

A review of the life history characteristics of blue tang and queen triggerfish

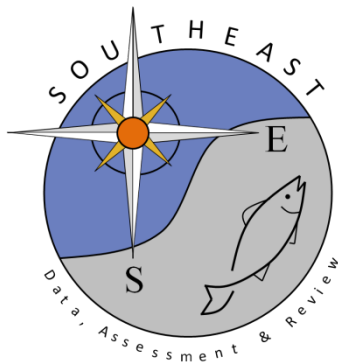
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## A review of the life history characteristics of blue tang and queen triggerfish

by

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### Introduction

This report reviews the life history information for *Acanthurus coeruleus* (blue tang) and *Balistes vetula* (queen triggerfish). Photos of these fish can be found in Figures 1-2. Life history information for each species was synthesized from the primary and the gray literature.

This report is organized by species and includes information on geographic ranges, habitats, reproduction, growth, and longevity. While this report focuses on blue tang and queen triggerfish in the Caribbean, parts of this report also include information associated with related species as well as information from a broader geographical range. Related species include *Acanthurus chirurgus* (doctorfish) and *Acanthurus bahianus* (ocean surgeon), and *Balistes capriscus* (gray triggerfish) and *Canthidermis sufflamen* (ocean triggerfish), for blue tang and queen triggerfish respectively. Table 1 defines the symbols and units for the age and growth parameters reported herein.

#### ***Acanthurus coeruleus*, blue tang** (Bloch and Schneider 1801)

##### *Geographic range and habitat*

Blue tang occur in the western Atlantic Ocean from New York to Rio de Janeiro (including Bermuda, the Gulf of Mexico, the Bahamas, the Caribbean, and the Central American coast), and have been reported as far southeast as Ascension (Carpenter 2002). They are shallow-water fish that are commonly on coral reefs and rocky habitats (Carpenter 2002; Reeson 1975). Occasionally seen in multi-species feeding aggregations, adult blue tang are herbivorous fish that graze diurnally on a wide variety of benthic algae (Carpenter 2002).

### *Reproduction*

Blue tang are gonochoristic (i.e., two distinct sexes) and reproduce via external fertilization. Spawning is suggested to correlate with lunar cycles, and to take place almost year round (Colin and Clavijo 1988; Reeson 1975; Thresher 1984).

### *Age and growth*

Table 2 summarizes maximum reported ages and lengths, as well as age-length and length-weight relationships for surgeonfishes in the western Atlantic. The following summarizes the values reported for blue tang in the Caribbean:

The maximum reported length was 457 mm total length, and was observed in St. Thomas, U.S. Virgin Islands (Olsen 2011). Mutz (2006) recorded a maximum age of 20 years at two locations in the southeast Caribbean (Table 2).

Several studies have evaluated age-length relationships for surgeonfishes (Table 2). Most studies used length frequency data, as well as aged otoliths to estimate von Bertalanffy growth parameters. Estimates of asymptotic length ( $L_{\infty}$ ) for blue tang in the Caribbean range from 188 mm fork length (n = 92) to 231 mm fork length (n = 110). The von Bertalanffy growth coefficient  $k$  ranges from 0.390 (n = 81) to 1.03 (n = 92), and the age at which fork length is equal to zero ( $t_0$ ) ranges from -0.251 (n = 110) to -0.112 (n = 81). Growth curves associated with these values are plotted in Figure 3.

The length weight relationship is calculated as:  $W = aL^b$ , where  $W$  is weight,  $L$  is length,  $a$  is a scalar, and  $b$  is a power parameter. The estimated scalar and power parameters for blue tang in the Caribbean range from  $2.15 \times 10^{-6}$  (n = 15) to  $2.78 \times 10^{-2}$  (n = 276) and from 2.15 (n = 15) to 3.02 (n = 276), respectively (units of length and weight are specified in Table 2).

