The Bigeye Scad, Selar crumenophthalmus (Bloch, 1793) (Family Carangidae), New to the California Marine Fauna, with a List to and Keys for All California Carangids

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The Bigeye Scad, *Selar crumenophthalmus* (Bloch, 1793) (Family Carangidae), New to the California Marine Fauna, with a List to and Keys for All California Carangids

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The anomalously warm waters of the northeast Pacific 2014–2015 brought with it a variety of subtropical and tropical fish species previously unusual or absent from California waters (Bond et al., 2015; pers. comm. M. McCrea, pers. comm.; J. Shepherd). On 1 February 2015, Mr. Keichichi Yamamoto speared a fish that we have identified as *Selar crumenophthalmus* (Bloch, 1793), the bigeye scad (Fig. 1). The fish was captured in the midwaters of a kelp bed (bottom depth 8 m) off Rancho Palos Verdes (33°48′N, 118°24′W), southern California. This is the first time this species has been reported from off California. The fish he speared was one of approximately 10 conspecifics that were swimming with a school of juvenile jack mackerel, *Trachurus symmetricus* (Ayres, 1855). This specimen is housed in the fish collection at the Natural History Museum of Los Angeles County, LACM 58288-1.

We identified this fish (22.4 cm fork length) through the following diagnostic characters: Two papillae on the bone margin at the rear of the gill chamber (the lower one larger than the upper); the presence of a large eye (eye width greater than snout length) with adipose eyelid covers; and dorsal, anal, and pectoral fin counts and gill raker counts (Table 1). Meristics from our specimen fall within the range reported by other studies. Hardened scutes were present in the posterior lateral line. No finlets were present. The fish color was olive on dorsum, with a golden stripe along flanks, and a silvery belly. There was a diffuse golden ring around the eye.

Bigeye scad are normally circumtropical. In the western Pacific, they have been found as far northward as the Pacific coast of southern Japan (Nakabo, 2002) and Sea of Japan (Parin, 2003). Previous to this capture, the eastern Pacific range was from Lagunas Ojo de Liebre-Guerrero Negro, central Baja California (Galván-Magaña et al., 2000) to Cabo Blanco, Peru (Chirichigno, 1974), including the Gulf of California (Smith-Vaniz in Fischer et al., 1995), Islas Galápagos (Grove and Lavenberg, 1997), Isla de Malpelo, Isla de Coco, Isla Clipperton, and Islas Revillagigedo (Robertson and Allen, 2008). This is a pelagic species found from surface waters to depths of 170 m (558 ft) (Randall et al., 1990, Allen and Robertson, 1994). It reaches a maximum length of 70 cm (Kuiter and Tonozuka, 2001).

Of particular interest is that Mr. Yamamoto first observed a similar number of what were likely the same species in the same location in November 2014, also mixed in with juvenile jack mackerel. In addition, Mr. Yamamoto continued to observe bigeye scad at this location to as late as early March 2015, at this time swimming with a school of juvenile Pacific barracuda (*Sphyraena argentea* Girard, 1852). These sightings suggest that at least some bigeye scad may remain within a relatively circumscribed area for lengthy periods.

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The addition of the bigeye scad to the California marine fauna brings the total number of jack species taken from these waters to 16 (Table 2). The last key to the California species (Miller and Lea, 1972) was based on 13 species and we include a new key to all known California species, using the key to eastern Pacific species created by W. F. Smith-Vaniz in Fischer et al. (1995) as a starting point. We note that this new key was tested on individuals of all carangids found in California waters. In addition to the California species, we have also included in the key the Japanese amberjack, *Seriola quinqueradiata* Timminck & Schlegel, 1845. In 2015, this species was found inside the wreckage of a Japanese vessel destroyed in the Fukushima tsunami that had floated to the Oregon coast (J. Burke, pers. comm.) raising the possibility of future captures off California. In addition, this species is often sold in California fish markets and in our experience this has led enforcement officers to confuse it with the eastern Pacific species, the yellowtail, *Seriola dorsalis* Gill (1863).

Key to the California Carangidae

1a Head profile strongly oblique; very small, embedded scales, leading to apparently naked body; very compressed body in adults ........................................... 2
1b Head profile not strongly oblique; no embedded scales; moderately compressed body in adults ................................................................. 3

2a Oblique head profile has a slight concavity in front of eyes; small juveniles with an oval black spot above the straight portion of the lateral line: ............... *Selene peruviana*
2b Oblique head profile lines nearly straight in front of eyes; small juveniles with 4 or 5 interrupted dark vertical stripes on the body: .................. *Selene brevoortii*

3a From 1b: Head profile not strongly oblique...

