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Cover Page Footnote

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Aspects of the Life Histories of Pinkrose Rockfish (*Sebastes simulator*) and Swordspine Rockfish (*Sebastes ensifer*) with Notes on the Subgenus *Sebastomus*

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The rockfishes, genus *Sebastes*, form an extremely speciose group that often dominates the fish assemblages of California reefs between depths of 30 and 300 m (Love et al. 2002). The genus is divided into a number of subgenera (estimated at between 13 and 15, Hyde and Vetter 2007) among which the subgenus *Sebastomus* is particularly well characterized by congruencies in both morphology and genetics (Chen 1971; Rochas-Olivares et al. 1999; Hyde and Vetter 2007). In general, species in this subgenus are relatively small (to a maximum of 56 cm total length) (Table 1) and all are benthic or epibenthic (Love 2011). In addition, with the exception of *Sebastes helvomaculatus*, all of the North American species are relatively warm-water, and most are rare or absent from waters north of central California (Table 1).

The basic biology and ecology of most of the *Sebastomus* living in the northeastern Pacific (i.e., with ranges extending at least into California waters) have been fairly well documented (summarized in Love et al. 2002; Love 2011; Fields 2016). The main exception was *Sebastes simulator*, the pinkrose rockfish, and to a lesser extent, *Sebastes ensifer*, the swordspine rockfish, whose life histories, were poorly understood. In this paper, we report on a number of aspects on the biology of *S. simulator*, provide supplementary data on the biology of *Sebastes ensifer*, and update basic information on all species in the subgenus *Sebastomus*. We collected specimens by hook-and-line from southern California waters (primarily from the northern Channel Islands), immediately placed them on ice aboard a research vessel, and then froze them in the lab for later examination. All specimens were measured [standard (SL), fork (FL), and total (TL) length] to the nearest millimeter and most were weighed (to the nearest 0.1 g). All lengths are reported as TL.

We used sagittal otoliths for age determinations; these were removed and stored dry in coin envelopes. For age determinations, each otolith was glued to a wooden block, placed on a Bueller Isomet low-speed saw and a 0.05-cm wafer was cut from it, using two diamond-edge blades separated by a stainless-steel shim. Before reading, the wafers were slightly burned over an alcohol lamp. The wafers were then placed in a water-filled, black-bottomed watch glass and examined under a dissecting microscope. All wafers were read twice by M. Love. When reading did not agree, the otoliths were read again. The value of two coincident readings was accepted as the best estimate of age. We judged that the otoliths of about 5% of the specimens were unreadable due to poorly developed annuli.

Lengths at ages were estimated by direct observation of otolith annuli and by using the von Bertalanffy growth model:

$$L_t = L_\infty [1 - \exp - k(t - t_0)],$$

Where L_t = length at time t ;

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Table 1. Species of the subgenus *Sebastomus* including maximum lengths, geographic ranges, and depth ranges. LACM = Los Angeles County Museum of Natural History; SIO = Scripps Institution of Oceanography Marine Invertebrate Collection; CAS = California Academy of Science; RACE = Resource Assessment and Conservation Engineering Division, NOAA; SAIAB = South African Institute for Aquatic Biodiversity; SCCWRP = Southern California Coastal Water Research Project.

