes et al. (2009). The influence of these extreme conditions, especially on Caridea crustaceans and fishes, causes a drastic reduction in species number and abundance in the oxygen minimum zone (OMZ). This zone, which started with oxygen values less than  $0.5 \text{ mg L}^{-1}$ , was located close to 250 m in the central Gulf of California; however, the species develops in shallower water off Sinaloa (Acevedo-Cervantes et al. 2009, Hendrickx and Serrano 2010, Serrano 2012). The Spinyeye Rockfish is a species that uses the prevalent environmental conditions in the OMZ successfully, both over rocky and soft bottoms within the Gulf of California.

With respect to length of Spinyeye Rockfish, they ranged from 68 to 268 mm SL, 5 mm less than the maximum recorded by Love et al. (2002) of 273 mm SL (344 mm TL). Its maximum size recorded suggests it is not a big species, compared to other members of the genus distributed off coastal California and which are attractive to fishing (Love et al. 1990).

The bathymetric distribution of Spinyeye Rockfish is apparently not related to size, contrary to size segregation with depth in several species of this genus observed by Love et al. (1990). The length-weight relationship showed a value of  $b$  close to isometry (2.978), which agreed with similar results for 19 species of the *Sebastes* genus obtained by Love et al. (1990) on the California coast.

Based on the gonadal maturity stages of the females caught, 67% were sexually mature (stages III to V). It may indicate that spawning for this species occurs from February to August in the Gulf of California.

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