   Posterior straight part of lateral line with hardened scutes or bony shields, scutes can be poorly developed ................................................................. 4
3b Posterior straight part of lateral line without scutes (only pored scales, not enlarged) .......... 12

Table 1. Meristics of bigeye scad, *Selar crumenophthalmus* (Bloch, 1793) from this study, Moser et al. (1996), Nakabo (2002), and Robertson and Allen (2015).

<table>
<thead>
<tr>
<th>Source</th>
<th>Dorsal fin</th>
<th>Anal fin</th>
<th>Pectoral fin</th>
<th>Gill rakers 1st arch</th>
</tr>
</thead>
<tbody>
<tr>
<td>This study</td>
<td>VIII+1,27</td>
<td>II+1,23</td>
<td>23</td>
<td>11+27&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Counts from right arch as left gill arches were lost during capture.
Table 2. Members of the family Carangidae that are known from California waters, with notes on their maximum sizes, and geographic and depth ranges.

<table>
<thead>
<tr>
<th><strong>Species</strong></th>
<th><strong>Common Name</strong></th>
<th><strong>Maximum Size</strong></th>
<th><strong>Geographic Range</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Caranx caballus</strong></td>
<td>Pacific Crevalle Jack</td>
<td>To 120 cm TL</td>
<td>Florida Keys to Galápagos Islands</td>
</tr>
<tr>
<td><strong>Caranx caninus</strong></td>
<td>Pacific Suzuki</td>
<td>To 100 cm TL</td>
<td>Peru to the Galápagos Islands</td>
</tr>
<tr>
<td><strong>Caranx sexfasciatus</strong></td>
<td>Pacific Bumper</td>
<td>To 38 cm SL</td>
<td>Palos Verdes to the Galápagos Islands</td>
</tr>
<tr>
<td><strong>Decapterus muroadsi</strong></td>
<td>Amberstreak Scad</td>
<td>To 55 cm TL</td>
<td>Florida to Isla Malpelo</td>
</tr>
<tr>
<td><strong>Naucrates ductor</strong></td>
<td>Pilotfish</td>
<td>To 70 cm TL</td>
<td>California to Japan</td>
</tr>
<tr>
<td><strong>Salar crumenophthalmus</strong></td>
<td>Bigeye Scad</td>
<td>To 70 cm</td>
<td>Peru to Japan</td>
</tr>
</tbody>
</table>
Table 2. Continued.

*Selene brevoortii* (Gill, 1863). Mexican Lookdown. To 42 cm TL (Robertson and Allen 2002). Seal Beach, southern California (Jarvis et al. 2009) to northern Chile (Sielfeld et al. 2010), including Gulf of California (Smith-Vaniz in Fischer et al. 1995). Coastal waters, including bays and estuaries (Moser 1996), to 50 m (Robertson and Allen 2002). D VII–VIII + I,20–24; A II + I,17–19; Pect. 18–19; GR 5–9 + 28–34; Vert. 24.

*Selenopsetta peruviana* (Guichenot, 1866). Pacific Moonfish. To variously between 35 cm TL (Velasco and Thiel 2002) and 85 cm TL (Franke and Acero 1993). Long Beach, southern California (Miller and Lea 1972) to Chile (Pequeño 1989), including Gulf of California (Smith-Vaniz in Fischer et al. 1995) and Islas Galápagos (Grove and Lavenberg 1997). Inshore (Grove and Lavenberg 1997) and shallow coastal waters (Moser 1996) to 450 m (Franke and Acero 1993). D VIII + I,20–24; A II + I,16–19; LL shields nearly obsolete; GR 8 + 28–32; Vert. 24.

*Seriola rivoliana* Gill (1863). Yellowtail. To at least 1.5 m (5 ft) TL (Miller and Lea 1972). In eastern Pacific from northern British Columbia (54°35’N, 31°00’W; Nagtegaal and Farlinger 1981) to central Mexico (Robertson and Allen 2015), including Gulf of California (Miller and Lea 1972), Islas Galápagos (Grove and Lavenberg 1997), and Isla Malpelo (Robertson and Allen 2002). Unverified reports from Gulf of Alaska off Kodiak Island and Cordova (Mecklenburg et al. 2002). Primarily epipelagic, recorded from surface to at least 91 m (300 ft) (min.: Miller and Lea 1972; max.: N. Ben-Aderet, pers. comm.). Individu- als from the eastern Pacific have recently been referred to as the widely distributed *Seriola lalandi* Valenciennes, 1833. However, we follow Martinez-Takeshita et al. (2015) and limit the distribution of *S. lalandi* to the Southern Hemisphere, resurrecting *S. aureovittata* Temminck & Schlegel (1845) in the northeast Pacific, and *S. dorsalis* in the eastern Pacific. D IV–VII + I,29–39; A O–II + I,19–25; Pect. 19–20; Pelvic I,5; GR 5–10 + 15–22; Vert. 25.