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- Sebastes capensis*** (Gmelin, 1789). **Cape Redfish.** 40 cm (15.7 in) TL (SAIAB 18249). Argentina, Falkland Islands, Trista de Cunha Island, and southern Africa (Venurus 2013). 4–223 m (13–731 ft) (min.: SAIAB 18242; max.: SAIAB 74972). Historically, this species has been confused with *S. oculatus*. Based on recent research (Venurus 2013), fish from at least Peru and Chile, once thought to be *S. capensis*, are now assumed to be *S. oculatus*. Therefore, length and depth records of “*S. capensis*” from the southeastern Pacific are not valid. In addition, *S. capensis* and *S. oculatus* co-occur off Argentina and there has likely been confusion in identifying the two species off that coast. Thus, the size and depth data we present are taken from museum records of individuals living in areas where only *S. capensis* is known to exist.
- Sebastes chlorostictus*** (Jordan & Gilbert, 1880). **Greenspotted Rockfish.** 53.4 cm (21 in) FL (D. Pearson, pers. comm. to M. Love). Vancouver Island (49°04'N, 126°50'W) (Canada Department of Fisheries and Oceans, unpubl. data) to at least Isla Cedros (28°22.62'N, 115°17.46'W), central Baja California (collected by M. L.) or perhaps to southern Baja California (25°32'N, 113°04'W; Snytko 1986) but without documentation. At depths of 30–379 m (98–1,243 ft) (min.: M. Love, unpubl. data; max.: RACE).
- Sebastes constellatus*** (Jordan & Gilbert, 1880). **Starry Rockfish.** To 46 cm (18 in) TL (Phillips 1957). Off the mouth of the Russian River, northern California (CAS 26375) to off Todos Santos (23°24'N, 110°14'W), southern Baja California (J. Snow, pers. comm. to M. Love). Tentatively identified from photographs taken at Rocas Alijos (about 25°N, 115°45'W; R.N. Lea, pers. comm. to M. Love). At depths of 15–274 m (50–900 ft) (min.: D. Jehl, pers. comm. to M. Love; max.: Miller and Lea 1972).
- Sebastes ensifer*** Chen, 1971. **Swordspine Rockfish.** To 30.5 cm (12 in) TL (Miller and Lea 1972). San Francisco, northern California (Miller and Lea 1972) to Banco Ranger (28°25'N, 115°32'W), central Baja California (Chen 1971). At depths of 50–433 m (164–1,420 ft) (min.: M. Love, unpubl. data; max.: Miller and Lea 1972).
- Sebastes eos*** (Eigenmann & Eigenmann, 1890). **Pink Rockfish.** To 56 cm (22 in) TL (Phillips 1957). Central Oregon (44°33'N; RACE) to southern Baja California (27°01.2'N, 114°16.2'W) (SIO 65-203) or perhaps to 25°24'N, 113°01'W (Snytko 1986), but without documentation, and Isla Guadalupe, central Baja California (Love et al. 2002). At depths of 45–366 m (150–1,200 ft) (min.: Allen et al. 2002¹; max.: Miller and Lea 1972).
- Sebastes exsul*** Chen, 1971. **Gulf Rockfish.** To 31 cm (12.1 in) (Love et al. 2002). Gulf of California in the vicinity of Bahia de los Angeles (Love et al. 2002). At depths of 110–213 m (363–699 ft) (min.: Love et al. 2002; max.: SIO 06-266).
- Sebastes helvomaculatus*** Ayres, 1859. **Rosethorn Rockfish.** To 43 cm (16.9 in) TL (Yamanaka 2005). Western Gulf of Alaska east of Sitkinak Island (Mecklenburg et al. 2002) to at least about U.S.-Mexican border (32°26.1'N, 119°06.6'W) (SIO 64-988) or perhaps to Banco Ranger (28°33'N, 115°25'W), central Baja California (Snytko 1986) but without documentation. At depths of 16–1,145 m (52–3,756 ft) (min.: Canada Department of Fisheries and Oceans, unpubl. data; max.: Ramsey et al. 2002²).
- Sebastes lentiginosus*** Chen, 1971. **Freckled Rockfish.** To about 23 cm (9 in) TL (Miller and Lea 1972). Point Conception, central California (34°36'N; RACE) to southern Baja California (25°37'N, 113°24'W) (LACM 42178.004). At depths of 22–168 m (73–551 ft) (min.: M. L., unpubl. data; max.: SIO 48-196), reported without documentation to 290 m (951 ft) (Snytko 1986).
- Sebastes notius*** Chen, 1971. **Guadalupe Rockfish** or Southern Rockfish. To 21.9 cm (8.6 in) SL (Chen 1971). This species has been collected at two sites: Isla Guadalupe (29°N; Chen 1971), central Baja California and in the vicinity of Banco del Tio Sam (Uncle Sam Bank; 25°35'N), southern Baja California (Rocha-Olivares 1998). At depths of 165–250 m (541–820 ft; Chen 1971).
- Sebastes oculatus*** Valenciennes, 1833 (in Cuvier and Valenciennes, 1833). **Patagonian Rockfish** or Patagonian Redfish. 40.8 cm (16 in) TL (Venurus et al. 2016). Peru, Chile, Argentina, and Falkland Islands (Venurus et al. 2013). At least 30–271 m (98–899 ft) and perhaps to 665 m (2,181 ft) (Venurus et al. 2013). Light and dark color morphotypes, perhaps incipient species, live off Argentina (Venurus et al. 2013).
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Table 1. Continued.

Sebastes rosaceus Girard, 1854. **Rosy Rockfish.** To 36 cm (14 in) TL (Eschmeyer and Herald 1983). Cobb Seamount (46°44'N, 130°47'W) (Oregon State Ichthyology Collection 15632) to Bahia Tortugas (27°30'N, 114°50'W), southern Baja California (Phillips 1957). A report from the Strait of Juan de Fuca, Washington (Echeverria and Love 2002) is undocumented. At depths of 7–328 m (24–1,076 ft) (min.: SCCWRP; max.: Bradburn et al. 2011).

Sebastes rosenblatti Chen, 1971. **Greenblotched Rockfish.** To 54 cm (21.3 in) TL (Love et al. 1990). Point Delgada, northern California (40°04'N; RACE) to Banco Ranger, central Baja California (Chen 1971). At depths of 55–491 m (180–1,610 ft) (min.: M. Love, unpubl. data; max.: Wilkins et al. 1998³).

Sebastes simulator Chen, 1971. **Pinkrose Rockfish.** Largest documented individual 34.5 cm (13.6 in) TL (SIO 79-73); one undocumented record at 42.1 cm (16.4 in) TL (León-Castro et al. 1993). Carmel Submarine Canyon, central California (R. N. Lea, pers. comm. to M. Love) or perhaps to Eureka, northern California (D. Pearson, pers. comm. to M. Love) to Punta Colnett (30°53'N, 116°30'W), northern Baja California (M. Love, unpubl. data) and Isla Guadalupe, central Baja California (León-Castro et al. 1993). At depths of 99–450 m (325–1,476 ft) (min.: Eschmeyer and Herald 1983; max.: Chen 1971).

Sebastes spinorbis Chen, 1975. **Spiny-eye Rockfish.** To 34.4 cm (13.4 in) (Love et al. 2002). Gulf of California in the vicinity of Bahia de los Angeles (Love et al. 2002). 130–213 m (429–700 ft) (min.: Love et al. 2002; max.: SIO 06-266).

