**Reef fish growth dataset: a dataset of annual otolith sagittal growth for 51 reef fish from French Polynesia**

Fabien Morat 1, 2\*, Jérémy Wicquart 1, 2\*, Guillemette de Sinéty 1, 2, Jean Bienvenu 1, 2, Simon J. Brandl 3, Jérémy Carlot 1, 2, Jordan M.Casey 1, 2, Alexandre Mercière1, 2, Pauline Fey 4, René Galzin 1, 2, Yves Letourneur 4,2, Pierre Sasal 1, 2, Nina M. D. Schiettekatte 1, 2, Jason Vii 1, 2, Valériano Parravicini 1, 2

Corresponding author e-mail: [fabien.morat@univ-perp.fr](mailto:fabien.morat@univ-perp.fr); [valeriano.parravicini@ephe.psl.eu](mailto:valeriano.parravicini@ephe.psl.eu)

Fabien Morat and Jérémy Wicquart equally contributed to the paper and share first authorship.

*1 PSL Université Paris: EPHE-UPVD-CNRS, USR 3278 CRIOBE, Université de Perpignan, 52 Avenue Paul Alduy, 66860 Perpignan Cedex, France*

*2 Laboratoire d’Excellence « CORAIL »*

*3 Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada*

*4 Université de la Nouvelle-Calédonie, Institut ISEA, Nouméa Cedex, New Caledonia*

*Orcid numbers :*

Fabien : <https://orcid.org/0000-0002-9925-1437>

J Wicquart : <https://orcid.org/0000-0003-3462-3188>

Simon : <https://orcid.org/0000-0002-6649-2496>

J Carlot : <https://orcid.org/0000-0003-0887-8005>

Jordan : <https://orcid.org/0000-0002-2434-7207>

Yves : <https://orcid.org/0000-0003-3157-1976>

Nina : <https://orcid.org/0000-0002-1925-3484>

Vale : <https://orcid.org/0000-0002-3408-1625>

Pierre : <https://orcid.org/0000-0002-2371-6912>

**Introduction**

Calcul des a et b des relations de W= f(L) et parametre des VB

**Metadata**

**Class I. Data set descriptors**

1. **Data set identity**

**Title:** Reef fish growth dataset: a dataset of annual otolith sagittal growth for 51 reef fish from French Polynesia

1. **Data set identification code**

size\_at\_age\_coral\_reef\_fishes\_data.csv

1. **Data set description**
2. **Principal Investigators**

Valeriano Parravicini

*PSL Université Paris: EPHE-UPVD-CNRS, USR 3278 CRIOBE, Université de Perpignan, 52 Avenue Paul Alduy, 66860 Perpignan Cedex, France, Laboratoire d’Excellence « CORAIL »*

Fabien Morat

*PSL Université Paris: EPHE-UPVD-CNRS, USR 3278 CRIOBE, Université de Perpignan, 52 Avenue Paul Alduy, 66860 Perpignan Cedex, France, Laboratoire d’Excellence « CORAIL »*

1. **Abstract**

Somatic growth, i.e. the increment in body mass across time is an important ecological trait, which is pivotal for the assessment of physiological as well as population to ecosystem-level processes. Indeed, the rate of somatic growth is directly correlated to the energetic demand of organisms, their metabolism the influence they may have on important ecological processes such as the nutrients cycling. As such, the rate of somatic growth is one of the basic information that feeds bioenergetic models, one of the main tools to quantify fluxes at individual to the ecosystem level. However, for marine fishes this information is available mainly for those species targeted by commercial fisheries and aquaculture often limiting our capacity to perform analysis at community level, on a large number of species in coastal areas. This is partly due to the fact that somatic growth can hardly be estimated in aquaria due to a general loss of weight of individuals kept in captivity. The analysis of the sagittal growth of fish otolith, a calcium carbonate structure in the inner ear, has shown as a powerful tool to estimate individual growth. However, this type of data is rarely available because of the extremely time-consuming nature of the otolith processing. This is especially true for coral reef fishes whose commercial importance mainly relies on local subsistence fisheries and whose large diversity often discourage assessments over a large number of species. Here we report information on the sagittal otolith growth of 848 individuals belonging to 51 species of coral reef fishes. Individuals were caught in French Polynesia in different islands belonging to different archipelagoes and subjected to different temperatures (Moorea, Mataiva, Hao and Mangareva). No copyright or proprietary restrictions are associated with the use of this data set other than citation of this Data Paper.