### ***Balistes vetula*, queen triggerfish** (Linnaeus 1758)

#### *Geographic range and habitat*

Queen triggerfish occur along the eastern and western gulfs of the Atlantic Ocean (Carpenter 2002). In the western Atlantic, queen triggerfish range from Massachusetts to Brazil (including the Caribbean and Gulf of Mexico). Adult of this species are found on coral reef habitats as well as sandy and grassy areas. Queen triggerfish frequently occupy depths fewer than 100m, but they can also occur in depths up to 275m (Aiken 1975; Tortonese 1986). Adult queen triggerfish are opportunistic feeders that rummage for a variety of invertebrates and other food along the reef floor. The species is diurnal and is often seen either solitary or in small groups (Randall 1968; Aiken 1975).

### *Reproduction*

Queen triggerfish are gonochoristic (i.e., two distinct sexes) and reproduce via external fertilization. Between 1969 and 1973, Aiken (1975) observed individuals with ripe gonads in Jamaica (n = 1,151) during all months except April and June.

*Age and growth*

Table 3 summarizes maximum reported ages and lengths, as well as age-length and length-weight relationships for triggerfishes in the Atlantic. The following summarizes the values reported for queen triggerfish in the Caribbean:

The maximum reported length was 572 mm fork length, and was observed in the US Virgin Islands (Randall 1968). Manooch and Drennon (1987) recorded a maximum age of 7 years in the US Caribbean (Table 3).

Only a small number of studies have evaluated age-length relationships for triggerfishes (Table 3). Most studies used length frequency data, as well as aged dorsal spines to estimate von Bertalanffy growth parameters. The only asymptotic length ( $L_{\infty}$ ) reported for queen triggerfish in the Caribbean was 415 mm fork length ( $n = 376$ ). The von Bertalanffy growth coefficient  $k$  was 0.3, and the age at which fork length is zero ( $t_0$ ) was -0.6 (Manooch and Drennon 1987). A growth curve associated with these values is plotted in Figure 4.

Estimates of the scalar parameter,  $a$ , and power parameter,  $b$ , for queen triggerfish in the Caribbean range from  $7.20 \cdot 10^{-8}$  ( $n = 177$ ) to  $5.16 \cdot 10^{-2}$  ( $n = 190$ ) and from 2.72 ( $n = 119$ ) to 2.88 ( $n = 190$ ), respectively (units of length and weight are specified in Table 3).

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**Tables and Figures:****Table 1:** Parameter symbols, descriptions, and units of measure used throughout this report.

Parameter	Description	Units
<i>Growth</i>		
$L_{\infty}$	Asymptotic length	mm
$k$	von Bertalanffy growth coefficient	years <sup>-1</sup>
$t_0$	Age at which length is 0	years
$a$	Length-weight scalar	none
$b$	Length-weight power parameter	none
$L_{\max}$	Maximum length	mm
$n$	Sample size	numbers of fish
<i>Age</i>		
$t_{\max}$	Maximum reported age	years



**Table 2:** Summary of ages and lengths (FL: fork length; SL: Standard length; TL: total length), as well as age-length and length-weight relationships for surgeonfishes in the western Atlantic (STT: St. Thomas; STJ: St. John; STX: St. Croix; San Blas: Punta de San Blas, Panama; Los Roques: Los Roques, Venezuela; Margarita: Margarita Island, Venezuela; FL: Florida; Lee Stocking: Lee Stocking Island, Bahamas; Cabo Frio: Cabo Frio, Brazil; Las Aves: Las Aves, Venezuela). Values reported for blue tang in the Caribbean are highlighted in gray.