Sebastes umbrosus (Jordan & Gilbert, 1882). **Honeycomb Rockfish.** To 28.5 cm (11.2 in) TL (M. Love, unpubl. data). Point Pinos, central California (Miller and Lea 1972) to Rocas Alijos (24°57'N, 15°44'W), southern Baja California (LACM 37658.002). At depths of 18–270 m (60–891 ft) (min.: M. Love, unpubl. data; max.: León-Castro 1993).

¹ Allen, M.J., A.K. Groce, D. Diener, J. Brown, S.A. Steinert, G. Deets, J.A. Noblet, S.L. Moore, D. Diehl, E.T. Jarvis, V. Raco-Rands, C. Thomas, Y. Ralph, R. Gartman, D. Cadien, S.B. Weisberg, and T. Mikel. 2002. Southern California Bight 1998 Regional Monitoring Program: V. Demersal fishes and megabenthic invertebrates. Southern California Coastal Water Research Project. Westminster, California.

² Ramsey, T.B., T.A. Turk, E.L. Funk, J.R. Wallace, B.H. Horness, A.J. Cook, K.L. Bosley, D.J. Kamikawa, L.C. Hufnagle, and K. Piner. 2002. The 1999 Northwest Fisheries Science Center Pacific West Coast upper continental slope trawl survey of groundfish resources. NOAA Tech. Mem. NMFS-NWFSC-55.

³ Wilkins, M.E., M. Zimmermann, and K.L. Weinberg. 1998. The 1995 Pacific West Coast bottom trawl survey of groundfish resources: Estimates of distribution, abundance, and length and age composition. NOAA Tech. Mem. NMFS-AFSC-89.

L_{∞} = theoretical maximum length;

K = slope of curve expressing the rate of approach to L ; and

T_0 = theoretical age at which $L_t = 0$

The relationships between total length and weight fit the relationship $W = aL^b$, where W = weight in grams and L = total length in centimeters, and a and b are constants. The values of a and b were determined using \log_{10} transformation and fitting the values to a straight line by least squares. The resulting relationships were compared using an F-test. To test whether differences between genders (if any) were an artifact caused by the larger female gonads, we subtracted gonad weight from body weight, generated the length-weight relationships for each gender and again tested these between genders.

We computed condition factor (a measure of fat storage) as

$$100 \times [(W - GW)/L^3]$$

Where W = body weight (g), GW = gonad weight (g), and L = total length (cm) of mature rockfishes. Condition factor was computed using body weight with gonad weight

subtracted, so as to minimize the effects of seasonal changes in gonad size. We compared these values between seasons (reproductive and nonreproductive) within sexes and between sexes, using the Mann-Whitney U-Test (Love et al. 1990).

We determined female reproductive stages macroscopically, characterizing the ovaries into five stages (Love et al. 2002): maturing (vitellogenesis), uneyed (fertilized), eyed, spent, and resting (transitional). Within the rockfishes, it is difficult to distinguish between prereproductive and mature-resting stage females during the nonreproductive season, as at both stages females exhibit small, light-colored ovaries (Love et al. 1990; Love et al. 2002). For this reason, our analyses of age and size at first maturity only included individuals from the reproductive season. A gonadosomatic index (GSI) was calculated for female *S. simulator* (this had previously been reported for *S. ensifer* in Love et al. 1990) using the formula:

$$\text{GSI} = (\text{GW}/\text{BW}) \times 100$$

Where GW = gonad weight and BW = total body weight.

We determined egg production by counting subsamples of unfertilized eggs, referable to “gonad stage 3” in Wyllie Echeverria (1987) or “vitellogenesis” in Love et al. (2002). We used only those females taken both 1) early enough in the reproductive season that no eye larvae were observed in ovaries and 2) late enough that eggs would be large and easily counted. In the lab, eggs were incised from the ovarian membrane and placed in Gilson’s solution (Love et al. 1990) for about one month or until the eggs came loose from the ovarian tissue. Before counting, the ovaries were repeatedly washed and the egg masses broken up to remove remaining connective tissue. The eggs were weighed, subsamples taken, and these were weighed. Eggs in each subsample were counted and the mean number per weight calculated for each subsample. Egg production was estimated by the calculation:

$$F = (\text{TW} \times \text{SN})/\text{SW}$$

Where F = fecundity, TW = total weight of gonads, SN = mean subsample of egg number, and SW = subsample weight.

Stomach contents were sorted taxonomically into six food item categories (copepods, crabs, euphausiids, fishes, salps, and crustacean pieces) and the volume of each category was measured by liquid displacement and presented through the Index of Relative Importance (Pinkas et al. 1971). We collected 181 *S. simulator* between 1995–2014 and 229 *S. ensifer* between 2000–2012; most individuals of both species were collected from 2007–2013. Length conversion factors between standard (SL), fork (FL), and total lengths (TL) for both species are shown in Table 2.