1. **Key words**

French Polynesia, coral reef, fish, otolith, back-calculation

**Class II. Research origin descriptors**

1. **“Overall” project description**
2. **Identity**

Titre du projet : REEF SERVICES

1. **Originator(s)**

Valeriano Parravicini

*PSL Université Paris: EPHE-UPVD-CNRS, USR 3278 CRIOBE, Université de Perpignan, 52 Avenue Paul Alduy, 66860 Perpignan Cedex, France, Laboratoire d’Excellence « CORAIL »*

1. **Period of study**

The project started in March 2016 with the sampling for the incentive project NECTAR (Funding by the LABEX CORAIL) and continued by the REEF SERVICE project since 2017.

The research started in March 2016 and finished in November 2018.

1. **Objectives**

Reef services aims to collect important ecological data to understand how climate change is impacting ecosystem processes and key services (eg. food provisioning, coastal protection) to humans.

1. **Abstract**

Resumé de projet Reef service.

1. **Sources of founding**

The project was supported by the BNP PARIBAS foundation (REEF SERVICES Project); the French national Agency for research (ANR-17-CE32-006); the Fondation de France; Make our Planet Great Again (Grant/Award number: mopga-pdf-0000000144); “Direction des ressources marines” (convention number 09419); and the French Polynesia.

1. **“Specific subproject” description**
2. **Site description**
3. Site type
4. Geography

The sites sampled during this study covered different island in French Polynesia.

1. Habitat

Fish were collected in lagoon and/or in the outer slope of the reefs.

1. Geology, landform
2. Watersheds, hydrology
3. Site history
4. Climate

All the French Polynesia is in tropical climate. The see surface temperature varied from the East to West and from the North to South. The table xx show the sea surface temperature (SST) recorded around each island.

1. **Experimental or sampling design**
2. Design characteristics
3. Permanent plots
4. Data collection period, frequency etc.
5. **Research methods**
6. Field/Laboratory

Fish from Moorea (Society Island) and Nuku Hiva (Marquesas) were collected using spear gun or clove oil depending on size; those from HAO (Tuamotu) and Mangareva (Gambier) were collected by spearfishing; those from Tuamotu Archipelago were bought on the fish market of Tahiti.

In the laboratory, total fish length (TL) were measured to the nearest millimeter and pairs of sagittae (largest otolith of the fish inner ear) were extracted, cleaned with distilled water, died and stored in microtubes.

For each species, otolith were cut transversely, using a diamond disc saw (Presi Mecatome T210) to obtain a section of 500 µm. Sections were then fixed on a glass side with a thermoplastic glue (Crystalbond TM). Sections of small otolith were obtain by sanding both side. Otolith were sanded with abrasive disc of decreasing grain size (2 400, 1 200 grains cm-²) and polished with 0.25 µm diameter diamonds suspension in order to be closest to the nucleus. All sections were photographed under Leica DM750 light microscope with Leica ICC50 HD microscope camera and LAS software (Leia Microsystems). When section were too large, multiple photographs were taken and assembled in one with Photostitch software (Canon).

For each species, a reading transect was chosen and distances between annual growth increments were measured with Image J software. This procedure was done twice by two readers in order to limit observer bias on age estimation. When the coefficient of variation (Panfili *et al.*, 2002) between observers was greater than 5 % a common reading was assessed. The measurements realized by the two readers were averaged for each section.