Species	Location	$t_{\max}$ (years)	$L_{\max}$ (mm)	Length-age $L_t = L_{\infty}(1 - e^{-K(t-t_0)})$				Length-weight $(W = aL^b)$					Source
				$L_{\infty}$ (mm)	k	$t_0$	n	a	b	n	Length Range (mm)	Units (W), (L)	
A. coeruleus	STT-STJ	-	285 FL	-	-	-	-	7.22E-04	2.396	410	135-285 FL	(g), (mm)	Bohnsack and Harper 1988
A. coeruleus	STX	-	295 FL	-	-	-	-	1.50E-03	2.264	2,767	100-295 FL	(g), (mm)	Bohnsack and Harper 1988
A. coeruleus	San Blas	16	-	183 SL	0.477	-0.310	110	-	-	-	-	-	Choat and Robertson 2002
A. coeruleus	Belize	15	242 FL	188 FL	1.030	-0.150	92	-	-	-	-	-	Mutz 2006
A. coeruleus	Los Roques	20	285 FL	199 FL	0.390	-0.112	81	-	-	-	-	-	Mutz 2006
A. coeruleus	Margarita	20	335 FL	-	-	-	74	-	-	-	-	-	Mutz 2006
A. coeruleus	San Blas	16	261 FL	231 FL	0.490	-0.251	110	-	-	-	-	-	Mutz 2006
A. coeruleus	St. Thomas	-	457 TL	-	-	-	-	-	-	-	-	-	Olsen 2011
A. coeruleus	USVI	-	-	-	-	-	-	2.15E-06	2.150	15	-	(kg), (mm)	Pagán 2002
A. coeruleus	St. John	-	191 FL	-	-	-	-	-	-	19	-	-	Randall 1962
A. coeruleus	Venezuela	-	366 TL	-	-	-	-	-	-	-	-	-	Randall 1968
A. coeruleus	Jamaica	-	236 FL	-	-	-	-	2.78E-02	3.022	276	85-245 FL	(g), (cm)	Reeson 1975
A. coeruleus	south FL	-	304 FL	-	-	-	-	6.07E-05	2.835	394	35-304 FL	(g), (mm)	Bohnsack and Harper 1988
A. coeruleus	Asencion	37	-	193 SL	0.403	-	-	-	-	-	-	-	Choat and Robertson 2002
A. coeruleus	Lee Stocking	27	-	174 SL	0.817	-	-	-	-	-	-	-	Choat and Robertson 2002
A. coeruleus	Asencion	37	304 FL	244 FL	0.420	-0.092	112	-	-	-	-	-	Mutz 2006
A. coeruleus	Bermuda	43	250 FL	203 FL	1.010	-0.142	105	-	-	-	-	-	Mutz 2006
A. coeruleus	Lee Stocking	27	256 FL	219 FL	0.880	-0.149	77	-	-	-	-	-	Mutz 2006
A. bahianus	south FL	-	243 FL	-	-	-	-	2.51E-05	2.975	29	35-243 FL	(g), (mm)	Bohnsack and Harper 1988
A. bahianus	St Helena	31	-	189 SL	1.241	-	-	-	-	-	-	-	Choat and Robertson 2002
A. bahianus	Ascension	19	-	176 SL	1.061	-	-	-	-	-	-	-	Choat and Robertson 2002
A. bahianus	Cabo Frio	22	-	183 SL	1.201	-	-	-	-	-	-	-	Choat and Robertson 2002
A. bahianus	San Blas	10	-	148 SL	1.584	-0.120	175	-	-	-	-	-	Choat and Robertson 2002