We aged *S. simulator* between the lengths of 10.1 and 28.1 cm. Male *S. simulator* live to at least 39 years and females to at least 32 years (Table 3). Males may grow somewhat larger than females (Fig. 1). The von Bertalanffy equation fits the male growth pattern well; however, it does not accurately predict female growth (Table 3, Fig. 1). This is likely because we aged too few young females. We aged *S. ensifer* between the lengths of 11.1 and 23.0 cm. The maximum life span of male and female *S. ensifer* may be similar as the oldest female was 38 years old and the oldest male was 37 years old (Table 3). We saw no evidence of gender-based differences in maximum length. For *S. ensifer*, the von Bertalanffy equation appeared to adequately fit the growth patterns of both genders (Table 3, Fig. 1) and, based on k values, growth rates were similar. We both measured and weighed a total of 77 males and 50 females of *S. simulator*. The overall length-weight relationship was $W = 0.004828\text{TL}^{3.33123}$; females were significantly heavier at length ($W = 0.004117\text{TL}^{3.39021}$) than males ($W = 0.003196\text{TL}^{3.45416}$) ($F = 4.2992$, $P = 0.05$). However, when gonad weight

Table 2. Conversions between standard, fork, and total lengths for *Sebastes simulator* and *S. ensifer*.

		<i>Sebastes simulator</i>						
Dependent variable	Independent variable	n	Intercept a	Coefficient b	R ²	F	Significance	
FL	SL	115	1.324	1.133	0.9817	6,119	<0.001	
TL	SL	115	1.424	1.152	0.9810	5,827	<0.001	
SL	FL	115	-0.788	0.866	0.9817	6,119	<0.001	
TL	FL	115	0.141	1.013	0.9937	18,090	<0.001	
SL	TL	115	-0.835	0.851	0.9810	5,827	<0.001	
FL	TL	115	0.009	0.980	0.9937	18,090	<0.001	
		<i>Sebastes ensifer</i>						
Dependent variable	Independent variable	n	Intercept a	Coefficient b	R ²	F	Significance	
FL	SL	171	0.846	1.127	0.9706	7825	<0.001	
TL	SL	173	0.879	1.160	0.9871	13,210	<0.001	
SL	FL	171	-0.393	0.868	0.9706	7,825	<0.001	
TL	FL	171	0.278	1.015	0.9896	16,120	<0.001	
SL	TL	173	-0.540	0.850	0.9871	13,210	<0.001	
FL	TL	171	-0.073	0.974	0.9896	16,120	<0.001	

was subtracted from body weight, there was no significant difference in the length-weight relationship ($F = 0.4929$). Length-weight relationships for *S. ensifer* are given in Love et al. (1990). For *S. simulator* we found significant within-gender differences in condition factor between seasons (Table 4). In both males and females, condition factor was slightly higher during the June–November season. Condition factors for both male and female *S. ensifer* are given in Love et al. (1990).

A few female *S. simulator* were mature at 14 cm, 50% were mature at about 17 cm, and all were mature at 18 cm (Fig. 2). Males tended to mature at a slightly larger size, a few at 17 cm, 50% at about 17 cm, and all at 23 cm. A lack of substantial numbers of young fishes made it difficult to estimate first and 50% maturity ages. However, it would appear that a few fish mature at about 8–9 years old, 50% of both males and females are mature at about 10–12 years old, and most are mature by 15–17 years old (Fig. 3). *Sebastes ensifer* maturation rates were similar, with a few females mature at 12 cm, 50% at about 15 cm, and all mature at 24 cm (Fig. 3). Similarly, a few male *S. ensifer* were mature at 12 cm, 50% at about 16 cm, and all were mature at 23 cm. Among females, this corresponded to a few fish maturing at as young as perhaps 5 years old, 50% at about 8–10 years old and all being mature at 16 years old. Maturation ages for males were similar as a few were mature at 6 years, 50% were mature at about 10 years, and all were mature in their mid-20s. For both

Table 3. Parameters of the von Bertalanffy equation for *Sebastes simulator* and *Sebastes ensifer* from southern California.

Species	Sex	L _∞	SE	K	SE	t ₀	SE	Maximum observed age (yr)
<i>simulator</i>	female	42.612	6.332	0.026	0.008	-8.092	1.757	32
	male	27.396	0.260	0.094	0.004	0.108	0.297	39
<i>ensifer</i>	female	22.098	0.304	0.120	0.010	-1.674	0.574	38
	male	20.492	0.258	0.126	0.011	-2.171	0.616	37

