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The Relationship between Mean Length at Maturity and Maximum Length in Coral Reef Fish

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Abstract: This article proposes a mechanism that triggers first maturation and spawning in coral reef (bony) fish, which allows for predicting their length at first maturity. Thus, mean lengths at first maturity (L_m) and the corresponding maximum lengths (L_{max}) in 207 populations of 131 species of coral reef fish were assembled and used to test the hypotheses that (a) there is, in coral reef fish, a single value of a size-related parameter acting as a trigger for their maturation and eventual spawning, and (b) that this single value is statistically the same as that published previously for other bony fish. The results, based on the assembled L_m and L_{max} data and on estimates of the parameter D, which link the length of fish with the relative surface of their gills, covered 44 families and L_{max} values ranging from 1.8 to 181.6 cm and confirmed that the threshold in (a) exists. Also, we assessed (in b) that this threshold value, i.e., $L_{max}{}^{D}/L_m{}^{D}$ = 1.35 (±0.02), is not statistically different from similar estimates for other groups of teleosts, notably semelparous salmonids, cichlids, sturgeons and Chinese and Turkish freshwater and marine fish. One implication is that given ocean warming and deoxygenation, coral reef fish will not only be smaller than they currently are, but also mature and spawn at smaller sizes, and thus produce fewer, smaller eggs.

Keywords: coral reef fish; GOLT; length at maturity; maximum length

Key Contribution: The main finding of this study is that in coral reef fish, the ratio of their metabolic rate at their maximum length (L_{max}) over their metabolic rate at first maturity (L_m) has a threshold value that triggers their maturation and spawning. This value is the same as in other groups of teleosts. This suggests that with ocean warming and deoxygenation, coral reef fish will mature and spawn at smaller sizes, leading to fewer and smaller eggs being produced.

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1. Introduction

The age and, particularly, the size when fish mature are important parameters of their life history and are important for fisheries management [1,2]. Compared to mammals and birds, fish mature at much smaller lengths (L_m) than the maximum lengths reached in the population to which they belong (L_{max}), a feature even more pronounced when one deals with weight (W), where $W_m << W_{max}$ [3,4].

This "early maturation" of fish may have been the reason why ichthyologists and fisheries biologists have believed that the "energy" that was previously used in growth is, once maturity is reached, transferred to gonad development, slowing down their growth all the way until it ceases [5–7]. However, this belief, which has undoubtedly been reinforced by the perception of a transition in length growth curves, from fast to slow growth following first maturity (Figure 1a), cannot be upheld when growth curves in weight are considered (Figure 1b).

The notion that it is reproduction that slows down the growth of fish, which may be referred to as the "reproductive load hypothesis", is also refuted (i) by every lone goldfish in a bowl, whose growth ceases at some point although they have never reproduced, (ii) by the fact that in 80% of fish species, it is the female who grow to larger sizes, although they have a bigger reproductive effort, and (iii) by the fact that sterile triploid fish do not exhibit higher growth rates than their fertile and diploid conspecifics [8]. There are other reasons why the "reproductive load hypothesis" is untenable [3,4], and the time has come to consider an alternative.

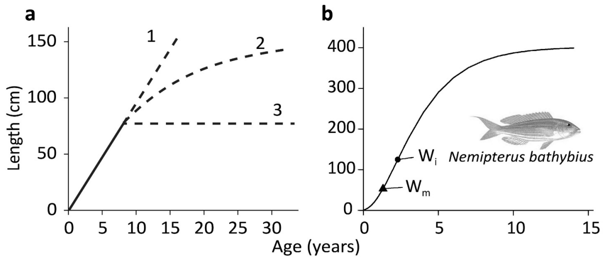

Figure 1. Two versions of the effect of reproduction on fish growth. (**a**) Representation of the "Reproductive Drain Hypothesis" (RDH), i.e., the notion that reaching the size at first maturity causes previously "linear" growth (line 1) to decline due to "energy" previously used for somatic growth being transferred to the elaboration of gonads, with the dotted line 2 implying a small, and line 3 a strong, transfer of "energy" (modified from Figure 2 in Lester et al. [9]). (**b**) When growth in weight is considered, the weight at first maturity (W_m) in most species of fish is reached at a size where growth is accelerating, i.e., well below the weight at which the maximum growth rate is attained (at W_i), as illustrated for yellowbelly threadfin bream (*Nemipterus bathybius*), based on data in Li et al. [10]. This is incompatible with the RDH.

The hypothesis proposed by Pauly [11], based on 34 species and 56 populations of marine bony fish, to replace the 'reproductive load hypothesis' has since been shown to apply to a vast number of other species [12–16].

Here, two hypotheses based on Pauly [11] are tested for 131 species of coral reef fish: (a) that there is, in coral reef fish, a single value of a size-related parameter acting as a trigger for their maturation and eventual spawning, and (b) that this single value is statistically the same as that published previously for bony fish.

The underlying growth model considered here was proposed by Pütter [17], and has the form

$$dW/dt = HW^d - kW \quad (1)$$

where dW/dt is the rate of growth, HW^d is the rate of protein synthesis, which is dependent on the oxygen supplied by the gills, and kW is the spontaneous denaturation rate of protein, a process requiring no oxygen, but which removes "working" proteins from the bodies of fish, and which, therefore, requires these proteins to be resynthesized [18,19]. Important here is that the parameter d in HW^d is related to the gill surface area (S, and hence oxygen supply) through a relationship is of the form $S \propto W^d$ (or respiration $\propto W^d$), with $d < 1$.

The parameter $d < 1$ implies that, as weight increases, kW will increase faster than HW^d, and that, when the rate of protein synthesis equals the rate of protein denaturation, growth ceases (at W_{max}). The overwhelming majority of bony fish (i.e., excluding those breathing air) have d ranging between 0.6 and 0.9 [20,21], but always less than 1 [22,23].

It is commonly accepted that fish start maturing when environmental stimuli "trigger" the hormonal cascade that leads to maturation and spawning [24]. However, this does not explain the fact that long-lived fish, despite experiencing—as juveniles—multiple spawning seasons and, thus, being exposed to the same environmental stimuli, do not actually start spawning until later in life, when a critical size is reached [23].

Therefore, a size-related internal readiness event ought to occur before any external stimuli and their triggering effect are perceived. The hypothesis proposed by Pauly [11] is that this internal readiness is established, in an individual fish, when its metabolic rate (Q_m) relative to its (maintenance) metabolic rate (Q_{maint}) decreases below a critical level (Q_m/Q_{maint}). It is this readiness that causes the fish to start responding to the external triggers [23].

Pauly [11] demonstrated that L_{max}^{D} vs. L_{m}^{D}, with D = 3(1 − d), is algebraically equivalent to Q_m vs. Q_{maint} and, based on a variety of marine fish species, that the critical level (Q_m/Q_{maint}) is 1.36 (95% C.I. 1.22–1.53). This estimate was confirmed by studies that produced estimates not significantly different from 1.36, pertaining to 3 species and 51 populations of semelparous freshwater salmonids [12]; 7 species and 41 populations of cichlids [13]; 96 species and 24 populations of marine and freshwater fish from Chinese waters [14]; 22 species of sturgeons [15]; and 57 species and 120 populations of marine and freshwater fish from Turkish waters [16].

The ubiquity of this ratio suggests that this is a trait that has been conserved through millions of years of evolution. Here, we test this ratio on 207 populations in 131 coral reef fish species.

2. Materials and Methods

The maximum length (L_{max}; fork length; in cm) and mean length at first maturity (L_m; fork length; in cm) of coral reef fish from various geographical locations were collected from the published literature on dioecious fish, i.e., hermaphroditic species—when known as such—were excluded. Care was taken to assemble data that (i) covered most families of coral reef fish (ii) originating from the Atlantic, Indian and Pacific Oceans, and the waters of both economically developed and developing countries, and (iii) which spanned a wide range of sizes. In total, 207 pairs were assembled and used for analysis. In cases where only the asymptotic length (L_{inf}) was available, L_{inf} was multiplied by 0.95 to obtain an approximate value of L_{max} [25].

The L_{max} values were then converted into W_{max} estimates using the parameters (a, b) of the length–weight relationship (LWR) obtained from FishBase (www.fishbase.org) in the form of $W = a \cdot L^b$. Length–weight relationships from the same locality were used when available. In cases where several LWRs were available (e.g., in *Acanthurus chirurgus*) or in cases where no LWRs were available for the species in question, the Bayesian estimates of a and b from FishBase were used, which account for seasonal variations and other sources of uncertainly in the LWR [26]. Also, note that the precision of the a and b estimates of the LWR had a minimal effect on the consideration that follows.

We used the empirical equation

$$d = 0.674 + 0.0357 \cdot \log(W_{max}) \quad (2)$$

Based on estimates of d from gill surface area and respiratory studies in 27 populations of 24 species of teleost fish ranging from guppies to tuna [18,27], we estimated d values with W_{max} in g; then, D was computed from D = 3(1 − d) to simplify things.

Table 1 presents the compiled life history traits and the resulting L_{max}^{D} and L_{m}^{D} values for the 207 coral reef cases that were assembled for this study.

The mean ratio L_{max}^{D} vs. L_{m}^{D} was estimated as the slope of a regression of L_{max}^{D} vs. L_{m}^{D}, along with its 95% confidence interval (C.I.), by running a Bayesian regression model with the intercept forced at zero using the *brm* function in the *brms* R package in R Statistical Software (v4.3.1, [28,29]).

To test for the effect of phylogeny on the estimated value, the effect of phylogenetic biases was accounted for by associating the mean L_{max}^{D} and L_{m}^{D} of each species with the full phylogeny tree obtained from the *Fish Tree of Life* through the R package *fishtree* [30]. A number of species (n = 131 − 11 = 120) that were not available in the *Fish Tree of Life* were removed from further analysis. Using the *brm* function [29], we re-estimated the slope with and without the phylogenetic component.

Comparing the results of the regression models with and without the phylogenetic component should allow for testing whether the inclusion of shared evolutionary history between species is an important factor to consider in the relationship between L_{max}^{D} and L_{m}^{D}. Although the model with the phylogenetic component requires a Bayesian framework, it is comparable to the widely used phylogenetic generalized least squares regression [29]. Furthermore, by employing Bayesian methods to estimate these models, we are provided with the advantage of generating a distribution of the slopes (i.e., a posterior distribution), which enables better comparison among slope estimates.

3. Results

In total, 207 L_{max} and L_m data pairs accounting for 131 species from 44 different families were collected. Out of the 131 species in the dataset of this study, 11 species did not have resolved phylogenetic positions on the *Fish Tree of Life*, leaving 120 species to be further analyzed separately with and without phylogeny taken into consideration.

Considering all $L_{max}{}^D$ vs. $L_m{}^D$ data pairs, the resulting slope was $L_{max}{}^D = 1.35 \cdot L_m{}^D \cdot (\pm 0.02)$. For species that were on the *Fish Tree of Life*, but without phylogeny, the result was similar, with $L_{max}{}^D = 1.34 \cdot L_m{}^D \cdot (\pm 0.03)$ (Figure 2a, Table 1). When phylogeny was considered, the resulting slope was $L_{max}{}^D = 1.20 \cdot L_m{}^D \cdot (\pm 0.11)$, i.e., not statistically different, but with the mean exhibiting a bias that is discussed below (Figure 2b, Table 1).