The back-calculation procedure, proposed by Vigliola and Meekan (2009), was used to estimate the fish length at previous ages. This method requires to examine the shape of the relationship (allometric or isometric) between the length at capture (Lcpt) and the radius of otolith at capture of all samples (Rcpt). In case of isometry (eq. 1) the fish size at otolith formation (a) was calculated from equation 2 although in case of allometry (eq. 3) it was calculated from equation 4. Back-calculation Modified Fry (MF) model (eq. 5), proposed by Vigliola *et al.* (2000) was carry out for each individual.

Isometry: (eq. 1) and (eq. 2)

Allometry: (eq. 3) and (eq. 4)

MF model: (eq. 5)

Where Li and Ri are the fish length and otolith radius at age *i,* and L0p and R0p are the fish size and radius of otolith at hatching. The L0p parameter was given in table I.

Table I. Fish size at hatching (Lop) for each species studied in this study. Level referred to the taxonomic level where L0p was found. When it was possible L0p from different studies were averaged.

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Lop (mm)** | **Level** | **Reference** |
| *Abudefduf sexfasciatus* (Lacepède, 1801) | 2.65 | Species | Shadrin and Emel’yanova (2007) |
| *Acanthurus achilles* Shaw, 1803 | 1.70 | Genus | Mccormick (1999) |
| *Acanthurus lineatus* (Linnaeus, 1758) | 1.70 | Genus | Mccormick (1999) |
| *Acanthurus nigricans* (Linnaeus, 1758) | 1.70 | Genus | Mccormick (1999) |
| *Acanthurus pyroferus* Kittlitz, 1834 | 1.70 | Genus | Mccormick (1999) |
| *Acanthurus triostegus* (Linnaeus, 1758) | 1.70 | Species | Mccormick (1999) |
| *Balistapus undulatus* Tilesius, 1820 | 1.80 | Family | Leis and Carson-Ewart (2000) |
| *Caranx melampygus,* Cuvier, 1833 | 3.15 | Family | Leis and Carson-Ewart (2000) |
| *Centropyge bispinosa* (Günther, 1860) | 1.95 | Family | Leis and Carson-Ewart (2000) |
| *Centropyge flavissima* (Cuvier, 1831) | 1.95 | Family | Leis and Carson-Ewart (2000) |
| *Cephalopholis argus* Schneider, 1801 | 1.90 | Family | Leis and Carson-Ewart (2000) |
| *Cephalopholis urodeta* (Forster, 1801) | 1.90 | Family | Leis and Carson-Ewart (2000) |
| *Chaetodon citrinellus* Cuvier, 1831 | 1.45 | Genus | Leis and Carson-Ewart (2000) |
| *Chaetodon ornatissimus* Cuvier, 1831 | 1.45 | Genus | Leis and Carson-Ewart (2000) |
| *Cheilinus chlorourus* (Bloch, 1761) | 1.97 | Genus | Hutapea and Slamet (2006) |
| *Chlorurus spilurus* (Valenciennes, 1840) | 1.65 | Family | Leis and Carson-Ewart (2000) |
| *Chromis iomelas* Jordan & Seale, 1906 | 3.05 | Family | Leis and Carson-Ewart (2000) |
| *Chromis viridis* (Cuvier, 1830) | 3.05 | Family | Leis and Carson-Ewart (2000) |
| *Ctenochaetus marginatus* (Valenciennes, 1835) | 1.70 | Family | Leis and Carson-Ewart (2000) |
| *Ctenochaetus striatus* (Quoy & Gaimard, 1825) | 1.70 | Family | Leis and Carson-Ewart (2000) |
| *Dascyllus aruanus* (Linnaeus, 1758) | 2.10 | Genus | Emel’yanova *et al.* (2009) |
| *Dascyllus flavicaudus* Randall & Allen, 1977 | 2.10 | Genus | Emel’yanova et al. (2009) |