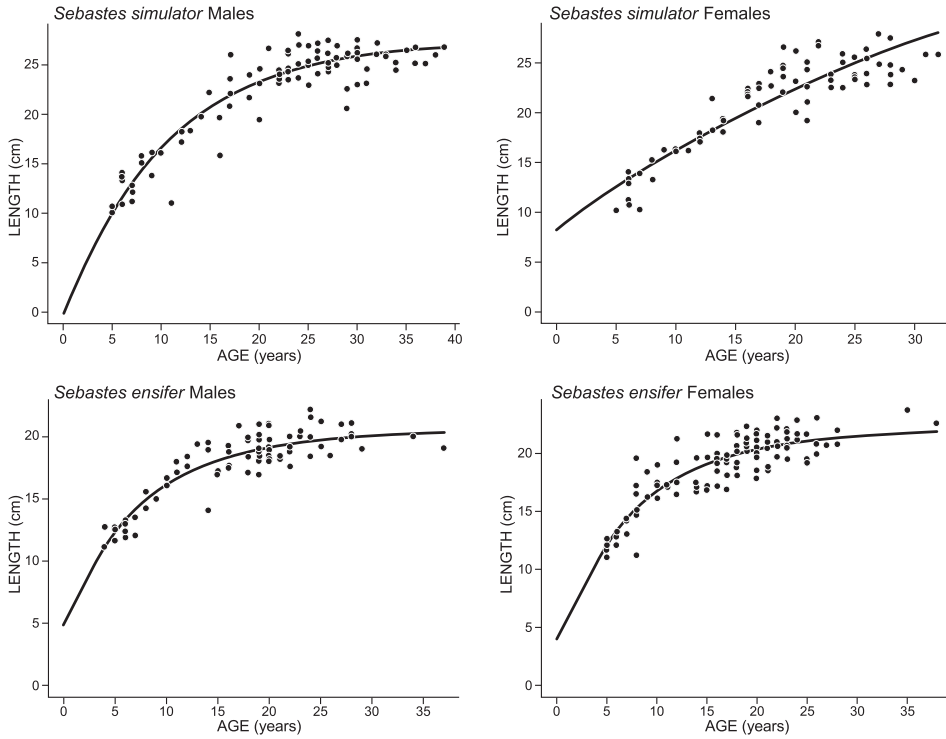


Fig. 1. Von Bertalanffy growth curves of female and male *S. simulator* and *S. ensifer*, including direct observation data points.

species, we note that assessing whether males were mature was, in a number of instances, particularly problematic.

Both *S. simulator* and *S. ensifer* released larvae between at least January and July (Table 5). It is likely that parturition for both species peaks in late winter and early spring. We note that the parturition season for *S. simulator* might extend further into the summer, but we were unable to capture specimens in August. The gonadosomatic indices for *S. simulator* reflect this pattern with maximum values peaking in February and March (Fig. 4).

Table 4. Condition factors of *S. simulator* from the southern California Bight. Significant differences are marked with an asterisk. N = number of individuals samples, K = Fulton's condition factor, U = output of the Mann-Whitney U test, and P = probability.

	N	K	U	P
Males				
December–May	54	1.34	232	<0.0001*
June–November	23	1.46		
Females				
December–May	32	1.32	109	0.0002*
June–November	18	1.44		
All Seasons				
Males	77	1.38	1,683	0.2334

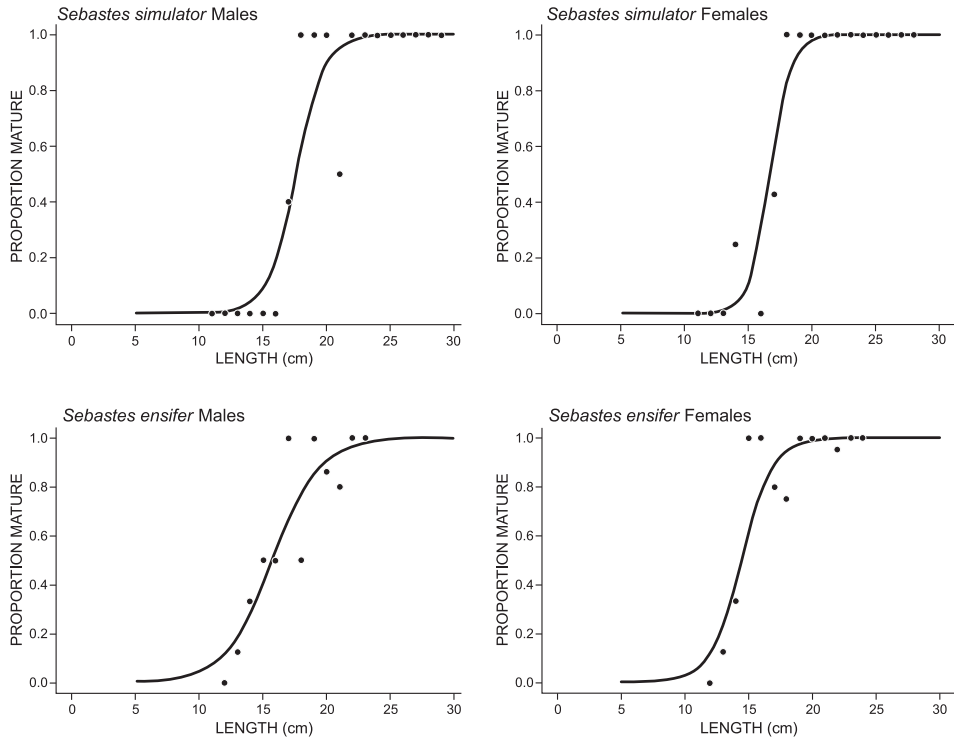


Fig. 2. Predicted proportion of mature female and male *S. simulator* and *S. ensifer* at length (solid lines) and observed proportion mature (by 1 cm length bins) (circles).

Gonadosomatic indices for *S. ensifer* are found in Love et al. (1990). *Sebastes simulator* females produced between 9,980 and 68,995 eggs within a season. Maximum egg production of *S. ensifer* was somewhat lower, ranging from 10,042 and 38,900. For both species, the relationship between length and egg production assumed a power function (Fig. 5). We saw no evidence of multiple brooding, where a female releases larvae two or more times per season. In previous research, we did observe multiple brooding in *S. ensifer* (Love et al. 1990). We found that *S. simulator* preyed primarily on benthic-oriented prey; crabs dominated their diets. By comparison, *S. ensifer* preyed mostly on water column prey, primarily euphausiids and copepods (Fig. 6).