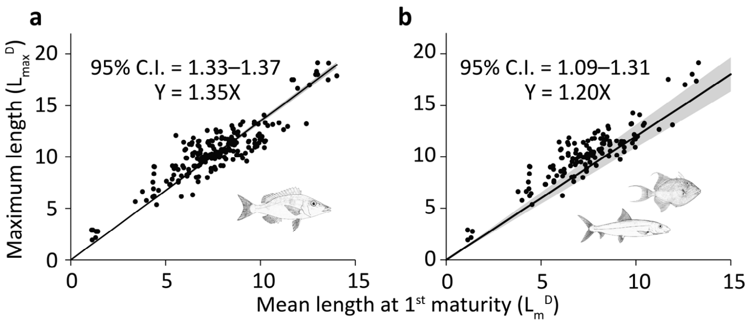

Figure 2. Plot of $L_{max}{}^D$ vs. $L_m{}^D$ for (**a**) all 207 cases; (**b**) 120 species on the *Fish Tree of Life* with phylogenetic affinities considered. Shaded area indicates the 95% confidence interval of slope.

Table 1. Comparison of estimated coefficients and their 95% confidence interval for different subsets in the relationship between length at first maturity and maximum length.

Dataset	N	Slope (95% C.I.)
All cases	207	1.35 (1.33–1.37)
Species on *FishTree* with phylogeny considered	120	1.20 (1.09–1.31)
Species on *FishTree* without phylogeny considered	120	1.34 (1.31–1.37)

Thus, L_m in coral reef fish can be estimated from $L_m = L_{max}/1.35^{1/D}$, with the D value estimated from $D = 3(1 - d)$ and d from Equation (2). As for its C.I., it can be estimated by using the standard error of 1.35, i.e., ± 0.02. Note, however, that the uncertainty in L_m values obtained by this relationship is likely to be an underestimate, because, while it accounts for the uncertainty in the 1.35 ratio, it does not account for the uncertainly in L_{max} and D.

4. Discussion

As was the case with previous tests, this study generated results compatible with the two-part hypotheses of Pauly [11] that in coral fish (i) the same relative individual size induces a readiness to perceive environmental stimuli that trigger maturation and spawning and (ii) that this relative size is not significantly different from $L_m = L_{max}/1.35^{1/D}$.

More precisely, the slope of the plot of $L_{max}{}^D$ vs. $L_m{}^D$ in Figure 2a (=1.35; 95% C.I. = 1.33–1.37) overlaps with confidence intervals reported in previous contributions dealing with other bony fish [11–16], implying that the slope estimates are not statistically different.

When phylogeny is considered (Figure 2b), the change in slope is similar to what was observed by Warren [31] for cartilaginous species, i.e., that the correlation was weak, with a wide confidence interval, which is apparently a common result when including phylogenetic signals into analyses such as ours [32,33]. While some authors have suggested that statistical analyses without phylogenetic elements are "flawed" or "biased" [32], it has also been demonstrated that "poor statistical performances" will be the result when phylogenetic methods based on incorrect assumptions are applied to regression models [34]. Our coral reef fish dataset is phylogenetically extremely diverse, which suggests that the consideration of phylogeny in our analysis may not only be superfluous, but also result in misleading results [32]. Therefore, we are focusing our remaining discussion solely on the results derived from the data without considering phylogeny, as these are more likely to provide a reliable basis for our conclusion.

The estimated critical threshold of the L_{max}^D vs. L_m^D ratio (1.35) varies slightly between populations and species because it is a heuristic [35] used by individual fish to determine when to start perceiving the external stimuli that make them start their maturation process [23]. As such, this heuristic can generate predictions (i.e., values of L_m) that are too low (thus leading to an egg production that is lower than would have been possible by allowing more growth before first maturity) or too high (thus exposing the individual to an elevated risk of being predated upon before having spawned at least once). This explains some of the differences between the lines and the dots in Figure 2a,b, the rest of these differences being mostly caused by imprecisions in the estimation of L_m and L_{max}.

What this study establishes, however, is that coral reef (bony) fish, for all the specificities associated with the singular ecosystems within which they evolved, initiate their maturation and reproduction under the same respiratory constraints as other teleosts. Notably, our results add to the evidence against the "Reproductive Drain Hypothesis", and in favor of the alternative hypothesis as presented in Pauly and Liang [4]; see also refs. [11–16]. Our results, thus, also suggest that generalizations concerning other aspects of the biology of coral reef fish, e.g., their respiratory physiology, would also benefit from being compared with the respiratory physiology of well-studied temperate fish, including freshwater species, rather than being a priori assumed to be different from other fish.

Some studies have shown that reef-associated fish have evolved a relatively high hypoxia tolerance, probably due to the fact that coral reefs go through daily cycles of oxygen levels [36–38]. However, the above considerations lead one to predict that the increased stress of ocean deoxygenation and increased temperatures [39] will not only lead to smaller maximum sizes in coral reef fish, but also to smaller sizes at first maturity, generally associated with fewer and smaller eggs [40] and, thus, with reduced fitness.

5. Conclusions

The Gill Oxygen Limitation Theory (GOLT) as proposed by Pauly [11] suggests that the triggering of maturation in fish occurs when the growth-induced reduction in gill surface area relative to body weight (and hence oxygen supply) reaches a critical level. This study confirms that this triggering effect also occurs in coral reef fish and that its level is the same as in other fish populations. Understanding the size and age of maturity of fish is an important aspect of effective fisheries management. The results of this study suggest that with increasing temperature and deoxygenation, coral reef fish will mature at smaller sizes and, as a result, will produce smaller eggs. These changes will influence the factors that must be considered in the management of coral reef fisheries.

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Data Availability Statement: Data are contained within the article and Appendix A.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table 1. Assembled data on reef-associated species for the analysis of the relationship between length at first maturity (L_m) and maximum length (L_{max}), arranged alphabetically by family and by species names. Lengths are in fork lengths. L_{max} values in brackets were estimated from L_{inf} using $L_{max} = 0.95 \times L_{inf}$. W_{max} estimated from L_{max} using length–weight relationship coefficients from FishBase. (F = female; M = male; U = unsexed).