**Table 2:** (continued)

Species	Location	t <sub>max</sub> (years)	L <sub>max</sub> (mm)	Length-age $L_t = L_\infty(1 - e^{-K(t-t_0)})$				Length-weight $(W = aL^b)$					Source	
				L <sub>∞</sub> (mm)	k	t <sub>0</sub>	n	a	b	n	Length Range (mm)	Units (W), (L)		
A. bahianus	Lee Stocking	13	-	156 SL	0.985	-	-	-	-	-	-	-	-	Choat and Robertson 2002
A. bahianus	Ascension	19	263 FL	219 FL	1.230	-0.107	109	-	-	-	-	-	-	Mutz 2006
A. bahianus	Barbados	15	132 FL	156 FL	0.940	-0.203	94	-	-	-	-	-	-	Mutz 2006
A. bahianus	Belize	10	151 FL	182 FL	0.860	-0.187	58	-	-	-	-	-	-	Mutz 2006
A. bahianus	Bermuda	32	179 FL	204 FL	0.630	-0.225	81	-	-	-	-	-	-	Mutz 2006
A. bahianus	Cabo Frio	21	180 FL	221 FL	1.280	-0.102	93	-	-	-	-	-	-	Mutz 2006
A. bahianus	Jamaica	8	136 FL	151 FL	1.710	-0.115	59	-	-	-	-	-	-	Mutz 2006
A. bahianus	Las Aves	12	138 FL	172 FL	1.220	-0.140	108	-	-	-	-	-	-	Mutz 2006
A. bahianus	Lee Stocking	13	145 FL	183 FL	1.060	-0.150	124	-	-	-	-	-	-	Mutz 2006
A. bahianus	Los Roques	12	134 FL	164 FL	1.120	-0.160	86	-	-	-	-	-	-	Mutz 2006
A. bahianus	Margarita	18	275 FL	207 FL	1.330	-0.105	135	-	-	-	-	-	-	Mutz 2006
A. bahianus	San Blas	10	156 FL	178 FL	1.640	-0.100	175	-	-	-	-	-	-	Mutz 2006
A. bahianus	St Helena	31	174 FL	225 FL	1.580	-0.081	102	-	-	-	-	-	-	Mutz 2006
A. bahianus	PR	-	-	-	-	-	-	2.01E-10	3.930	48	-	-	(kg), (mm)	Pagán 2002
A. bahianus	USVI	-	148 FL	-	-	-	-	4.38E-08	2.890	11	-	-	(kg), (mm)	Pagán 2002
A. bahianus	St. John	-	180 FL	-	-	-	-	-	-	10	-	-	-	Randall 1962
A. bahianus	Brazil	-	356 SL	-	-	-	-	-	-	-	-	-	-	Randall 1968
A. bahianus	Jamaica	-	221 FL	280 FL	-	-	-	1.91E-02	3.080	142	105-185 FL	-	(g), (cm)	Reeson 1975
A. bahianus	Belize	10	191 SL	151 SL	1.010	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Panama	10	198 SL	146 SL	2.100	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Barbados	15	167 SL	129 SL	1.140	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Los Roques	12	169 SL	134 SL	1.360	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Las Aves	12	174 SL	143 SL	1.430	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Bahamas	13	183 SL	153 SL	1.260	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Ascension	19	210 SL	175 SL	1.220	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	Cabo Frio	21	228 SL	183 SL	1.430	-	-	-	-	-	-	-	-	Robertson et al 2005

Table 2: (continued)

Species	Location	$t_{\max}$ (years)	$L_{\max}$ (mm)	Length-age $L_t = L_{\infty}(1 - e^{-K(t-t_0)})$				Length-weight $(W = aL^b)$					Source	
				$L_{\infty}$ (mm)	k	$t_0$	n	a	b	n	Length Range (mm)	Units (W), (L)		
A. bahianus	Bermuda	32	227 SL	168 SL	0.940	-	-	-	-	-	-	-	-	Robertson et al 2005
A. bahianus	St Helena	31	220 SL	188 SL	1.400	-	-	-	-	-	-	-	-	Robertson et al 2005
A. chirurgus	STT-STJ	-	320 FL	-	-	-	-	9.23E-05	2.744	139	160-320 FL	(g), (mm)	-	Bohnsack and Harper 1988
A. chirurgus	STX	-	337 FL	-	-	-	-	3.75E-03	2.077	227	175-337 FL	(g), (mm)	-	Bohnsack and Harper 1988
A. chirurgus	south FL	-	304 FL	-	-	-	-	1.20E-06	3.533	61	39-304 FL	(g), (mm)	-	Bohnsack and Harper 1988
A. chirurgus	San Blas	13	-	200 SL	0.705	-	-	-	-	-	-	-	-	Choat and Robertson 2002
A. chirurgus	Belize	12	163 FL	210 FL	1.100	-0.124	47	-	-	-	-	-	-	Mutz 2006
A. chirurgus	Bermuda	29	285 FL	240 FL	0.820	-0.146	116	-	-	-	-	-	-	Mutz 2006
A. chirurgus	Los Roques	14	243 FL	206 FL	1.100	-0.128	43	-	-	-	-	-	-	Mutz 2006
A. chirurgus	Margarita	16	330 FL	-	-	-	113	-	-	-	-	-	-	Mutz 2006
A. chirurgus	San Blas	13	276 FL	239 FL	0.730	-0.195	97	-	-	-	-	-	-	Mutz 2006
A. chirurgus	USVI	-	-	-	-	-	-	2.16E-08	3.010	13	-	(kg), (mm)	-	Pagán 2002
A. chirurgus	St. John	-	186 FL	-	-	-	-	-	-	21	-	-	-	Randall 1962
A. chirurgus	Venezuela	-	343 SL	-	-	-	-	-	-	-	-	-	-	Randall 1968
A. chirurgus	Jamaica	-	350 FL	-	-	-	-	2.21E-02	3.009	271	65-245 FL	(g), (cm)	-	Reeson 1975