| *Epibulus insidiator* (Pallas, 1770) | 2.10 | Family | Leis and Carson-Ewart (2000) |
| *Epinephelus fasciatus* (Forsskål, 1775) | 1.50 | Species | Kawabe and Kohno (2009) |
| *Epinephelus hexagonatus* (Forster, 1801) | 1.70 | Genus | Hussain and Higuchi (1980), Glamuzina *et al.* (2000), Colin *et al.* (1996), Leu *et al.* (2005), Yoseda *et al.* (2006), Lim (1993), Duray *et al.* (1996), Duray *et al.* (1997), Ma *et al.* (2013), Glamuzina *et al.* (1998), James *et al.* (1997), Ukawa *et al.* (1966), Jagadis *et al.* (2006) |
| *Epinephelus merra* Bloch, 1793 | 1.50 | Species | Jagadis et al. (2006) |
| *Epinephelus polyphekadion* (Bleeker, 1849) | 1.65 | Species | James et al. (1997) |
| *Gnathodentex aureolineatus* (Lacepède, 1802) | 1.55 | Family | Leis and Carson-Ewart (2000) |
| *Gymnosarda unicolor* (Rüppell, 1836) | 2.75 | Family | Leis and Carson-Ewart (2000) |
| *Halichoeres trimaculatus* (Quoy & Gaimard, 1834) | 1.58 | Genus | Kimura and Kiriyama (1993) |
| *Lutjanus fulvus* (Forster, 1801) | 1.83 | Genus | Suzuki and Hioki (1979) |
| *Lutjanus gibbus* (Forsskål, 1775) | 1.83 | Genus | Suzuki and Hioki (1979) |
| *Lutjanus kasmira* (Forsskål, 1775) | 1.83 | Species | Suzuki and Hioki (1979) |
| *Monotaxis grandoculis* (Forsskål, 1775) | 1.55 | Family | Leis and Carson-Ewart (2000) |
| *Mulloidichthys flavolineatus* (Lacepède, 1801) | 2.50 | Family | Leis and Carson-Ewart (2000) |
| *Myripristis berndti* Jordan & Evermann, 1903 | 1.80 | Family | Leis and Carson-Ewart (2000) |
| *Naso lituratus* (Forster, 1801) | 1.70 | Family | Leis and Carson-Ewart (2000) |
| *Naso unicornis* (Forsskål, 1775) | 1.70 | Family | Leis and Carson-Ewart (2000) |
| *Odonus niger* (Rüppell, 1836) | 1.80 | Family | Leis and Carson-Ewart (2000) |
| *Ostorhinchus angustatus* (Smith & Radcliffe, 1911) | 4.25 | Family | Leis and Carson-Ewart (2000) |
| *Ostorhinchus apogonoides* (Bleeker, 1856) | 4.25 | Family | Leis and Carson-Ewart (2000) |
| *Parupeneus barberinus* (Lacepède, 1801) | 1.95 | Genus | Pavlov *et al.* (2011) |
| *Plectropomus laevis* (Lacepède, 1801) | 1.62 | Genus | Masuma *et al.* (1993) |
| *Pristiapogon taeniopterus* (Bennett, 1836) | 4.25 | Family | Leis and Carson-Ewart (2000) |
| *Sargocentron microstoma* (Günther, 1860) | 1.80 | Family | Leis and Carson-Ewart (2000) |
| *Scarus psittacus* Forsskål, 1775 | 1.65 | Family | Leis and Carson-Ewart (2000) |
| *Siganus argenteus* (Quoy & Gaimard, 1825) | 2.02 | Genus | May *et al.* (1974), Bryan and Madraisau (1977), Hara *et al.* (1986), Popper *et al.* (1976) |
| *Siganus spinus* (Linnaeus, 1758) | 2.02 | Genus | May et al. (1974), Bryan and Madraisau (1977), Hara et al. (1986), Popper et al. (1976) |
| *Stegastes albifasciatus* (Schlegel & Müller, 1839) | 3.05 | Family | Leis and Carson-Ewart (2000) |
| *Stegastes nigricans* (Lacepède, 1802) | 3.05 | Family | Leis and Carson-Ewart (2000) |
| *Zebrasoma scopas* (Cuvier, 1829) | 1.70 | Family | Leis and Carson-Ewart (2000) |