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	L_{max}^D	L_m^D	Reference
1	Acanthuridae	*Acanthurus chirurgus*	Pedro Bank, Jamaica	M	35.0	17.0	978.3	0.66	10.33	6.43	[41]
2	Acanthuridae	*Acanthurus lineatus*	Tutuila Isl. Amer.	U	28.9	18.0	670.2	0.67	9.66	7.02	[42]
3	Acanthuridae	*Acanthurus lineatus*	Pohnpei State, Micronesia	F	20.5	16.8	250.3	0.72	8.81	7.63	[43]
4	Acanthuridae	*Acanthurus nigricauda*	Pohnpei State, Micronesia	F	22.6	18.4	311.2	0.71	9.15	7.91	[43]
5	Acanthuridae	*Acanthurus nigrofuscus*	Coil reef, Northern Queensland	U	15.5	10.5	85.7	0.77	8.26	6.12	[44]
6	Acanthuridae	*Acanthurus nigrofuscus*	Yankee reef, N. Queensland	U	17.9	10.5	108.7	0.76	8.95	5.96	[44]
7	Acanthuridae	*Acanthurus triostegus*	Lakshadweep lagoons, India	U	17.5	7.3	154.3	0.74	8.36	4.38	[45]
8	Acanthuridae	*Naso lituratus*	Terengganu, Malaysia	U	38.1	19.9	1331.2	0.64	10.36	6.82	[46]
9	Albulidae	*Albula vulpes*	Florida Keys, US	F	70.0	48.8	5534.2	0.58	11.56	9.39	[47]
10	Albulidae	*Albula vulpes*	Florida Keys, US	M	70.2	41.8	5584.8	0.58	11.56	8.57	[47]
11	Apogonidae	*Cheilodipterus artus*	Terengganu, Malaysia	U	17.7	11.2	112.6	0.76	8.80	6.21	[46]
12	Apogonidae	*Cheilodipterus macrodon*	Terengganu, Malaysia	U	23.6	15.1	306.8	0.71	9.46	6.89	[46]
13	Apogonidae	*Cheilodipterus quinquelineatus*	Terengganu, Malaysia	U	11.9	8.2	26.8	0.82	7.69	5.68	[46]
14	Apogonidae	*Ostorhinchus compressus*	Terengganu, Malaysia	U	11.1	7.4	24.2	0.83	7.34	5.24	[46]
15	Apogonidae	*Pterapogon kauderni*	Banggai Archipelago	U	7.6	4.9	10.4	0.87	5.79	3.99	[48]
16	Balistidae	*Balistapus undulatus*	Kavieng, PNG	F	20.2	15.7	217.6	0.73	8.89	7.40	[49]
17	Balistidae	*Balistes capriscus*	Ghana	F	34.0	14.5	679.5	0.67	10.76	6.06	[50,51]
18	Balistidae	*Balistes vetula*	Pedro Bank, Jamaica	F	39.0	23.5	1936.2	0.62	9.87	7.19	[52]
19	Balistidae	*Balistes vetula*	Pedro Bank, Jamaica	M	44.0	26.5	2738.9	0.61	10.01	7.35	[52]
20	Belonidae	*Tylosurus acus*	Suez Canal, Egypt	M	74.5	45.9	727.3	0.67	18.00	13.02	[53]
21	Belonidae	*Tylosurus acus*	Suez Canal, Egypt	F	74.5	45.3	727.3	0.67	18.00	12.91	[53]
22	Belonidae	*Tylosurus crocodilus*	Suez Canal, Egypt	M	94.4	50.1	1759.7	0.63	17.51	11.75	[53]
23	Belonidae	*Tylosurus crocodilus*	Suez Canal, Egypt	F	94.4	49.5	1759.7	0.63	17.51	11.66	[53]
24	Carangidae	*Alepes djedaba*	Kerala, India	U	(26.2)	16.0	339.0	0.71	10.03	7.08	[54]
25	Carangidae	*Alepes kleinii*	SW Coast, India	U	(14.2)	11.3	58.9	0.79	8.09	6.75	[54]
26	Carangidae	*Atule mate*	Kerala, India	U	(29.0)	15.4	360.9	0.70	10.68	6.85	[54]
27	Carangidae	*Carangoides bajad*	Shathleen, Egypt	U	56.4	34.8	2970.5	0.61	11.47	8.56	[55]
28	Carangidae	*Carangoides bajad*	Coast of Abu Dhabi, UAE	U	(38.4)	24.7	697.7	0.67	11.62	8.64	[56]
29	Carangidae	*Carangoides equula*	Northern South China Sea	U	(28.1)	18.7	513.0	0.69	9.88	7.48	[57]
30	Carangidae	*Caranx heberi*	South Africa	U	100.0	50.0	19,887.8	0.52	10.79	7.54	[58,59]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^D$	$L_m{}^D$	Reference
31	Carangidae	*Caranx ignobilis*	Northwestern Islands, Hawaii	U	162.6	56.0	83,360.9	0.45	9.87	6.12	[60]
32	Carangidae	*Caranx melampygus*	Northwestern Islands, Hawaii	U	70.8	32.7	10,551.0	0.55	10.23	6.71	[60]
33	Carangidae	*Caranx melampygus*	Shathleen, Egypt	U	73.9	44.3	652.8	0.68	18.30	12.96	[55]
34	Carangidae	*Caranx sexfasciatus*	South Africa	U	80.0	50.0	9456.4	0.55	11.19	8.64	[58,59]
35	Carangidae	*Decapterus macrosoma*	Java Sea, Indonesia	M	20.1	13.7	75.6	0.78	10.27	7.61	[61,62]
36	Carangidae	*Decapterus macrosoma*	Java Sea, Indonesia	F	20.1	14.3	75.6	0.78	10.27	7.88	[61,62]
37	Carangidae	*Decapterus maruadsi*	East China Sea	U	20.8	17.5	133.1	0.75	9.74	8.55	[63,64]
38	Carangidae	*Decapterus maruadsi*	Gulf of Tonkin/Beibu Gulf	U	24.2	17.1	100.1	0.76	11.38	8.74	[65]
39	Carangidae	*Decapterus punctatus*	South Atlantic Bight	U	21.0	11.0	125.3	0.75	9.88	6.08	[66,67]
40	Carangidae	*Elagatis bipinnulata*	Pernambuco, Brazil	F	97.0	64.6	7563.3	0.56	13.05	10.39	[68]
41	Carangidae	*Megalaspis cordyla*	SW coast, India	U	(33.6)	22.5	502.2	0.69	11.22	8.50	[54]
42	Carangidae	*Megalaspis cordyla*	East Coast, India	U	(35.0)	22.5	517.0	0.69	11.47	8.46	[54]
43	Carangidae	*Megalaspis cordyla*	NW Coast India	U	(44.8)	22.5	837.5	0.66	12.48	7.89	[54]
44	Carangidae	*Parastromateus niger*	Taiwan Strait, Taiwan	U	30.5	19.1	1131.1	0.65	9.22	6.80	[69]
45	Carangidae	*Scomberoides commersonnianus*	Weipa region, Queensland, Australia	M	(108.3)	38.5	11,888.7	0.54	12.58	7.19	[70]
46	Carangidae	*Scomberoides commersonnianus*	Weipa region, Queensland, Australia	F	(122.6)	63.5	16,788.9	0.52	12.45	8.82	[70]
47	Carangidae	*Selar crumenophthalmus*	Caribbean coast, Colombia	U	(27.8)	19.6	342.3	0.71	10.45	8.18	[71]
48	Carangidae	*Selaroides leptolepis*	Tamil Nadu/Pondicherry, India	U	(17.0)	8.9	69.0	0.78	9.12	5.53	[54]
49	Carangidae	*Selaroides leptolepis*	Inner Gulf of Thailand	U	(16.8)	8.9	80.4	0.77	8.87	5.44	[72]
50	Carangidae	*Seriola dumerili*	Pelagie Islands, Italy	F	157.2	114.3	43,955.9	0.48	11.31	9.70	[73]
51	Carangidae	*Seriola dumerili*	Pelagie Islands, Italy	M	157.2	118.4	43,009.6	0.48	11.37	9.92	[73]
52	Carangidae	*Trachinotus falcatus*	Florida Keys/Tampa Bay, US	M	85.5	48.6	13,816.4	0.53	10.73	7.94	[74]
53	Carangidae	*Trachinotus falcatus*	Florida Keys/Tampa Bay, US	F	91.6	54.7	16,760.5	0.52	10.69	8.16	[74]
54	Carangidae	*Trachurus lathami*	Southern region, Brazil	U	21.4	11.8	118.8	0.75	10.10	6.43	[75]
55	Centriscidae	*Centriscus scutatus*	Terengganu, Malaysia	U	15.0	10.0	4.2	0.91	11.78	8.14	[46]
56	Chaenopsidae	*Acanthemblemaria paula*	Carrie Bow Cay, Belize	U	2.0	1.3	0.0	1.12	2.17	1.31	[76]
57	Chaetodontidae	*Chaetodon auriga*	Lakshadweep lagoons, India	U	14.9	13.0	86.3	0.77	8.00	7.20	[45]
58	Dorosomatidae	*Amblygaster sirm*	Lagoons, New Caledonia	U	21.0	14.6	71.3	0.78	10.72	8.06	[77]
59	Dorosomatidae	*Herklotsichthys quadrimaculatus*	Seychelles	U	12.8	10.1	31.2	0.82	8.03	6.62	[78]
60	Dorosomatidae	*Opisthonema oglinum*	Ceará, Brazil	M	17.0	11.0	69.3	0.78	9.12	6.49	[79,80]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^D$	$L_m{}^D$	Reference
61	Dorosomatidae	*Opisthonema oglinum*	Ceará, Brazil	F	17.0	11.5	69.3	0.78	9.12	6.72	[79,80]
62	Dorosomatidae	*Opisthonema oglinum*	Pernambuco, Brazil	U	22.4	12.5	126.4	0.75	10.35	6.69	[81]
63	Dorosomatidae	*Sardinella albella*	Mandapam, India	U	(10.9)	7.8	16.7	0.85	7.56	5.67	[82]
64	Engraulidae	*Encrasicholina devisi*	Ysabel Passage, PNG	U	(6.2)	3.6	1.9	0.95	5.67	3.40	[83]
65	Engraulidae	*Encrasicholina devisi*	Karnataka, India	U	9.6	6.0	5.3	0.90	7.64	5.04	[84]
66	Engraulidae	*Encrasicholina heteroloba*	Singapore Strait	U	(8.9)	5.3	7.4	0.88	6.92	4.36	[85]
67	Engraulidae	*Stolephorus insularis*	Singapore Strait	U	(10.0)	5.3	8.1	0.88	7.56	4.33	[85]
68	Fistulariidae	*Fistularia commersonii*	Mediterranean Sea, Lebanon	F	113.0	65.4	1969.1	0.62	19.12	13.59	[86]
69	Fistulariidae	*Fistularia commersonii*	Mediterranean Sea, Lebanon	M	100.0	54.7	1368.0	0.64	19.16	13.01	[86]
70	Gerreidae	*Gerres filamentosus*	Manila Bay, Philippines	M	14.3	8.4	50.9	0.79	8.25	5.43	[87]
71	Gerreidae	*Gerres filamentosus*	Manila Bay, Philippines	F	12.7	7.9	35.6	0.81	7.84	5.35	[87]
72	Gerreidae	*Gerres longirostris*	Southern Arabian Gulf	M	(17.9)	16.3	1680.6	0.63	6.18	5.83	[88]
73	Gerreidae	*Gerres longirostris*	Southern Arabian Gulf	F	(20.1)	20.6	2404.1	0.61	6.34	6.43	[88]
74	Gobiidae	*Eviota melasma*	Lizard Island, Australia	M	2.7	1.1	0.1	1.07	2.91	1.10	[89]
75	Gobiidae	*Eviota melasma*	Lizard Island, Australia	F	2.7	1.2	0.1	1.07	2.91	1.16	[89]
76	Gobiidae	*Eviota queenslandica*	Lizard Island, Australia	M	2.6	1.3	0.1	1.08	2.77	1.34	[89]
77	Gobiidae	*Eviota queenslandica*	Lizard Island, Australia	F	2.6	1.4	0.1	1.08	2.77	1.43	[89]
78	Gobiidae	*Eviota sigillata*	Lizard Island, Australia	M	1.8	1.1	0.0036	1.13	1.94	1.13	[89]
79	Gobiidae	*Eviota sigillata*	Lizard Island, Australia	F	1.8	1.1	0.0036	1.13	1.94	1.14	[89]
80	Gobiidae	*Exyrias belissimus*	Terengganu, Malaysia	U	15.0	10.0	31.8	0.82	9.12	6.55	[46]
81	Gobiidae	*Istigobius decoratus*	Terengganu, Malaysia	U	13.0	9.0	22.4	0.83	8.46	6.23	[46]
82	Gobiidae	*Istigobius goldmanni*	Terengganu, Malaysia	U	6.0	5.0	2.3	0.94	5.37	4.53	[46]
83	Haemulidae	*Diagramma pictum*	Southern Arabian Gulf	M	(57.6)	30.7	1832.3	0.63	12.72	8.58	[90]
84	Haemulidae	*Diagramma pictum*	Southern Arabian Gulf	F	(60.6)	31.8	2137.0	0.62	12.76	8.55	[90]
85	Haemulidae	*Diagramma pictum*	Arabian Gulf, Kuwait	U	(69.1)	52.3	4963.3	0.58	11.72	9.97	[91]
86	Haemulidae	*Haemulon aurolineatum*	Pernambuco, Brazil	M	23.5	15.3	178.1	0.74	10.21	7.45	[92]
87	Haemulidae	*Haemulon aurolineatum*	Pernambuco, Brazil	F	23.5	15.0	178.1	0.74	10.21	7.34	[92]
88	Haemulidae	*Haemulon plumierii*	Ceará State, Bazil	F	34.3	16.9	843.6	0.66	10.45	6.53	[93]
89	Haemulidae	*Haemulon plumierii*	Ceará State, Brazil	M	27.7	18.6	446.9	0.69	10.00	7.59	[93]
90	Haemulidae	*Pomadasys stridens*	Gulf of Suez	F	18.3	10.3	104.9	0.76	9.13	5.90	[94]
91	Haemulidae	*Pomadasys stridens*	Gulf of Suez	M	18.3	9.1	104.9	0.76	9.13	5.36	[94]
92	Hemiramphidae	*Hemiramphus brasiliensis*	Pernambuco, Brazil	M	29.9	18.6	229.7	0.72	11.71	8.31	[95]
93	Hemiramphidae	*Hemiramphus brasiliensis*	Pernambuco, Brazil	F	29.9	19.3	229.7	0.72	11.71	8.53	[95]
94	Hemiramphidae	*Hemiramphus far*	Bardawil lagoon, Egypt	M	27.6	21.1	128.3	0.75	12.10	9.87	[96]
95	Hemiramphidae	*Hemiramphus far*	Bardawil lagoon, Egypt	F	28.1	21.3	127.9	0.75	12.25	9.94	[96]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^D$	$L_m{}^D$	Reference
96	Holocentridae	*Holocentrus adscensionis*	Pernambuco, Brazil	F	17.8	12.1	211.0	0.73	8.13	6.13	[97,98]
97	Holocentridae	*Holocentrus rufus*	Jamaica	F	23.0	13.5	206.8	0.73	9.84	6.67	[99]
98	Holocentridae	*Myripristis murdjan*	Lakshadweep lagoons, India	U	19.2	15.6	212.9	0.73	8.59	7.39	[45]
99	Holocentridae	*Sargocentron rubrum*	Terengganu, Malaysia	U	29.1	18.2	571.9	0.68	9.94	7.22	[46]
100	Kyphosidae	*Kyphosus bigibbus*	Northwest Kyushu, Japan	F	57.4	36.0	3327.5	0.60	11.35	8.58	[100]
101	Kyphosidae	*Kyphosus bigibbus*	Northwest Kyushu, Japan	M	50.6	28.4	2320.0	0.62	11.24	7.87	[100]