**Table 3:** Summary of ages and lengths (FL: fork length; SL: Standard length; TL: total length), as well as age-length and length-weight relationships for triggerfishes in the western Atlantic (PR: Puerto Rico; STT: St. Thomas; STJ: St. John; USVI: U.S. Virgin Islands; FL: Florida; GOM: Gulf of Mexico; NE GOM: northeast Gulf of Mexico). Values reported for queen triggerfish in the Caribbean are highlighted in gray.

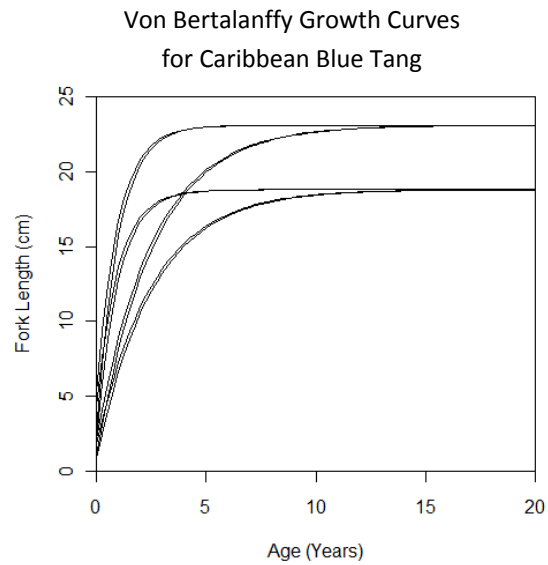
Species	Location	t <sub>max</sub> (years)	L <sub>max</sub> (mm)	Length-age $L_t = L_{\infty}(1 - e^{-K(t-t_0)})$				Length-weight $(W = aL^b)$					Source
				L <sub>∞</sub> (mm)	k	t <sub>0</sub>	n	a	b	n	Length Range (mm)	Units (W), (L)	
<i>B. vetula</i>	Jamaica	-	447 FL	-	0.570	-	-	5.16E-02	2.875	190	190-310 FL	(g), (cm)	Aiken 1975
<i>B. vetula</i>	PR	-	546 FL	-	-	-	-	6.57E-05	2.829	339	175-546 FL	(g), (mm)	Bohnsack and Harper 1988
<i>B. vetula</i>	STT & STJ	-	465 FL	-	-	-	-	8.64E-05	2.784	509	170-435 FL	(g), (mm)	Bohnsack and Harper 1988
<i>B. vetula</i>	PR & USVI	7	-	415 FL	0.300	-0.600	376	1.01E-04	2.750	151	200-399 FL	(g), (mm)	Manooch and Drennon 1987
<i>B. vetula</i>	PR	-	760 FL	-	-	-	-	7.20E-08	2.820	177	-	(kg), (mm)	Pagán 2002
<i>B. vetula</i>	USVI	-	-	-	-	-	-	1.23E-07	2.720	119	-	(kg), (mm)	Pagán 2002
<i>B. vetula</i>	St. John	-	385 FL	-	-	-	-	-	-	10	-	-	Randall 1962
<i>B. vetula</i>	USVI	-	572 FL	-	-	-	-	-	-	-	-	-	Randall 1968
<i>B. vetula</i>	Brazil	14	460 FL	441 FL	0.140	-1.800	476	3.00E-05	2.950	649	180-460 FL	(g), (mm)	de Albuquerque et al. 2011
<i>B. vetula</i>	south FL	-	425 FL	-	-	-	-	2.73E-05	2.990	22	165-425 FL	(g), (mm)	Bohnsack and Harper 1988
<i>B. vetula</i>	Brazil	-	450 FL	-	-	-	-	3.14E-02	2.900	340	110-450 FL	(g), (cm)	Menezes 1979
<i>B. vetula</i>	Brazil	7	37.6 FL	538 TL	0.150	-	-	-	-	-	-	-	Menezes 1985
<i>B. vetula</i>	Texas	-	387 SL	-	-	-	-	-	-	-	-	-	Moore 1967
<i>B. Capriscus</i>	Brazil	11	410 FL	510 FL	0.268	-0.005	1,800	4.00E-06	3.299	2,054	139-347 FL	(g), mm	Bernardes 2002
<i>B. Capriscus</i>	south FL	-	536 FL	-	-	-	-	2.91E-05	2.935	233	158-536 FL	(g), (mm)	Bohnsack and Harper 1988
<i>B. Capriscus</i>	east GOM	14	725 FL	645 FL	0.152	-1.900	626	3.70E-05	2.910	270	-	(g), (mm)	Hood and Johnson 1997
<i>B. Capriscus</i>	NE GOM	13	561 FL	446 FL	0.382	0.189	1,746	2.10E-05	2.992	175	-	(g), (mm)	Johnson and Saloman 1984
<i>B. Capriscus</i>	east US	-	319 SL	-	-	-	-	-	-	-	-	-	Moore 1967
<i>C. sufflamen</i>	Jamaica	-	500 FL	-	-	-	-	5.99E-02	2.817	-	350-470 FL	(g), (cm)	Aiken 1975
<i>C. sufflamen</i>	Bahamas	-	560 TL	-	-	-	-	-	-	-	-	-	Böhlke and Chaplin 1968
<i>C. sufflamen</i>	STT & STJ	-	350 FL	-	-	-	-	9.16E-10	4.728	3	330-350 FL	(g), (mm)	Bohnsack and Harper 1988
<i>C. sufflamen</i>	south FL	-	555 FL	-	-	-	-	1.55E-05	3.055	34	363-555 FL	(g), (mm)	Bohnsack and Harper 1988
<i>C. Sufflamen</i>	PR	-	-	-	-	-	-	3.29E-08	2.930	68	-	(kg), (mm)	Pagán 2002