In the northeast Pacific, growth rates among rockfish species are variable. At the extremes, some species grow quite slowly ($K = 0.03$, *S. borealis*; $K = 0.04$, *S. ruberrimus* and *S. rufus*) and some, primarily dwarf, species grow considerably faster (i.e., $K = 0.5$ *S. semicinctus*, *S. emphaeus*) (summarized in Love 2011). At least male *S. simulator* and both genders of *S. ensifer* grow at rates mid-range between these two extremes.

There were no previous growth rate studies of *S. simulator*. However, Chen (1971) presented an age-length relationship for *S. ensifer* (genders combined) (Fig. 7) based on reading whole otoliths as opposed to the sectioned ones we utilized. Previous research with rockfishes has shown that ageing younger individuals using whole otoliths is reasonably accurate. In older fish, however, using whole otoliths often tends to underestimate age at

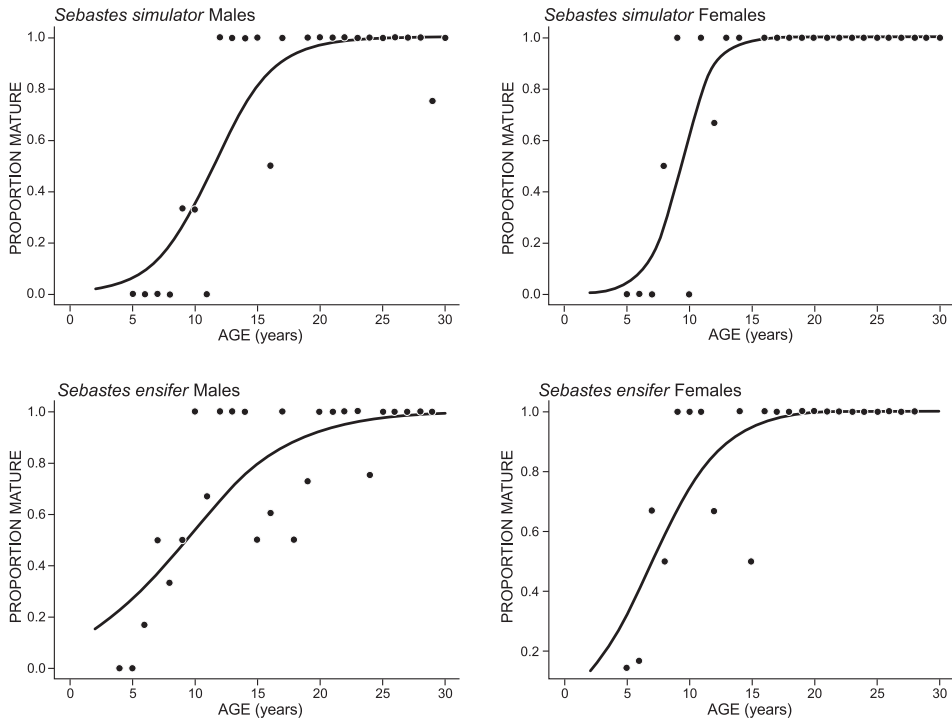


Fig. 3. Predicted proportion of mature female and male *S. simulator* and *S. ensifer* at age (solid lines) and observed proportion mature (by 1 cm length bins) (circles).

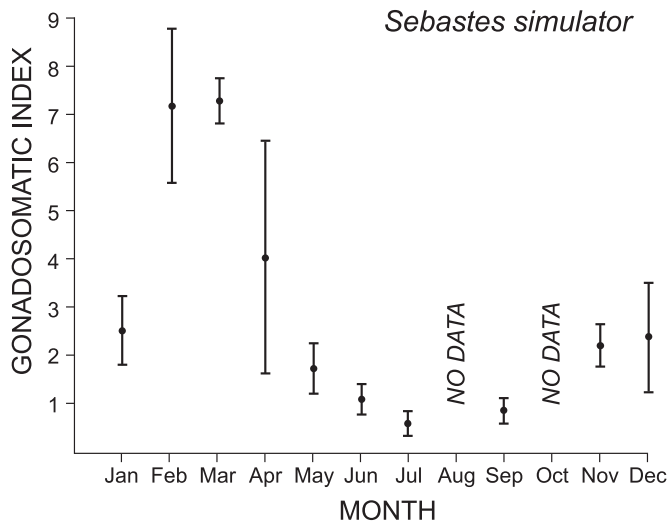


Fig. 4. Seasonal changes in the gonadosomatic indices of female *Sebastes simulator*.