102	Kyphosidae	*Kyphosus cinerascens*	Kavieng, Papua New Guinea	F	34.0	22.6	935.2	0.66	10.21	7.80	[49]
103	Kyphosidae	*Kyphosus cinerascens*	Kavieng, Papua New Guinea	M	30.0	20.1	647.3	0.68	9.97	7.60	[49]
104	Labridae	*Halichoeres hortulanus*	Lakshadweep lagoons, India	U	28.9	12.8	356.2	0.70	10.67	6.02	[45]
105	Labridae	*Halichoeres marginatus*	Lakshadweep lagoons, India	U	17.9	7.0	99.6	0.76	9.04	4.42	[45]
106	Lethrinidae	*Lethrinus borbonicus*	Southern Arabian Gulf	M	28.7	22.1	366.8	0.70	10.57	8.80	[101]
107	Lethrinidae	*Lethrinus borbonicus*	Southern Arabian Gulf	F	28.7	21.3	366.8	0.70	10.57	8.57	[101]
108	Lethrinidae	*Lethrinus borbonicus*	Gulf of Suez, South Sinai coast	U	27.6	19.4	426.8	0.70	10.05	7.88	[102]
109	Lethrinidae	*Lethrinus borbonicus*	Foul Bay, Egypt, Red Sea	U	28.9	19.3	501.9	0.69	10.11	7.65	[103]
110	Lethrinidae	*Lethrinus lentjan*	Southern Arabian Gulf	M	(29.2)	24.6	446.9	0.69	10.36	9.21	[104]
111	Lethrinidae	*Lethrinus lentjan*	Southern Arabian Gulf	F	(32.4)	27.7	604.7	0.68	10.61	9.54	[104]
112	Lethrinidae	*Lethrinus microdon*	Southern Arabian Gulf	M	(32.6)	27.4	512.8	0.69	10.94	9.72	[101]
113	Lethrinidae	*Lethrinus microdon*	Southern Arabian Gulf	F	(32.0)	29.1	487.2	0.69	10.90	10.21	[101]
114	Lethrinidae	*Lethrinus nebulosus*	Southern Arabian Gulf	M	54.1	28.6	2230.2	0.62	11.80	7.95	[90]
115	Lethrinidae	*Lethrinus nebulosus*	Southern Arabian Gulf	F	55.7	27.6	2423.5	0.61	11.82	7.68	[90]
116	Lethrinidae	*Monotaxis grandoculis*	Pohnpei state, Micronesia	F	33.0	27.5	858.7	0.66	10.15	9.00	[43]
117	Lutjanidae	*Aphareus rutilans*	South China Sea	U	(67.2)	41.7	5356.0	0.58	11.36	8.62	[105]
118	Lutjanidae	*Aprion virescens*	Hawaii, US	F	102.8	44.9	15,361.5	0.53	11.57	7.47	[106]
119	Lutjanidae	*Apsilus dentatus*	Jamaica	F	54.0	40.0	2346.2	0.62	11.67	9.70	[107,108]
120	Lutjanidae	*Apsilus dentatus*	Jamaica	M	56.0	44.0	2634.2	0.61	11.68	10.08	[107,108]
121	Lutjanidae	*Etelis coruscans*	Hawaii, US	F	96.9	66.3	13,830.8	0.53	11.47	9.37	[106]
122	Lutjanidae	*Lutjanus apodus*	Great Barrier Reef, Australia	M	92.8	34.3	11,905.6	0.54	11.57	6.76	[109]
123	Lutjanidae	*Lutjanus apodus*	Jamaica	F	57.0	25.0	3764.4	0.59	11.04	6.77	[107]
124	Lutjanidae	*Lutjanus bohar*	Great Barrier Reef, Australia	F	67.5	42.9	5932.5	0.57	11.17	8.61	[110]
125	Lutjanidae	*Lutjanus buccanella*	Jamaica	F	49.0	24.0	1741.2	0.63	11.61	7.40	[107,108]
126	Lutjanidae	*Lutjanus buccanella*	Jamaica	M	49.0	26.0	1494.1	0.64	11.93	7.97	[107,108]
127	Lutjanidae	*Lutjanus carponotatus*	Palm Island, GBR, Australia	F	33.7	19.0	558.5	0.68	11.05	7.47	[111]
128	Lutjanidae	*Lutjanus carponotatus*	Lizard Island, Australia	F	35.4	19.0	646.4	0.68	11.15	7.32	[111]
129	Lutjanidae	*Lutjanus ehrenbergii*	Southern Arabian Gulf	U	(23.0)	20.4	199.1	0.73	9.89	9.06	[104]
130	Lutjanidae	*Lutjanus ehrenbergii*	Southern Arabian Gulf	M	(20.8)	19.9	148.0	0.74	9.59	9.27	[104]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^D$	$L_m{}^D$	Reference
131	Lutjanidae	*Lutjanus erythropterus*	Great Barrier Reef, Australia	U	62.4	48.5	34,639.3	0.49	7.60	6.72	[112]
132	Lutjanidae	*Lutjanus fulviflamma*	Southern Arabian Gulf	M	(21.2)	16.7	254.6	0.72	8.99	7.58	[113]
133	Lutjanidae	*Lutjanus fulviflamma*	Southern Arabian Gulf	F	(22.4)	18.7	301.0	0.71	9.14	8.04	[113]
134	Lutjanidae	*Lutjanus fulviflamma*	Okinawa island	F	34.2	19.6	931.8	0.66	10.25	7.11	[114]
135	Lutjanidae	*Lutjanus fulvus*	Yaeyama Isl., Okinawa, Japan	M	31.4	20.7	495.9	0.69	10.73	8.05	[115]
136	Lutjanidae	*Lutjanus fulvus*	Yaeyama Isl., Okinawa, Japan	F	33.2	22.5	585.6	0.68	10.85	8.32	[115]
137	Lutjanidae	*Lutjanus gibbus*	Pohnpei State, Micronesia	F	33.5	21.5	756.8	0.67	10.47	7.78	[43]
138	Lutjanidae	*Lutjanus lutjanus*	Persian Gulf and Sea of Oman	U	25.5	17.2	31.5	0.82	14.08	10.19	[116]
139	Lutjanidae	*Lutjanus malabaricus*	Great Barrier Reef, Australia	F	81.0	59.5	6923.8	0.57	12.01	10.09	[117]
140	Lutjanidae	*Lutjanus sebae*	Great Barrier Reef, Australia	F	72.0	54.8	7956.9	0.56	10.93	9.38	[117]
141	Lutjanidae	*Lutjanus synagris*	Jamaica	F	43.0	26.8	1288.8	0.64	11.27	8.31	[118]
142	Lutjanidae	*Lutjanus griseus*	Florida, US	F	72.4	23.0	6463.8	0.57	11.43	5.95	[119,120]
143	Megalopidae	*Megalops atlanticus*	Santa Fe, Ceará State, Brazil	M	153.6	120.0	23,369.2	0.51	12.97	11.44	[121,122]
144	Megalopidae	*Megalops atlanticus*	Santa Fe, Ceará State, Brazil	F	181.6	160.0	30,615.0	0.50	13.23	12.42	[121,122]
145	Menidae	*Mene maculata*	Taiwan	U	23.0	15.3	263.8	0.72	9.49	7.10	[123]
146	Monacanthidae	*Aluterus monoceros*	Veraval, India	U	58.9	48.5	2031.2	0.62	12.66	11.22	[124]
147	Mugilidae	*Mugil curema*	Sergipe State, Brazil	M	29.6	25.1	317.9	0.71	11.04	9.82	[125]
148	Mugilidae	*Mugil curema*	Sergipe State, Brazil	F	34.3	22.5	496.6	0.69	11.39	8.52	[125]
149	Mullidae	*Mulloidichthys flavolineatus*	Lakshadweep lagoons, India	U	24.2	16.0	200.7	0.73	10.27	7.58	[45]
150	Mullidae	*Mulloidichthys martinicus*	Jamaica	F	28.0	18.0	410.8	0.70	10.21	7.50	[126]
151	Mullidae	*Mulloidichthys martinicus*	Jamaica	M	28.0	19.0	332.3	0.71	10.55	8.02	[126]
152	Mullidae	*Pseudupeneus maculatus*	Pernambuco, Brazil	U	29.2	20.0	634.3	0.68	9.82	7.60	[127]
153	Mullidae	*Pseudupeneus maculatus*	Jamaica	F	24.9	18.0	232.5	0.72	9.97	8.10	[126,128]
154	Mullidae	*Pseudupeneus maculatus*	Jamaica	M	26.4	18.5	344.9	0.71	9.95	7.83	[126,128]
155	Muraenidae	*Muraena augusti*	Canary Islands	U	90.0	55.8	1750.1	0.63	17.00	12.58	[129]
156	Muraenidae	*Muraena helena*	Adriatic Sea, Croatia	M	121.0	79.0	3541.7	0.60	17.50	13.57	[130]
157	Muraenidae	*Muraena helena*	Adriatic Sea, Croatia	F	113.1	76.0	2679.8	0.61	17.88	14.03	[130]
158	Muraenidae	*Muraena helena*	Canary Island	U	134.0	75.1	5714.9	0.57	16.68	11.96	[129]
159	Nemipteridae	*Nemipterus japonicus*	Manila Bay, Philippines	F	16.2	9.2	69.2	0.78	8.79	5.66	[87,131]
160	Platycephalidae	*Platycephalus indicus*	Hong Kong, China	M	44.2	23.5	624.1	0.68	13.03	8.50	[132]
161	Platycephalidae	*Platycephalus indicus*	Hong Kong, China	F	62.2	45.7	1862.0	0.63	13.31	10.98	[132]
162	Pomacanthidae	*Pomacanthus maculosus*	Southern Arabian Gulf	F	33.3	21.6	1070.9	0.65	9.85	7.43	[101]
163	Pomacentridae	*Abudefduf vaigiensis*	Lakshadweep lagoons, India	U	16.8	10.7	146.4	0.75	8.18	5.83	[45]
164	Pomacentridae	*Chromis viridis*	Lakshadweep lagoons, India	U	9.7	4.9	21.4	0.83	6.65	3.78	[45]
165	Pomacentridae	*Dascyllus trimaculatus*	Terengganu, Malaysia	U	13.1	8.4	79.3	0.77	7.33	5.21	[46]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^D$	$L_m{}^D$	Reference
166	Pomacentridae	*Pomacentrus coelestis*	Terengganu, Malaysia	U	8.3	5.6	11.5	0.86	6.24	4.39	[46]
167	Priacanthidae	*Priacanthus hamrur*	Saurashtra, India	F	29.2	18.5	409.8	0.70	10.51	7.65	[133]
168	Rachycentridae	*Rachycentron canadum*	Northwest Coast, India	U	(176.0)	66.9	53,225.4	0.47	11.40	7.23	[134]
169	Sciaenidae	*Pennahia aneus*	Manila Bay, Philippines	M	21.1	13.1	128.9	0.75	9.89	6.89	[87,135]
170	Sciaenidae	*Pennahia aneus*	Manila Bay, Philippines	F	20.0	12.6	112.7	0.76	9.67	6.81	[87,135]
171	Scombridae	*Scomberomorus brasiliensis*	Maranhâo	F	79.5	41.1	3804.2	0.59	13.42	9.08	[136]
172	Scombridae	*Scomberomorus brasiliensis*	Maranhâo, Brazil	M	76.5	44.3	3405.3	0.60	13.42	9.68	[136]
173	Scombridae	*Scomberomorus brasiliensis*	Rio Grande do Norte, Brazil	M	72.7	31.2	3943.7	0.59	12.64	7.66	[137]
174	Scombridae	*Scomberomorus brasiliensis*	Rio Grande do Norte, Brazil	F	54.0	25.3	1675.4	0.63	12.43	7.70	[137]
175	Scombridae	*Scomberomorus cavalla*	Ceará State, Brazil	F	100.5	63.0	7535.8	0.56	13.32	10.25	[138]
176	Scombridae	*Scomberomorus cavalla*	Ceará State, Brazil	F	113.6	77.0	10,910.2	0.54	13.15	10.64	[139]
177	Scombridae	*Scomberomorus maculatus*	Ceará, State, Brazil	F	65.5	41.0	2304.0	0.62	13.19	9.88	[138]
178	Scombridae	*Scomberomorus maculatus*	Ceará State, Brazil	F	78.0	46.0	3878.6	0.59	13.22	9.67	[140]
179	Scorpaenidae	*Pterois russelii*	Terengganu, Malaysia	U	30.0	19.0	249.1	0.72	11.59	8.34	[46]
180	Siganidae	*Siganus canaliculatus*	Southern Arabian Gulf	M	33.2	21.5	731.9	0.67	10.46	7.82	[141]
181	Siganidae	*Siganus canaliculatus*	Southern Arabian Gulf	F	36.9	25.7	1004.9	0.66	10.65	8.40	[141]
182	Sillaginidae	*Sillago sihama*	Gulf of Mannar, India	U	(26.2)	12.8	137.7	0.75	11.52	6.73	[142]
183	Sillaginidae	*Sillago sihama*	Pulicat Lake, India	U	(38.0)	22.1	327.3	0.71	13.13	8.95	[143]
184	Sparidae	*Archosargus rhomboidalis*	Terminos Lagoon, Mexico	U	24.6	8.5	491.0	0.69	9.07	4.38	[144]
185	Sparidae	*Rhabdosargus sarba*	Southern Arabian Gulf	M	29.3	23.5	513.5	0.69	10.17	8.74	[104]
186	Sparidae	*Rhabdosargus sarba*	Southern Arabian Gulf	F	29.3	23.7	513.5	0.69	10.17	8.79	[104]
187	Sparidae	*Rhabdosargus sarba*	South-eastern Australia	U	(25.1)	19.4	325.1	0.71	9.79	8.17	[145]
188	Sparidae	*Sparus aurata*	North Island, New Zealand	U	(55.9)	24.0	3388.1	0.60	11.13	6.71	[146]
189	Sparidae	*Sparus aurata*	Western North Island, N.Z.	U	(63.4)	24.0	4818.1	0.58	11.21	6.37	[146]
190	Sparidae	*Sparus aurata*	Western South Island, N.Z.	U	(66.1)	24.0	5426.2	0.58	11.23	6.26	[146]
191	Sphyraenidae	*Sphyraena barracuda*	Florida, USA	F	141.8	65.6	60,587.5	0.46	9.99	6.98	[147]
192	Synanceiidae	*Inimicus didactylus*	Terengganu, Malaysia	U	25.0	16.0	231.4	0.72	10.28	7.44	[46]
193	Synodontidae	*Saurida tumbil*	East China Sea	U	(54.7)	25.7	2664.8	0.61	11.50	7.25	[148]
194	Synodontidae	*Saurida tumbil*	Manila Bay, Philippines	M	28.0	23.9	192.5	0.73	11.48	10.22	[87]
195	Synodontidae	*Saurida tumbil*	Manila Bay, Philippines	F	29.2	24.7	218.9	0.73	11.59	10.27	[87]
196	Synodontidae	*Saurida undosquamis*	off Visakhapatnam, India	U	(34.1)	20.9	364.2	0.70	11.96	8.48	[149]
197	Synodontidae	*Synodus variegatus*	Terengganu, Malaysia	U	36.8	15.6	659.8	0.68	11.40	6.40	[46]
198	Synodontidae	*Trachinocephalus myops*	Minnan-Taiwan Bank	U	(41.0)	16.5	804.7	0.67	11.86	6.47	[150]
199	Tetraodontidae	*Canthigaster valentini*	Lizard Island, Australia	F	8.8	5.8	22.3	0.83	6.14	4.33	[151]
200	Tetraodontidae	*Canthigaster valentini*	Lizard Island, Australia	M	10.7	6.7	39.5	0.81	6.77	4.63	[151]