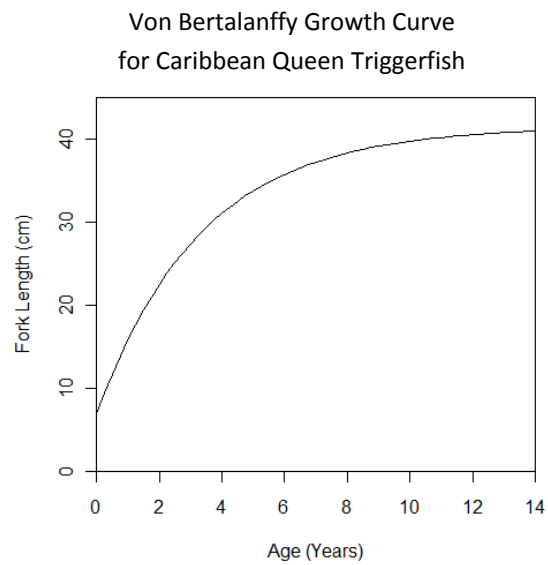
**Figure 1:** Photo of *Acanthurus coeruleus*, blue tang. Credit: Florida Keys National Marine Sanctuary



**Figure 2:** Photo of *Balistes vetula*, queen triggerfish. Credit: NOAA CCMA Biogeography Team (2005)



**Figure 3:** Von Bertalanffy growth curves associated with values of  $L_{\infty}$ ,  $k$ , and  $t_0$  reported for blue tang in the Caribbean.



**Figure 4:** Von Bertalanffy growth curve associated with values of  $L_{\infty}$ ,  $k$ , and  $t_0$  reported for queen triggerfish in the Caribbean.