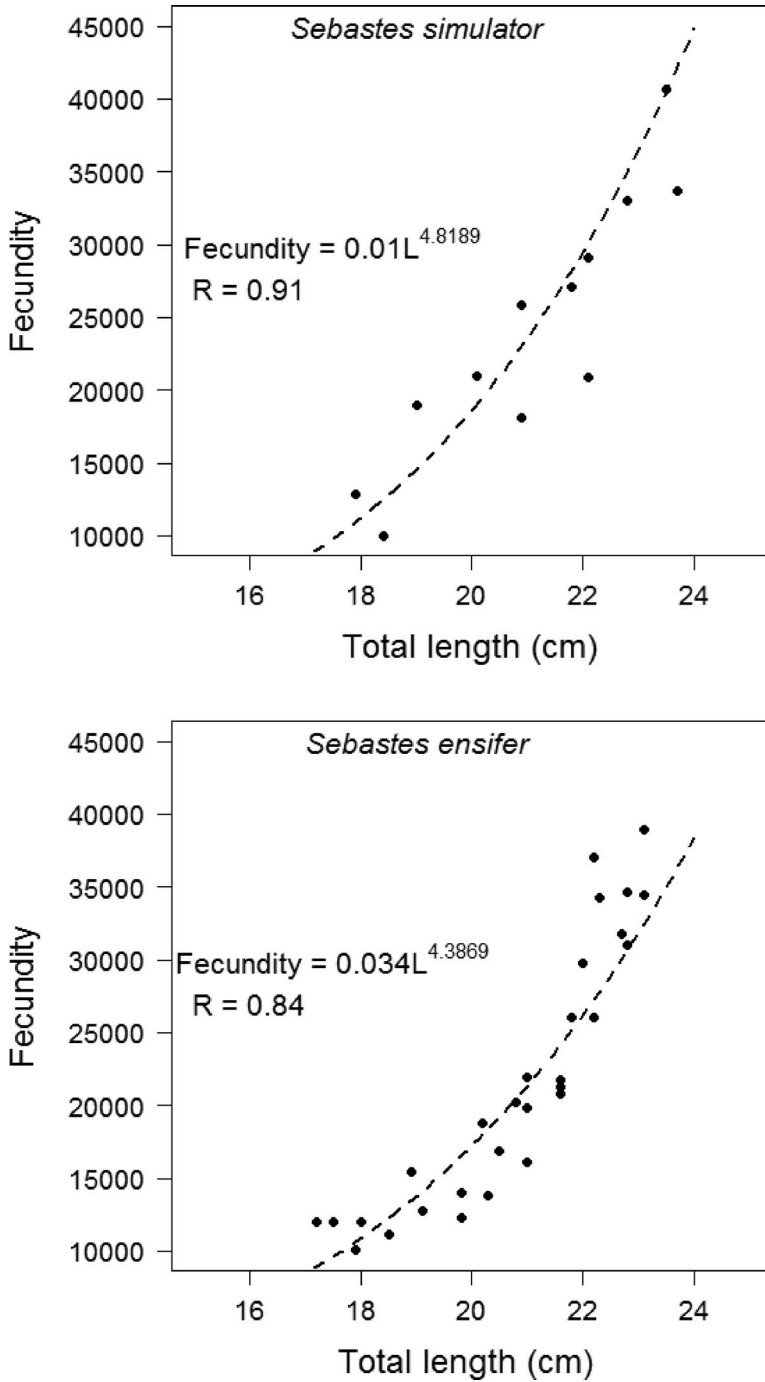
Fig. 5. Fecundity patterns of *Sebastes simulator* and *S. ensifer*.

Table 5. Reproductive stages, by month, of female *Sebastes simulator* and *Sebastes ensifer*.

<i>Sebastes simulator</i>	Resting	Maturing	Uneyed	Eyed	Spent
Month					
January	1	5	1	3	2
February	5	2	2		
March	6	4			
April	2	2	1	2	
May	4	5	3		
June	3	1	4	5	2
July	5	1	2	1	
August	No Data				
September	8				
October	No Data				
November	2	7			
December	8	1			
<i>Sebastes ensifer</i>					
January	7	2	1		
February	8	6	6	2	
March	7	8	3	5	
April	1	2	4	6	
May	6	1	1	1	
June	7	1			
July	1	1			
August	5				
September	6				
October	No Data				
November	2	6			
December	3	1			

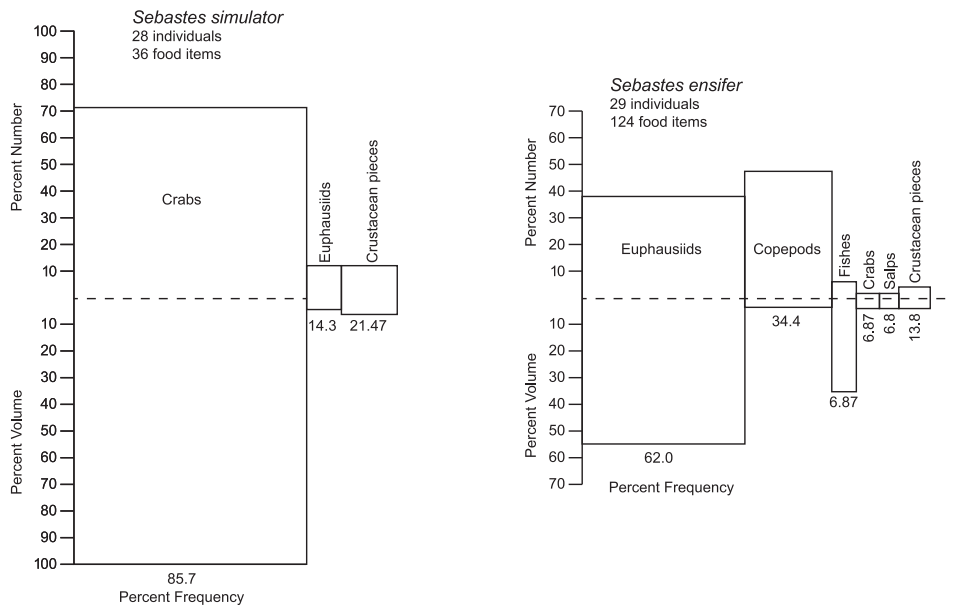


Fig. 6. Index of Relative Importance of food items eaten by *Sebastes simulator* and *S. ensifer*.