Table 1. *Cont.*

No.	Family	Species	Location	Sex	L_{max} (cm)	L_m (cm)	W_{max} (g)	D	$L_{max}{}^{D}$	$L_m{}^{D}$	Reference
201	Tetraodontidae	*Lagocephalus sceleratus*	Suez Canal, Egypt	F	76.5	42.2	5076.6	0.58	12.38	8.77	[152]
202	Tetraodontidae	*Lagocephalus sceleratus*	Suez Canal, Egypt	M	76.5	41.0	5076.6	0.58	12.38	8.63	[152]
203	Tetraodontidae	*Lagocephalus sceleratus*	Rhodes, Greece	U	61.5	35.1	2646.6	0.61	12.36	8.77	[153]
204	Tetraodontidae	*Lagocephalus sceleratus*	Lebanon	U	71.6	39.0	5439.2	0.58	11.75	8.27	[154]
205	Tetraodontidae	*Lagocephalus sceleratus*	Southwest Cyprus	UI	71.2	40.8	4454.7	0.59	12.18	8.80	[155]
206	Tetraodontidae	*Lagocephalus sceleratus*	Southeast Cyprus	U	78.0	47.6	5872.6	0.57	12.15	9.15	[155]
207	Tetraodontidae	*Lagocephalus sceleratus*	Cyprus	F	75.0	19.4	5355.1	0.58	12.11	5.54	[156]

References

1. Trippel, E.A. Age at Maturity as a Stress Indicator in Fisheries: Biological Processes Related to Reproduction in Northwest Atlantic Groundfish Populations That Have Undergone Declines. *BioScience* **1995**, *45*, 759–771. [CrossRef]
2. Prince, J.D.; Wilcox, C.; Hall, N. How to Estimate Life History Ratios to Simplify Data-Poor Fisheries Assessment. *ICES J. Mar. Sci.* **2023**, *80*, 2619–2629. [CrossRef]
3. Froese, R.; Pauly, D. Comment on "Metabolic Scaling Is the Product of Life-History Optimization". *Science* **2023**, *380*, eade6084. [CrossRef] [PubMed]
4. Pauly, D.; Liang, C. A Reconceptualization of the Interactions between Spawning and Growth in Bony Fish. *Sci. Mar.* **2022**, *86*, e044. [CrossRef]
5. van Oosten, J. The Whitefishes (Coregonus Clupeaformis). A Study of the Scales of Whitefishes of Known Ages. *Zoologica* **1923**, *2*, 380–412. [CrossRef]
6. Lagler, K.F.; Bardach, J.E.; Miller, R.R.; Passino, D.R.M. *Ichthyology*, 2nd ed.; Wiley: New York, 1977; ISBN 978-0-471-51166-3.
7. Quince, C.; Abrams, P.A.; Shuter, B.J.; Lester, N.P. Biphasic Growth in Fish I: Theoretical Foundations. *J. Theor. Biol.* **2008**, *254*, 197–206. [CrossRef]
8. Pauly, D.; Cheung, W.W.L. Sound Physiological Knowledge and Principles in Modeling Shrinking of Fishes under Climate Change. *Glob. Change Biol.* **2017**, *24*, e15–e26. [CrossRef]
9. Lester, N.P.; Shuter, B.J.; Abrams, P.A. Interpreting the von Bertalanffy Model of Somatic Growth in Fishes: The Cost of Reproduction. *Proc. Biol. Sci.* **2004**, *271*, 1625–1631. [CrossRef]
10. Li, Z.; Lu, H.; Gan, X.; Jin, X. Growth and mortality of bottom threadfin bream Nemipterus bathybius in the mouth of Beibu Gulf, South China Sea. *Fish. Sci.* **2009**, *28*, 556–562.
11. Pauly, D. A Mechanism for the Juvenile-to-Adult Transition in Fishes. *ICES J. Mar. Sci.* **1984**, *41*, 280–284. [CrossRef]
12. Meyer, K.A.; Schill, D.J. The Gill-Oxygen Limitation Theory and Size at Maturity/Maximum Size Relationships for Salmonid Populations Occupying Flowing Waters. *J. Fish Biol.* **2021**, *98*, 44–49. [CrossRef] [PubMed]
13. Amarasinghe, U.S.; Pauly, D. The Relationship Between Size at Maturity and Maximum Size in Cichlid Populations Corroborates the Gill-Oxygen Limitation Theory (GOLT). *AFS* **2021**, *34*, 14–22. [CrossRef]
14. Chen, Z.; Bigman, J.; Xian, W.; Liang, C.; Chu, E.; Pauly, D. The Ratio of Length at First Maturity to Maximum Length across Marine and Freshwater Fishes. *J. Fish Biol.* **2022**, *101*, 400–407. [CrossRef] [PubMed]
15. Chu, E.; Pauly, D. Key Information on 25 Species of Sturgeon; Family Acipenseridae. In *Marine and Freshwater Miscellanea IV*; Fisheries Centre Research Reports; Institute for the Oceans and Fisheries: Vancouver, BC, Canada, 2022; pp. 57–68.
16. Keskiṅ, Ç.; Pauly, D. Testing Predictions of Length at First Maturity of Teleostean Fishes, given Their Maximum Length. *Cybium* **2023**, *47*, 249–257. [CrossRef]
17. Pütter, A. Studien über physiologische Ähnlichkeit VI. Wachstumsähnlichkeiten. *Pflügers Arch.* **1920**, *180*, 298–340. [CrossRef]
18. Pauly, D. The Gill-Oxygen Limitation Theory (GOLT) and Its Critics. *Sci. Adv.* **2021**, *7*, eabc6050. [CrossRef] [PubMed]
19. Pauly, D.; Lam, M.E. Too Hot or Too Cold: The Biochemical Basis of Temperature-Size Rules for Fish and Other Ectotherms. *Environ. Biol. Fishes* **2023**, *106*, 1519–1527. [CrossRef]
20. De Jager, S.; Dekkers, W.J. Relations Between Gill Structure and Activity in Fish. *Neth. J. Zool.* **1974**, *25*, 276–308. [CrossRef]
21. Palzenberger, M.; Pohla, H. Gill Surface Area of Water-Breathing Freshwater Fish. *Rev. Fish Biol. Fish.* **1992**, *2*, 187–216. [CrossRef]
22. Pauly, D. Gill Size and Temperature as Governing Factors in Fish Growth: A Generalization of von Bertalanffy's Growth Formula. Ph.D. Thesis, Christian-Albrechts-Universität Kiel, Kiel, Germany, 1979.
23. Pauly, D. Why Do Fish Reach First Maturity When They Do? *J. Fish Biol.* **2022**, *101*, 333–341. [CrossRef]
24. Pankhurst, N.W. Development. In *Fish Physiology*; Schreck, C.B., Tort, L., Farrell, A.P., Brauner, C.J., Eds.; Biology of Stress in Fish; Academic Press: Cambridge, MA, USA, 2016; Volume 35, pp. 295–331.
25. Taylor, C.C. Cod Growth and Temperature. *ICES J. Mar. Sci.* **1958**, *23*, 366–370. [CrossRef]
26. Froese, R.; Thorson, J.T.; Reyes Jr, R.B. A Bayesian Approach for Estimating Length-Weight Relationships in Fishes. *J. Appl. Ichthyol.* **2014**, *30*, 78–85. [CrossRef]
27. Pauly, D. The Relationships between Gill Surface Area and Growth Performance in Fish: A Generalization of von Bertalanffy's Theory of Growth. *Berichte Dtsch. Wiss. Komm. Für Meeresforsch.* **1981**, *28*, 251–282.
28. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2023; Available online: https://www.R-project.org/ (accessed on 2 November 2022).
29. Bürkner, P.-C. Brms: An R Package for Bayesian Multilevel Models Using Stan. *J. Stat. Softw.* **2017**, *80*, 1–28. [CrossRef]
30. Chang, J.; Rabosky, D.L.; Smith, S.A.; Alfaro, M.E. An r Package and Online Resource for Macroevolutionary Studies Using the Ray-Finned Fish Tree of Life. *Methods Ecol. Evol.* **2019**, *10*, 1118–1124. [CrossRef]
31. Warren, M.; Pauly, D. The likely role of urea in delaying the size at first maturity of ureosmotic Chondrichthyes. *Environ. Biol. Fishes*, 2024; *in press*.
32. Ricklefs, R.E.; Starck, J.M. Applications of Phylogenetically Independent Contrasts: A Mixed Progress Report. *Oikos* **1996**, *77*, 167–172. [CrossRef]
33. Rohle, F.J. A comment on phylogenetic correction. *Evolution* **2006**, *60*, 1509–1515. [CrossRef]
34. Revell, L.J. Phylogenetic Signal and Linear Regression on Species Data. *Methods Ecol. Evol.* **2010**, *1*, 319–329. [CrossRef]