*Seriola dorsalis* Gill (1863). Mexican Lookdown. To at least 1.5 m (5 ft) TL (Miller and Lea 1972). In eastern Pacific from northern British Columbia (54°35’N, 31°00’W; Nagtegaal and Farlinger 1981) to central Mexico (Robertson and Allen 2015), including Gulf of California (Miller and Lea 1972), Islas Galápagos (Grove and Lavenberg 1997), and Isla Malpelo (Robertson and Allen 2002). Unverified reports from Gulf of Alaska off Kodiak Island and Cordova (Mecklenburg et al. 2002). Primarily epipelagic, recorded from surface to at least 91 m (300 ft) (min.: Miller and Lea 1972; max.: N. Ben-Aderet, pers. comm.). Indivi- duals from the eastern Pacific have recently been referred to as the widely distributed *Seriola lalandi* Valenciennes, 1833. However, we follow Martinez-Takeshita et al. (2015) and limit the distribution of *S. lalandi* to the Southern Hemisphere, resurrecting *S. aureovittata* Temminck & Schlegel (1845) in the northeast Pacific, and *S. dorsalis* in the eastern Pacific. D IV–VII + I,29–39; A O–II + I,19–25; Pect. 19–20; Pelvic I,5; GR 5–10 + 15–22; Vert. 25.

*Seriola rivoliana* Valenciennes, 1833. Almaco Jack. To 160 cm FL [about 176 cm TL] (IGFA). Circumglobal; Korea (Kim et al. 1997) and southern Japan (Nakabo 2002); Oceanside, southern California (Eschmeyer 1937) to Cabo Blanco, Peru (Chirichigno and Vélez 1998), including Gulf of California (Smith-Vaniz in Fischer et al. 1995) and Islas Galápagos (Chirichigno and Vélez 1998). Pelagic, at depths of 1–250 m (min.: Kuiter and Tonozuka 2001; max.: Robertson and Allen 2002). D VIII + I,26–33; A II + I,18–21; Pect. 19–24; Pelvic I,5; Vert. 23; LLs 167; GR 6–9 + 16–19 = 22–28; Vert. 24.


*Trachurus symmetricus* Ayres, 1855. Jack Mackerel. To 81.3 cm TL (Miller and Lea 1972). Pacific Ocean south of Aleutian Islands (Mecklenburg et al. 2002 [UW 15469]) and in Gulf of Alaska to Gulf of Cali- fornia (Smith-Vaniz in Fischer et al. 1995) and to Acapulco, Mexico (Palacios-Salgado et al. 2014). Pri- marily pelagic, surface (Miller and Lea 1972) from surf zone (Carlisle et al. 1960) and offshore to 403 m (Hart 1973). Although *Trachurus murphyi* Nichols, 1920, found off South America, is considered by some authors (e.g., Grove and Lavenberg 1997) to be a subspecies of *T. symmetricus*, DNA evidence indicates it is a separate species (Poulin et al. 2004). D VIII + I,28–38; A II + I,22–33; Pect. 21–24; Pelvic I,5; LLs 87–111, the later 40–55 as enlarged shields; GR 7–15 + 25–42 = 32–57; Vert. 23–25.

*Uraspis helvola* (Forster, 1801). Whitemouth Jack. To 58 cm TL (Jiménez Prado and Béarez 2004). Indo-Paci- fic; perhaps southern Kuril Islands (Savinykh and Shevtsov 2001) and southern Japan (Nakabo 2002); Santa Catalina Island, southern California (Miller and Lea 1972), southernmost Gulf of California (J. Snow, pers. comm.), and at a number of more southerly locations (Robertson and Allen 2015) to Ecuador (Béarez 1996), including Islas Galápagos (Grove and Lavenberg 1997). 10–300 m (Robertson and Allen 2002). D V–VIII + I,25–30; A II + I,19–22; Pect. I,22; LL with 32–38 keeled shields; GR 6 + 16 = 22. The Santa Catalina Island specimen was originally identified as *Uraspis secunda* (Fitch 1972). However, *U. secunda* appears to be an Atlantic and Indo-Central Pacific species (W. Smith-Vaniz and R. Robertson, pers. comm.s. to M. L.).
4a Lateral line with reduced (very stunted), barely perceptible scutes; a black spot on the saddle of the upper region of the caudal peduncle; strongly compressed body: .......................... Chloroscombrus orqueta