1. Taxonomy and systematics
2. Permit history

Sampling collection is permit by the French Polynesia government (Authorization N°:681MCE/ENV)

1. **Project personnel**

This work was conducted by FM, JW and VP. Fish collection on the field was made by FM, SJB, JC, JMC, PF, RG, AM, YL, PS, NMDS, VP. Otoliths analysis were made by FM, JW, GdS, JB. Funds were get by VP, PS, JMC. Statistical analyses were conducted by JW, NMDS. Temperature data were compiled by JV from DATA SOURCES DE TEMPERATURE. Sampling maps were made by JV. All authors have contributed to the paper writing.

**Class III. Data set status and accessibility**

1. **Status**
2. **Latest update**

July 2019

1. **Latest archive date:**

July 2019

1. **Accessibility**
2. **Storage location and medium**
3. **Contact person(s)**

Fabien Morat ([fabien.morat@univ-perp.fr](mailto:fabien.morat@univ-perp.fr)) and Valeriano Parravicini ([valeriano.parravicini@ephe.psl.eu](mailto:valeriano.parravicini@ephe.psl.eu))

1. **Copyright restrictions**

No copyright restriction

1. **Proprietary restrictions**

None. When using the dataset, we request the users to cite this data paper.

1. **Costs: None**

**Class IV. Data structural descriptors**

1. **Data set file**
2. **Identity**: size\_at\_age\_coral\_reef\_fishes\_data.csv
3. **Size**: 950 Kb
4. **Format and storage mode**: Comma-separated values, no compression
5. **Header information**: The header row indicates variable names as described in Table II (see part IV.B).
6. **Alphanumeric attributes**:
7. **Special characters/fields**:
8. **Authentication procedures**:
9. **Variable information**
   1. **Variable identity**: see Table II
   2. **Variable definition**: see Table II
   3. **Units of measurement**: see Table II
   4. **Data type**
      1. **Storage type**: see Table II
      2. **List and definition of variable codes**: None.
      3. **Range for numeric values**: see Table II
      4. **Missing values codes**:
      5. **Precision**:
   5. **Data format**

Table II. Description of the variables included in the dataset file

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Column** | **Variable identity** | **Variable definition** | **Unit** | **Storage type** | **Range** |
| 1 | Family | Family names according to Fishbase (https://www.fishbase.de/search.php) | - | Factor | - |
| 2 | Genus | Genus names according to Fishbase (https://www.fishbase.de/search.php) | - | Factor | - |
| 3 | Species | Species names according to Fishbase (https://www.fishbase.de/search.php) | - | Factor | - |
| 4 | ID | Unique code identifying each individual | - | Factor | - |
| 5 | Agei | Age *i* | years | Integer | 0 - 30 |
| 6 | Ri | Otolith radius at age *i* | mm | Numeric | 0 - 3.784 |
| 7 | Agecpt | Age at capture | years | Integer | 0 - 30 |
| 8 | Rcpt | Otolith radius at capture | mm | Numeric | 0.152 - 3.859 |
| 9 | Lcpt | Total length at capture | mm | Numeric | 28.11 - 984.69 |
| 10 | L0p | Total length at hatching | mm | Numeric | 1.45 - 4.25 |
| 11 | R0p | Otolith radius at hatching | mm | Numeric | 0.012 - 0.086 |
| 12 | Li | Total length at age *i* | mm | Numeric | 1.45 - 949.576 |
| 13 | Biomass | Wet biomass at capture | g | Numeric | 0.4 - 12950 |
| 14 | Location | Island or archipelago of the sampling | - | Factor | - |
| 15 | Observer | Name of the person who made the reading of the otolith | - | Factor | - |

1. **Data anomalies**

NA in the dataset indicates missing data. Missing values are present in the variables ‘Ri’ (366) and ‘Biomass’ (603). For variable ‘Ri’ missing values correspond to individuals for whom it has not been possible to estimate the radius at hatching on photographs. For variable ‘Biomass’ missing values are due to lack of measurement during sampling.