35. Budaev, S.; Jørgensen, C.; Mangel, M.; Eliassen, S.; Giske, J. Decision-Making From the Animal Perspective: Bridging Ecology and Subjective Cognition. *Front. Ecol. Evol.* **2019**, *7*, 164. [CrossRef]
36. Nelson, H.R.; Altieri, A.H. Oxygen: The Universal Currency on Coral Reefs. *Coral Reefs* **2019**, *38*, 177–198. [CrossRef]
37. Nilsson, G.E.; Ostlund-Nilsson, S. Hypoxia in Paradise: Widespread Hypoxia Tolerance in Coral Reef Fishes. *Proc. R. Soc. London Ser. B Biol. Sci.* **2004**, *271*, S30–S33. [CrossRef] [PubMed]
38. Nilsson, G.E.; Hobbs, J.-P.A.; Östlund-Nilsson, S.; Munday, P.L. Hypoxia Tolerance and Air-Breathing Ability Correlate with Habitat Preference in Coral-Dwelling Fishes. *Coral Reefs* **2007**, *26*, 241–248. [CrossRef]
39. Pauly, D.; Dimarchopoulou, D. Introduction: Fishes in a Warming and Deoxygenating World. *Environ. Biol. Fishes* **2022**, *105*, 1261–1267. [CrossRef]
40. Heath, D.D.; Blouw, D.M. Are Maternal Effects in Fish Adaptive or Merely Physiological Side Effects? In *Maternal Effects as Adaptations*; Mousseau, T.A., Fox, C.W., Eds.; Oxford University Press: Oxford, UK, 1998; ISBN 978-0-19-511163-7.
41. Reeson, P.H. The Biology, Ecology and Bionomics of the Surgeonfishes, Acanthuridae. In *Caribbean Coral Reef Fishery Resources*; Munro, J.L., Ed.; ICLARM Stud. Rev.; ICLARM: Manila, Philippines, 1983; pp. 178–190.
42. Craig, P.; Choat, J.; Axe, L.M.; Saucerman, S. Population Biology and Harvest of a Coral Reef Surgeonfish (*Acanthurus Lineatus*) in American Samoa. *Fish. Bull.* **1997**, *95*, 680–693.
43. Longnecker, K.; Langston, R. *Rapid Reproductive Analysis of Four Heavily Exploited Reef Fishes from Pohnpei State, Federated States of Micronesia*; Bishop Museum Press: Honolulu, HI, USA, 2016; p. 41.
44. Hart, A.M.; Russ, G.R. Response of Herbivorous Fishes to Crown-of-Thorns Starfish Acanthaster Planci Outbreaks. III. Age, Growth, Mortality and Maturity Indices of Acanthurus Nigrofuscus. *Mar. Ecol. Prog. Ser.* **1996**, *136*, 25–35. [CrossRef]
45. Murty, V.S. *Marine Ornamental Fish Resources of Lakshadweep*; CMFRI Special Publication; CMFRI: Kochi, India, 2002.
46. Du, J.; Loh, K.-H.; Hu, E.; Zheng, X. *Common Reef Fishes of Terengganu, Malaysia*; Science Press: Beijing, China, 2019.
47. Crabtree, R.E.; Harnden, C.W.; Snodgrass, D.; Stevens, C. Age, Growth, and Mortality of Bonefish, *Albula vulpes*, from the Waters of the Florida Keys. *Fish. Bull.* **1996**, *94*, 442–451.
48. Ndobe, S.; Soemarno; Herawati, E.Y.; Setyohadi, D.; Moore, A.; Palomares, M.L.D.; Pauly, D. Life History of Banggai Cardinalfish, Pterapogon Kauderni (Actinopterygii: Perciformes: Apogonidae), in Banggai Islands and Palu Bay, Sulawesi, Indonesia. *Acta Ichthyol. Piscat.* **2013**, *43*, 237–250. [CrossRef]
49. Longnecker, K.; Langston, R.; Bolick, H.; Crane, M.; Donaldson, T.J.; Franklin, E.C.; Kelokelo, M.; Kondio, U.; Potuku, T. Rapid Reproductive Analysis and Length-Weight Relations for Five Species of Coral-Reef Fishes (Actinopterygii) from Papua New Guinea: *Nemipterus isacanthus*, *Parupeneus barberinus*, *Kyphosus cinerascens*, *Ctenochaetus striatus* (Perciformes), and *Balistapus undulatus* (Tetraodontiformes). *Acta Ichthyol. Piscat.* **2017**, *47*, 107–124. [CrossRef]
50. Ofori-Danson, P.K. Growth of Grey Triggerfish *Balistes Capriscus*, Based on Growth Checks of the Dorsal Spine. *Fishbyte* **1989**, *7*, 11–12.
51. Aggrey-Fynn, J. The Fishery of Balistes Capriscus (Balistidae) in Ghana and Possible Reasons for Its Collapse. Ph.D. Dissertation, University of Bremen, Bremen, Germany, 2007.
52. Aiken, K.A. The Biology, Ecology and Bionomics of the Triggerfishes, Balistidae. In *Caribbean Coral Reef Fishery Resources*; Munro, J.L., Ed.; ICLARM Stud. Rev.; ICLARM: Manila, Philippines, 1983; pp. 191–205.
53. Sabrah, M.M.; Amin, A.M.; Attia, A.O. Family Belonidae from the Suez Canal, Egypt: Age, Growth, Mortality, Exploitation Rate and Reproductive Biology. *Egypt. J. Aquat. Biol. Fish.* **2018**, *44*, 29–35. [CrossRef]
54. Reuben, S.; Mohamad Kasim, H.; Sivakami, S.; Nair, P.N.R.; Kurup, K.N.; Sivadas, M.; Noble, A.; Nair, K.V.S.; Raje, S.G. Fishery, Biology and Stock Assessment of Carangid Resources from the Indian Seas. *Indian J. Fish.* **1992**, *39*, 195–234.
55. Mehanna, S.; Mohammad, A.; Mahmoud, U. Fishery Status of *Carangoides bajad* and *Caranx melampygus* (Family Carangidae) from Shalateen Fishing Area, Red Sea, Egypt, Based on Yield per Recruit (Y/R) Analysis. *Egypt. J. Aquat. Biol. Fish.* **2016**, *20*, 21–68. [CrossRef]
56. Grandcourt, E.M.; Al Abdessalaam, T.Z.; Francis, F.; Al Shamsi, A. Population Biology and Assessment of Representatives of the Family Carangidae *Carangoides bajad* and *Gnathanodon speciosus* (Forsskål, 1775), in the Southern Arabian Gulf. *Fish. Res.* **2004**, *69*, 331–341.
57. Chen, P. Optimum First Capture Standards of Major Capture Species of the Northern South China Sea. *J. Fish. China* **2004**, *28*, 393–400.
58. van der Elst, R.P.; Adkin, F. (Eds.) *Marine Linefish: Priority Species and Research Objectives in Southern Africa*; Oceanography Research Institute Special Publication; Oceanography Research Institute: Durban, South Africa, 1991.
59. Torres, F. Tabular Data on Marine Fishes from Southern Africa. Part 1: Length-Weight Relationships. *Fishbyte* **1991**, *9*, 50–53.
60. Sudekum, A.E.; Parrish, J.D.; Radtke, R.L.; Ralston, S. Life History and Ecology of Large Jacks in Undisturbed, Shallow, Oceanic Communities. *Fish. Bull.* **1991**, *89*, 493–513.
61. Widodo, J. Maturity and Spawning of Shortfin Scad (*Decapterus macrosoma*) (Carangidae) of the Java Sea. *Asian Fish. Sci.* **1991**, *4*, 245–252. [CrossRef]
62. Atmadja, S.B. Estimation of Growth and Mortality of Round Scad (*Decapterus macrosoma*) in the Java Sea, Indonesia. *FAO Fish. Rep.* **1988**, *389*, 324–345.
63. Lin, L.; Zheng, Y.J.; Cheng, J.H.; Liu, Y.; Ling, J.Z. A preliminary study on fishery biology of main commercial fishes surveyed from the bottom trawl fisheries in the East China Sea. *Mar. Sci.* **2006**, *30*, 21–25.

64. Lin, L.; Cheng, J.; Ling, J.; Zhang, H. First Capture Sizes of Major Commercial Fishes in the East China Sea Region. *J. Fish. Sci. China* **2006**, *13*, 250–256.
65. Geng, P. *A Study of Inter-Annual Changes in Growth, Mortality and Exploitation Rate of Representative Fish Stocks in Beibu Gulf*; Shanghai Ocean University: Shanghai, China, 2019.
66. Hales, L.S.J. Distribution, Abundance, Reproduction, Food Habits, Age, and Growth of Round Scad, *Decapterus punctatus*, in the South Atlantic Bight. *Fish. Bull.* **1987**, *85*, 251–268.
67. Wilk, S.J.; Morse, W.W.; Ralph, D.E. Length-Weight Relationships of Fishes Collected in the New York Bight. *Bull. New Jersey Acad. Sci.* **1978**, *23*, 58–64.
68. Pinheiro, P.B.; Hazin, F.H.V.; Travassos, P.; Oliveira, P.G.V.; Carvalho, F.; Rêgo, M.G. The Reproductive Biology of the Rainbow Runner, Elagatis Bipinnulata (Quoy & Gaimard, 1825) Caught in the São Pedro and São Paulo Archipelago. *Braz. J. Biol.* **2011**, *71*, 99–106. [CrossRef] [PubMed]
69. Tao, Y.; Chen, M.; Du, J.; Zhenbin, L.; Shengyun, Y. Age and Growth Changes and Population Dynamics of the Black Pomfret (*Parastromateus niger*) and the Frigate Tuna (*Auxis Thazard Thazard*), in the Taiwan Strait. *Lat. Am. J. Aquat. Res.* **2012**, *40*, 649–656. [CrossRef]
70. Griffiths, S.; Fry, G.; van der Velde, T. *Age, Growth and Reproductive Dynamics of the Talang Queenfish (Scomberoides Commersonnianus) in Northern Australia*; CSIRO Cleveland: Celevland, Australia, 2005; ISBN 978-1-921061-08-0.
71. Escobar, F.D.; Polo, C.J.; Alonso, J.C.; Puentes, V. *Estados de Los Principales Recursos Pesqueros de Colombia 2014*; Autoridad Nacional de Acuicultura y Pesca—AUNAP: Bogotá, Colombia, 2014; ISBN 978-958-58993-3-9.
72. Morsuwan, P. On the Biology of Slender Trevally, Caranx leptolepis, in the Gulf of Thailand. Marine Fish Laboratory: Bangkok Thailand, 1970.
73. Marino, G.; Mandich, A.; Massari, A.; Andaloro, F.; Porrello, S.; Finoia, M.G.; Cevasco, F. Aspects of Reproductive Biology of the Mediterranean Amberjack (*Seriola dumerilii* Risso) during the Spawning Period. *J. Appl. Ichthyol.* **1995**, *11*, 9–24. [CrossRef]
74. Crabtree, R.E.; Hood, P.; Snodgrass, D. Age, Growth, and Reproduction of Permit (*Trachinotus falcatus*) in Florida Waters. *Fish. Bull.* **2002**, *100*, 26–34.
75. Saccardo, S.A.; Cergole, M.C.; Masumoto, C. Trachurus Lathami Nichols, 1920. In *Análise das Principais Pescarias Commerciais da Região Sudeste-Sul do Brasil: Dinâmica Populacional das Espécies em Explotaçao*; Cergole, M.C., Ávila-da-Silva, A.O., Rossi-Wongtchowski, C.L.D.B., Eds.; Instituto Oceanográfico: São Paulo, Brazil, 2005; pp. 156–161.
76. Johnson, G.D.; Brothers, E.B. Acanthemblemaria Paula, a New Diminutive Chaenopsid (Pisces: Blennioidei) from Belize with Comments on Life History. *Proc. Biol. Soc. Wash.* **1989**, *120*, 1018–1030.
77. Conand, F. Biology and Phenology of *Amblygaster sirm* (Clupeidae) in New Caledonia, a Sardine of the Coral Environment. *Bull. Mar. Sci.* **1991**, *48*, 137–149.
78. de Moussac, G.; Poupon, J.C. Croissance et Ovogénèsis d'*Herklotsichthys punctatus* (Pisces, Clupeidae) Ruppel, 1837 Aux Seychelles. *Cybium* **1986**, *10*, 31–45.
79. Alves, M.I.M.; Sawaya, P. Sobre a reprodução da sardinha-bandeira, *Opisthonema oglinum* (Le sueur), na costa do estado do Ceará (Brasil). *Arq. Ciências Mar* **1975**, *15*, 19–28.
80. Bezerra, R.C. Relacâo Comprimento-Peso Da Sardinha-Bandeira, Opisthonema Oglinum (LeSueur), No Estado Do Ceará. *Arq. Est. Mar. Univ. Fed. Ceará* **1968**, *8*, 225–227.
81. LINO; da Silva, M.A. Estudo Biológico-Pesqueiro da Manjuba Opisthonema Oglinum (Lesueur, 1818) da Região de Itapissuma, Pernambuco. Master's Thesis, Universidade Federal Rural de Pernambuco, Recife, Brazil, 2003. Available online: https://bdtd.ibict.br/vufind/Record/URPE_cf1178c45b99e5eba3f960e083317969 (accessed on 2 November 2022).
82. Sekharan, K.V. Observations on the Choodai Fishery of Mandapam Area. *Indian J. Fish.* **1955**, *2*, 113–131.
83. Dalzell, P.J. *The Population Biology and Management of Bait-Fish in Papua New Guinea Waters*; Report; Fisheries Research and Surveys Branch, Department of Primary Industry: Port Moresby, Independent State of Papua New Guinea, 1984.
84. CMFRI. *Annual Report 2016-17*; Central Marine Fisheries Research Institute: Kochi, India, 2016; p. 345.
85. Tham, A.K. A Contribution to the Study of the Growth of Members of the Genus Stolephorus Lacépède in Singapore Strait. *Proc. Indo-Pac. Fish. Comm.* **1967**, *12*, 1–25.
86. Bariche, M.; Kajajian, A.; Azzurro, E. Reproduction of the Invasive Bluespotted Cornetfish Fistularia Commersonii (Teleostei, Fistulariidae) in the Mediterranean Sea. *Mar. Biol. Res.* **2013**, *9*, 169–180. [CrossRef]
87. Manacop, P.R. The Sexual Maturity of Some Commercial Fishes Caught in Manila Bay. *Philipp. J. Sci.* **1936**, *59*, 383–391.
88. Grandcourt, E.M.; Al Abdessalaam, T.Z.; Francis, F.; Al Shamsi, A.T. Fisheries Biology of a Short-Lived Tropical Species: Gerres Longirostris (Lacépède, 1801) in the Arabian Gulf. *ICES J. Mar. Sci.* **2006**, *63*, 452–459. [CrossRef]
89. Depczynski, M.; Bellwood, D.R. Shortest Recorded Vertebrate Lifespan Found in a Coral Reef Fish. *Curr. Biol.* **2005**, *15*, R288–R289. [CrossRef]
90. Grandcourt, E.; Al Abdessalaam, T.Z.; Al Shamsi, A.T.; Francis, F. Biology and Assessment of the Painted Sweetlips (*Diagramma pictum* (Thunberg, 1792)) and the Spangled Emperor (*Lethrinus nebulosus* (Forsskål, 1775)) in the Southern Arabian Gulf. *Fish. Bull.* **2006**, *104*, 75–88.
91. Lee, J.U.; Al-Baz, A. Assessment of Fish Stocks Exploited by Fish Traps in the Arabian Gulf Area. *Asian Fish. Sci.* **1989**, *2*, 213–231. [CrossRef]