4b Well-developed lateral line scutes; caudal peduncle without black spot; body not strongly compressed .......................................................... 5

5a Dorsal accessory branch of the lateral line extends at least to below origin of 2nd dorsal fin, usually farther posteriorly: ................................. Trachurus symmetricus

5b Dorsal accessory branch of the lateral line terminating before origin of dorsal fin ........ 6

6a Independent 2-rayed finlet at caudal peduncle (dorsal and ventral): ........... Decapterus muroadsi

6b Second dorsal and anal fins without finlets ........................................ 7

7a Cleithrum, under the operculum, with a furrow (groove) on the ventral side, a large papilla-like structure immediately above the groove; eye nearly covered by an adipose eyelid, forming a vertical slit on the center of the pupil: .......................... Seral crumenophthalmus

7b Smooth-edge cleithrum; adipose eyelid marginally covering eye but not pupil ........ 8

8a Tongue, roof, and floor of mouth white, the rest black; no teeth on vomer or palatines: .......................................................... Uraspis helvola

8b Lining of mouth not distinctly black and white; teeth present on vomer and palatines ... 9

9a Breast without scales except for a small patch of scales at base of pelvic fins (prepelvic): .......................................................... Caranx caninus

9b Breast completely scaled. ........................................................................ 10

10a Number of scutes in the lateral line 26–42; total number of gill rakers on the lower limb (including rudiments) 15–22; lobe of second dorsal fin with a white tip and its height into fork length 5.0 to 6.6 times in adults: ........................................ Caranx sexfasciatus

10b Number of scutes in the lateral line 42–56; total number of gill rakers on the lower limb (including rudiments) 27–30; lobe of second dorsal fin without white tip and its height into fork length 6.0 to 8.0 times in adults .................................................. 11

11a In adults, body without dark vertical stripes; scaly basal sheath along the lobes of the dorsal and anal fins with relatively narrow scales, above which the fins are almost entirely covered with small scales; back of the eye covered by a weak adipose eyelid extending to the rear edge of the pupil: .......................... Caranx caballus

11b In adults, body with 8–9 dark incomplete vertical stripes; scaly basal sheath along the lobes of the dorsal and anal fins with relatively wide scales above which the fins are devoid of small scales; back of the eye covered by a weak adipose eyelid that does not reach the posterior edge of the pupil: .......................... Caranx vinctus

12a From 3b: Posterior straight part of lateral line without scutes...

Caudal-peduncle grooves (or shallow notch) present dorsally and ventrally; base of soft dorsal and anal fins unequal in length with anal-fin base shorter (only about 45–70%) than dorsal-fin base length .................................................. 13

12b Caudal-peduncle grooves absent; base of soft anal fin as long as, or only slightly shorter than, base of dorsal fin .......................................................... 15

13a Fleshy keel on caudal peduncle well developed; soft anal-fin rays 15–17; body with 5–6 dark vertical bars, extending to bases of dorsal and anal fins: .................. Naucrates ductor

13b Fleshy keel on caudal peduncle absent to moderately developed; soft anal-fin rays 18–22; body lacking obvious wide vertical bars. .......................... 14

14a Longest dorsal soft-ray about 1/2 length of head; relatively slender supramaxilla; caudal fin yellowish; yellow stripe along mid-body; head longer than body depth at origin of dorsal fin: ........................................... Seriola dorsalis

Note: Seriola quinqueradiata can be differentiated from S. dorsalis by 1) the latter’s more rounded dorsoposterior corner of upper jaw (Figure 2) and 2) a pectoral fin shorter than pelvic fin versus 1) more angular and 2) almost equal in length.
14b Longest dorsal soft-ray about 2/3 length of head in fish over 18 cm fork length; relatively
broad supramaxilla; caudal fin dark to dusky; black stripe radiating from mandibles, through eye,
to 1st dorsal spines; head shorter than body depth at origin of dorsal fin: .......... Seriola rivoliana

15a From 12b: Caudal-peduncle grooves absent...
First 4–5 dorsal and anal soft-rays elongated, longer than head length in fish over 8 cm fork
length; in adults, 4–6 incomplete vertical bars extending beyond the lateral line; 22–26
gill rakers (8–10 on upper limb): ...................... Trachinotus rhodopus

15b First 4–5 dorsal and anal soft-rays equal to or shorter than head length; in adults, no vertical bars as
described above; 15–18 gill rakers (5–7 on upper limb): ............... Trachinotus paitensis

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