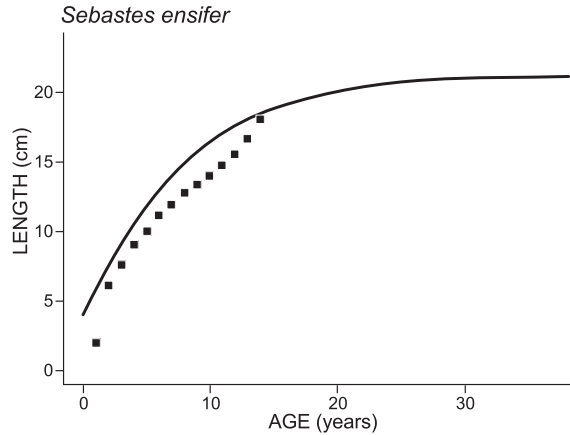


Fig. 7. A comparison of the age-length relationship of *S. ensifer* (both genders combined) between data from this paper (solid line representing von Bertalanffy growth equation) and data from Chen (1971) (squares).

length [i.e., *S. alutus* (Beamish 1979); *S. rosaceus* in Lea et al. (1999) compared to Fields (2016)].

The subgenus *Sebastomus* is of relatively recent origin having evolved around 2.5 million years ago (Hyde and Vetter 2007) and it is interesting to note that a number of life history traits seem to have been retained among the various species. For instance, with one exception, throughout the *Sebastomus* of the northeast Pacific and Gulf of California, the maximum age a species attains tends to be correlated with that species' maximum size (data from Love et al. 2002; Yamanaka et al. 2005; Benet et al. 2009; Love 2011; Fields 2016, and current data) (Fig. 8). *Sebastes helvomaculatus* is an exception as, despite its small maximum size, the species lives to at least 87 years, far longer than even its much

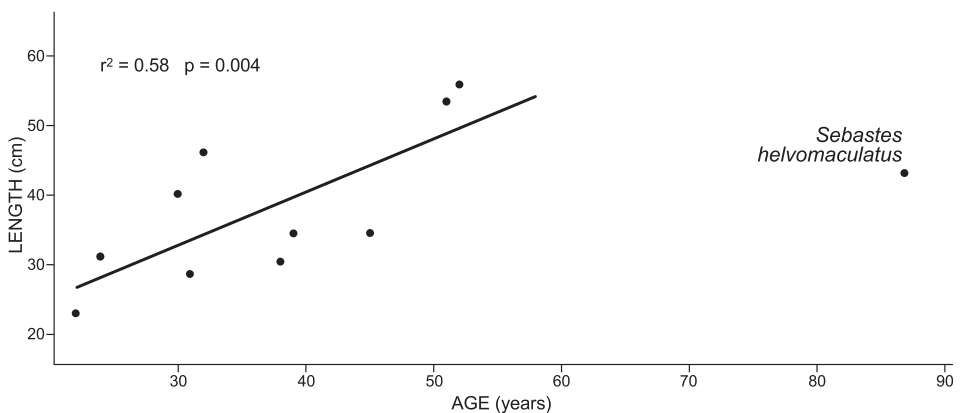


Fig. 8. The relationship between maximum length and maximum age in the subgenus *Sebastomus*. The relationship between the two variables was derived from an analysis of all species for which data were available (*S. chlorostictus*, *S. constellatus*, *S. ensifer*, *S. exsul*, *S. lentiginosus*, *S. rosaceus*, *S. rosenblatti*, *S. simulator*, *S. spinorbis*, and *S. umbrosus*) except for *S. helvomaculatus*.

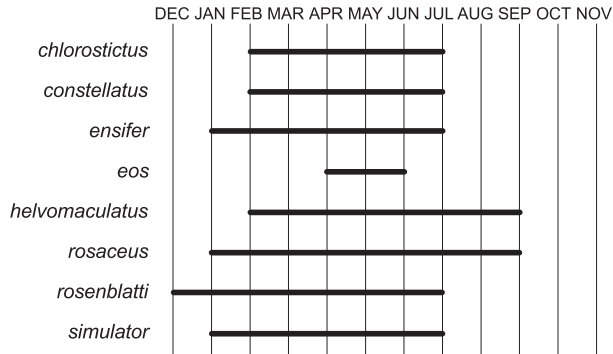


Fig. 9. Parturition season of the members of the rockfish subgenus *Sebastomus* living in the northeast Pacific.

larger congeners. *Sebastes helvomaculatus* is the only northern member (as defined by Love et al. 2002) of the subgenus. Love et al. (2002) noted that, almost without exception, within the northeastern Pacific rockfishes the more northerly species tend to live longer than congeners more typical of southerly waters. Parturition seasons are remarkably similar within the northeastern Pacific *Sebastomus* (these seasons are unknown in species endemic to the outer coast of Baja California, Gulf of California, or southern Hemisphere) (Fig. 9). Perhaps without exception (note that data on *S. eos* is very limited), the parturition season is long, commencing during the winter (between December and February) and extending well into the summer and perhaps into the early fall. Compared to other northeastern Pacific rockfishes, these seasons are relatively long (Love et al. 1990, 2002; Love 2011). Among subgenera, only members of the subgenus *Sebastodes* (i.e., *S. goodei*, *S. jordani*, and *S. paucispinis*) release larvae over as extended a period (Love et al. 1990, Love 2011).

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