92. Lima, M.M.; Lessa, R.P.; Duarte-Neto, P.J. Haemulon Aurolineatum. In *Dinâmica de Populações e Avaliação de Estoques dos Recursos Pesqueiros da Região Nordeste*; Lessa, R.P., Nóbrega, M.F., Júnior, J.L.B., Eds.; Departamento de Pesca—Universidade Federal Rural de Pernambuco: Recife, Brazil, 2004; Volume 2, pp. 142–150.
93. Shinozaki-Mendes, R.A.; Santander-Neto, J.; Silva, J.R.F.; Hazin, F.H.V. Reproductive Biology of Haemulon Plumieri (Teleostei: Haemulidae) in Ceará State, Northeastern Brazil. *Braz. J. Biol.* **2013**, *73*, 391–396. [CrossRef] [PubMed]
94. Osman, H.M.; Saber, M.A.; El Ganainy, A.A. Population Structure of the Striped Piggy *Pomadasys stridens* in the Gulf of Suez. *Egypt. J. Aquat. Res.* **2019**, *45*, 53–58. [CrossRef]
95. Nóbrega, M.F.; Monteiro, A.; Lessa, R.P. Hemiramphus Brasiliensis. In *Dinâmica de Populações e Avaliação de Estoques dos Recursos Pesqueiros da Região Nordeste*; Lessa, R.P., Nóbrega, M.F., Júnior, J.L.B., Eds.; Departamento de Pesca—Universidade Federal Rural de Pernambuco: Recife, Brazil, 2004; Volume 2, pp. 151–161.
96. Mehanna, S.F.; Salem, M.; Mahmoud, H.S. Some Biological Aspects and Reproductive Dynamic of the Black-Barred Halfbeak *Hemiramphus far* (Family: Hemiramphidae) in Bardawil Lagoon, Egypt. *Egypt. J. Aquat. Biol. Fish.* **2019**, *23*, 127–137. [CrossRef]
97. Shinozaki-Mendes, R.A.; Hazin, F.H.V.; De Oliveira, P.G.; de Carvalho, F.C. Reproductive Biology of the Squirrelfish, *Holocentrus adscensionis* (Osbeck, 1765), Caught off the Coast of Pernambuco, Brazil. *Sci. Mar.* **2007**, *71*, 715–722. [CrossRef]
98. Nomura, H. Length-Weight Tables of Some Fish Species from Northeastern Brazil. *Arq. Est. Biol. Mar. Univ. Fed. Ceará* **1965**, *5*, 103–105.
99. Wyatt, J.R. The Biology, Ecology and Bionomics of the Squirrelfishes, Holocentridae. In *Caribbean Coral Reef Fishery Resources*; Munro, J.L., Ed.; ICLARM Stud. Rev.; ICLARM: Manila, Philippines, 1983; pp. 50–58.
100. Yamaguchi, A.; Kume, G.; Yoshimura, Y.; Kiriyama, T.; Yoshimura, Y. Spawning Season and Size at Sexual Maturity of *Kyphosus bigibbus* (Kyphosidae) from Northwest Kyushu, Japan. *Ichthyol. Res.* **2011**, *58*, 283–287. [CrossRef]
101. Grandcourt, E.; Al Abdessalaam, T.Z.; Francis, F.; Al Shamsi, A.T. Age-Based Life History Parameters and Status Assessments of by-Catch Species (*Lethrinus borbonicus, Lethrinus microdon, Pomacanthus maculosus* and *Scolopsis taeniatus*) in the Southern Arabian Gulf. *J. Appl. Ichthyol.* **2010**, *26*, 381–389. [CrossRef]
102. El-Ganainy, A.; Amin, A. Age, Growth, Mortality Rates and Corresponding Yield Estimates of the Snubnose Emperor Lethrinus Borbonicus from South Sinai Coast, Gulf of Suez, Egypt. *Egypt. J. Aquat. Biol. Fish.* **2012**, *16*, 27–34. [CrossRef]
103. Mehanna, S. *Population Dynamics and Management of Snubnose Emperor Lethrinus bungus (L. borbonicus) from the Foul Bay, Red Sea*; INOC-XI International Symposium: Bogor, Indonesia, 2011; pp. 121–129.
104. Grandcourt, E.; Al Abdessalaam, T.Z.; Francis, F.; Al Shamsi, A.T. Demographic Parameters and Status Assessments of *Lutjanus ehrenbergii, Lethrinus lentjan, Plectorhinchus sordidus* and *Rhabdosargus sarba* in the Southern Arabian Gulf. *J. Appl. Ichthyol.* **2011**, *27*, 1203–1211. [CrossRef]
105. Li, Y. Species Diversity and Biology of Fish in Coral Reef Waters of Xisha, Zhongsha and Nansha Islands, South China Sea. PhD Thesis, Ocean University of China, Qingdao, China, 2010.
106. Everson, A.R.; Williams, H.A.; Ito, B.M. Maturation and Reproduction in Two Hawaiian Eteline Snappers, Uku, *Aprion virescens*, and Onaga, *Etelis coruscans*. *Fish. Bull.* **1989**, *87*, 877–888.
107. Thompson, R.; Munro, J.L. The Biology, Ecology and Bionomics of Caribbean Reef Fishes: Lutjanidae (Snappers). In *Caribbean Coral Reef Fishery Resources*; Munro, J.L., Ed.; ICLARM Stud. Rev.; ICLARM: Manila, Philippines, 1983; pp. 94–109.
108. Pauly, D. On the Interrelationships between Natural Mortality, Growth Parameters, and Mean Environmental Temperature in 175 Fish Stocks. *ICES J. Mar. Sci.* **1980**, *39*, 175–192. [CrossRef]
109. Williams, D.M.; Russ, G.R. *Review of Data on Fishes of Commercial and Recreational Fishing Interest in the Great Barrier Reef*; Great Barrier Reef Marine Park Authority Res. Publ; Great Barrier Reef Marine Park Authority: South Townsville, Australia, 1994; p. 103.
110. Marriott, R.J.; Mapstone, B.D.; Begg, G.A. Age-Specific Demographic Parameters, and Their Implications for Management of the Red Bass, *Lutjanus bohar* (Forsskal 1775): A Large, Long-Lived Reef Fish. *Fish. Res.* **2007**, *83*, 204–215. [CrossRef]
111. Kritzer, J. Sex-Specific Growth and Mortality, Spawning Season, and Female Maturation of the Stripey Bass (*Lutjanus carponotatus*) on the Great Barrier Reef. *Fish. Bull.* **2004**, *102*, 94–107.
112. Newman, S.J.; Cappo, M.; Williams, D.M. Age, Growth, Mortality Rates and Corresponding Yield Estimates Using Otoliths of the Tropical Red Snappers, *Lutjanus erythropterus, L. malabaricus* and *L. sebae*, from the Central Great Barrier Reef. *Fish. Res.* **2000**, *48*, 1–14. [CrossRef]
113. Grandcourt, E.; Al Abdessalaam, T.Z.; Francis, F. Age, Growth, Mortality and Reproduction of the Blackspot Snapper, *Lutjanus fulviflamma* (Forsskål, 1775), in the Southern Arabian Gulf. *Fish. Res.* **2006**, *78*, 203–210. [CrossRef]
114. Shimose, T.; Tachihara, K. Age, Growth and Maturation of the Blackspot Snapper *Lutjanus fulviflammus* around Okinawa Island, Japan. *Fish. Sci.* **2005**, *71*, 48–55. [CrossRef]
115. Shimose, T.; Nanami, A. Age, Growth, and Reproductive Biology of Blacktail Snapper, *Lutjanus fulvus*, around the Yaeyama Islands, Okinawa, Japan. *Ichthyol. Res.* **2014**, *61*, 322–331. [CrossRef]
116. Kamali, S.; Ramzani, M.; Kamali, I. Study of Big Eye Snapper (*Lutjanus lutjanus*) Reproduction in Persian Gulf Waters and Oman Sea. *J. Anim. Environ.* **2017**, *9*, 269–274.
117. Mcpherson, G.R.; Squire, L. Age and Growth of Three Dominant Lutjanus Species of the Great Barrier Reef Inter-Reef Fishery. *Asian Fish. Sci.* **1992**, *5*, 25–36. [CrossRef]

118. Aiken, K.A. Aspects of Reproduction, Age and Growth of the Lane Snapper, *Lutjanus synagris* (Linnaeus, 1758) in Jamaican Coastal Water. In Proceedings of the 52nd Gulf and Caribbean Fisheries Institute, Key West, FL, USA, 1–5 November 1999; LeRoy Creswell, R., Ed.; Gulf and Caribbean Fisheries Institute: Fort Pierce, FL, USA, 2001; pp. 116–134.
119. Starck, W.A.I. The Biology of the Grey Snapper, *Lutjanus griseus* (Linnaeus), in the Florida Keys. In *Investigations on the Gray Snapper, Lutjanus Griseus*; Starck, W.A.I., Schroeder, R.E., Eds.; Studies in Tropical Oceanography; Rosenstiel School of Marine and Atmospheric Sciences, University of Miami Press: Miami, USA, 1971; pp. 11–150.
120. Burton, M. Age, Growth, and Mortality of Gray Snapper, *Lutjanus griseus*, from the East Coast of Florida. *Fish. Bull.* **2001**, *99*, 254–265.
121. de Menezes, M.F.; Paiva, M.P. Notes on the Biology of Tarpon, *Tarpon atlanticus* (Cuvier and Valenciennes), from Coastal Waters of Ceará, Santa Fé, Brazil. *Arq. Ciências Mar* **1966**, *6*, 83–98.
122. Menezes, M.F. Relacão Peso-Comprimento Do Camurupim, *Tarpon atlanticus* (Valenciennes) No Nordeste Brasileiro. *Arq. De Ciências Do Mar* **1967**, *7*, 101–102.
123. Hwang, S.-Y.; Chen, C.-T.; Liu, K.-M. Age and Growth of the Moon Fish, *Mene maculata*, before and after Heavy Exploitation in Southwestern Taiwan Waters. *J. Fish. Soc. Taiwan* **2002**, *29*, 299–311.
124. Ghosh, S.; Thangavelu, R.; Mohammed, G.; Dhokia, H.; Zala, M.; Savaria, Y.; Polara, J.; Ladani, A. Sudden Emergence of Fishery and Some Aspects of Biology and Population Dynamics of *Aluterus monoceros* (Linnaeus, 1758) at Veraval. *Indian J. Fish.* **2011**, *58*, 31–34.
125. Araújo, A.R.; Silva, F.D. Aspectos Da Pesca e Biologia Da Tainha, *Mugil curema* (Osteichthyes: Mugilidae), No Estuario Do Rio Vaza Barris, Sergipe, Brasil. *Arq. Cienc. Mar* **2013**, *46*, 29–38.
126. Munro, J.L. The Biology, Ecology and Bionomics of the Goatfishes, Mullidae. In *Caribbean Coral Reef Fishery Resources*; Munro, J.L., Ed.; ICLARM Stud. Rev.; ICLARM: Manila, Philippines, 1983; pp. 142–154.
127. Santana, F.M.; Morize, E.; Lessa, R. Age and Growth of the Spotted Goatfish, *Pseudupeneus maculatus* (Bloch, 1793) in Brazil, Validated through Marginal Increment and Oxytetracycline Dyes in the Sagittae. *J. Appl. Ichthyol.* **2006**, *22*, 132–137. [CrossRef]
128. Munro, J.L. Aspects of the Biology and Ecology of Caribbean Reef Fishes: Mullidae (Goat Fishes). *J. Fish Biol.* **1976**, *9*, 79–97. [CrossRef]
129. Jiménez, S.; Schönhuth, S.; Lozano, I.J.; González, J.A.; Sevilla, R.G.; Diez, A.; Bautista, J.M. Morphological, Ecological, and Molecular Analyses Separate Muraena Augusti from Muraena Helena as a Valid Species. *Cope* **2007**, *2007*, 101–113. [CrossRef]
130. Matić-Skoko, S.; Tutman, P.; Petrić, M.; Skaramuca, D.; Đikić, D.; Lisičić, D.; Skaramuca, B. Mediterranean Moray Eel *Muraena helena* (Pisces: Muraenidae): Biological Indices for Life History. *Aquat. Biol.* **2011**, *13*, 275–284. [CrossRef]
131. Wang, X.H.; Qiu, Y.S.; Zhu, G.P.; Du, F.Y.; Sun, D.R.; Huang, S.L. Length-Weight Relationships of 69 Fish Species in the Beibu Gulf, Northern South China Sea. *J. Appl. Ichthyol.* **2011**, *27*, 959–961. [CrossRef]
132. Ho, C.M. Biology and Fishery of the Bartail Flathead, *Platycephalus Indicus* (Linn., 1758), in the Northern South China Sea. PhD Dissertation, The University of Hong Kong, Hong Kong, China, 2005.
133. Kizhakudan, S.; Zala, M. Dynamics of *Priacanthus hamrur* (Forsskal) Exploited off Saurashtra Coast. *Indian J. Fish.* **2006**, *53*, 409–416.
134. Moosamikandy, S.; Kurup, M. Stock Assessment of Cobia *Rachycentron canadum* (Linnaeus, 1766) Occurring in the North West Coast of India. *Indian J. Geo-Mar. Sci.* **2016**, *45*, 378–387.
135. Tuuli, C.D.; Sadovy de Mitcheson, Y.; Liu, M. Reproductive Biology of the Greyfin Croaker Pennahia Anea in the Northern South China Sea. *Ichthyol. Res.* **2011**, *58*, 302–309. [CrossRef]
136. Lima, P.R.; Lessa, R.; de Castro, A.C.; de Jesus Azevedo, J.W. Tamanho E idade de primeira maturação do serra, Scomberomorus brasiliensis (Osteichthyes; Scombridae-Collette Russo & Zavalla-Camin, 1978) no litoral ocidental do Maranhão-Brasil. *Bol. Laboratório Hidrobiol.* **2009**, *22*, 39–44.
137. Lima, J.T.; Fonteles Filho, A.A.; Chellappa, S. Biologia reprodutiva da serra, Scomberomorus brasiliensis (Osteichthyes: Scombridae), em águas costeiras do Rio Grande do Norte. *Arq. Ciências Mar* **2007**, *40*, 24–30.
138. Gesteira, T.C.V.; Lôbo de, A.L. Época de Reprodução, Tamanho e Idade na Primeira Desova da Cavala e da Serra, na Costa Do Estado do Ceará (Brasil). 1976. Available online: https://repositorio.ufc.br/handle/riufc/1654 (accessed on 16 February 2023).
139. Ivo, C.T.C. Época de Desova e Idade na Primeira Maturação Sexual da Cavala, Scomberomorus Cavalla (Cuvier), no Estado do Ceará. 1972. Available online: https://repositorio.ufc.br/handle/riufc/1715 (accessed on 16 February 2023).
140. Gesteira, T.C.V. Sobre a reprodução e fecundidade da serra, scomberomorus maculatus (mitchill), no estado do ceará. *Arq. Ciências Mar* **1972**, *12*, 117–122.
141. Grandcourt, E.; Al Abdessalaam, T.; Francis, F.; Al Shamsi, A. Population Biology and Assessment of the White-Spotted Spinefoot, *Siganus canaliculatus* (Park, 1797), in the Southern Arabian Gulf. *J. Appl. Ichthyol.* **2007**, *23*, 53–59. [CrossRef]
142. Radhakrishnan, N. A Contribution to the Biology of Indian Sand Whiting Sillago Sihama (Forskal). *Indian J. Fish.* **1957**, *4*, 254–283.
143. Krishnamurthy, K.N.; Kaliyamurthy, M. Studies on the age and growth of sandwhiting sillago sihama (forskal) from pulicat lake with observations on its biology and fishery. *Indian J. Fish.* **1978**, *25*, 84–97.
144. Chavance, P.; Yáñez-Arancibia, A.; Flores-Hernandez, D.; Lara, A.; Amezcua, F. Ecology, Biology and Population Dynamics of Archosargus rhomboidalis (Pisces, Sparidae) in a Tropical Coastal Lagoon System, Southern Gulf of Mexico. *An. Inst. Cienc. Mar Limnol. Univ. Nac. Auton. Mex.* **1986**, *13*, 11–30.

145. Hughes, J.M.; Stewart, J.; Kendall, B.W.; Gray, C.A. Growth and Reproductive Biology of Tarwhine Rhabdosargus Sarba (Sparidae) in Eastern Australia. *Mar. Freshw. Res.* **2008**, *59*, 1111–1123. [CrossRef]
146. Annala, J.H. *Report from the Fishery Assessment Plenary, May 1994: Stock Assessments and Yield Estimates*; Unpublished Report Held in Maf Fisheries Greta Point Library; Fisheries Science Group, Ministry for Primary Industries: Wellington, New Zealand, 1994.
147. De Sylva, D.P. *Systematics and Life History of the Great Barracuda, Sphyraena Barracuda (Walbaum)*; Studies in Tropical Oceanography; University of Miami Press: Coral Gables, FL, USA, 1963.
148. Shindo, S. Note on the Study on the Stock of Lizard Fish, *Saurida tumbil* in the East China Sea. *Proc. Indo-Pac. Fish. Comm.* **1972**, *13*, 298–305.
149. Rajkumar, U.; Sivakami, S.; Rao, K.N.; Kingsly, H.J. Lizardfish Fishery, Biology and Population Dynamics of Saurida Undosquamis (Richardson) off Visakhapatnam. *Indian J. Fish.* **2003**, *50*, 149–156.
150. Du, J.; Lu, Z.; Yang, S.; Chen, M. Studies on Ecological Characteristics Variation and Population Dynamics of Four Lizardfishes in the Southern Taiwan Straits. *Acta Oceanol. Sin.* **2011**, *30*, 72–81. [CrossRef]
151. Gladstone, W.; Westoby, M. Growth and Reproduction in *Canthigaster valentini* (Pisces, Tetraodontidae): A Comparison of a Toxic Reef Fish with Other Reef Fishes. *Environ. Biol. Fishes* **1988**, *21*, 207–221. [CrossRef]
152. Sabrah, M.; El-Ganainy, A.; Zaky, M.A. Biology and Toxicity of the Pufferfish *Lagocephalus sceleratus* (GMELIN, 1789) from the Gulf of Suez. *Egypt. J. Aquat. Res.* **2006**, *32*, 283–297.
153. Kalogirou, S. Ecological Characteristics of the Invasive Pufferfish Lagocephalus Sceleratus (Gmelin, 1789) in Rhodes, Eastern Mediterranean Sea. A Case Study. *Mediterr. Mar. Sci.* **2013**, *14*, 251–260. [CrossRef]
154. Boustany, L.; El Indary, S.; Nader, M. Biological Characteristics of the Lessepsian Pufferfish Lagocephalus Sceleratus off Lebanon. *Cah. De Biol. Mar.* **2015**, *56*, 137–142. [CrossRef]
155. Rousou, M.; Ganias, K.; Kletou, D.; Loucaides, A.; Tsinganis, M. Maturity of the Pufferfish Lagocephalus Sceleratus in the Southeastern Mediterranean Sea. *Sex. Early Dev. Aquat. Org.* **2014**, *1*, 35–44. [CrossRef]
156. Michailidis, N. Study on the Lessepian Migrant *Lagocephalus sceleratus* in Cyprus. In Proceedings of the Report of the Technical Meeting on the Lessepsian Migration and Its Impact on Eastern Mediterranean Fishery, Nicosia, Cyprus, 7–9 December 2010; FAO: Nicosia, Cyprus, 2010; pp. 74–87.