Faire un paragraphe sur les trajectoires individuelle aberrantes : pour *Acanthurus lineatus* (individu AC\_LI\_MA\_03\_17\_263) celui le plus âgé, et pour *Lutjanus kasmira* (individu GAM18\_B070) la trajectoire avec les points inférieurs à 5 ans et supérieurs à 250 mm.

**Class V. Supplemental descriptors**

**References**

Bryan, P.G. & Madraisau, B.B. (1977) Larval rearing and development of Siganus lineatus (Pisces: Siganidae) from hatching through metamorphosis. *Aquaculture,* **10,** 243-252.

Colin, P., Koenig, C. & Laroche, W. (1996) Development from egg to juvenile of the red grouper (Epinephelus morio)(Pisces: Serranidae) in the laboratory. *Biology, fisheries and culture of tropical groupers and snappers. ICLARM Conf. Proc.*

Duray, M.N., Estudillo, C.B. & Alpasan, L.G. (1996) The effect of background color and rotifer density on rotifer intake, growth and survival of the grouper (Epinephelus suillus) larvae. *Aquaculture,* **146,** 217-224.

Duray, M.N., Estudillo, C.B. & Alpasan, L.G. (1997) Larval rearing of the grouper Epinephelus suillus under laboratory conditions. *Aquaculture,* **150,** 63-76.

Emel’yanova, N., Pavlov, D. & Thuan, L. (2009) Hormonal stimulation of maturation and ovulation, gamete morphology, and raising of larvae in Dascyllus trimaculatus (Pomacentridae). *Journal of Ichthyology,* **49,** 249-263.

Glamuzina, B., Glavic, N., Tutman, P., Kozul, V. & Skaramuca, B. (2000) Egg and early larval development of laboratory reared goldblotch grouper, Epinephelus costae (Steindachner, 1878)(Pisces, Serranidae). *Scientia Marina,* **64,** 341-345.

Glamuzina, B., Skaramuca, B., Glavic, N., Kozvul, V., Dulcic, J. & Kraljevic, M. (1998) Egg and early larval development of laboratory reared dusky grouper, Epinephelus marginatus (Lowe, 1834)(Picies, Serranidae). *Scientia Marina,* **62,** 373-378.

Hara, S., Duray, M.N., Parazo, M. & Taki, Y. (1986) Year-round spawning and seed production of the rabbitfish, Siganus guttatus. *Aquaculture,* **59,** 259-272.

Hussain, N.A. & Higuchi, M. (1980) Larval rearing and development of the brown spotted grouper, Epinephelus tauvina (Forskål). *Aquaculture,* **19,** 339-350.

Hutapea, J.H. & Slamet, B. (2006) MORPHOLOGICAL DEVELOPMENT OF Napoleon WRASSE, Cheilinus undulatus LARVAE. *Indonesian Aquaculture Journal,* **1,** 145-151.

Jagadis, I., Ignatius, B., Kandasami, D. & Khan, M.A. (2006) Embryonic and larval development of honeycomb grouper Epinephelus merra Bloch. *Aquaculture research,* **37,** 1140-1145.

James, C., Al‐Thobaiti, S., Rasem, B. & Carlos, M. (1997) Breeding and larval rearing of the camouflage grouper Epinephelus polyphekadion (Bleeker) in the hypersaline waters of the Red Sea coast of Saudi Arabia. *Aquaculture Research,* **28,** 671-681.

Kawabe, K. & Kohno, H. (2009) Morphological development of larval and juvenile blacktip grouper, Epinephelus fasciatus. *Fisheries Science,* **75,** 1239-1251.

Kimura, S. & Kiriyama, T. (1993) Development of eggs, larvae and juveniles of the labrid fish, Halichoeres poecilopterus, reared in the laboratory. *Japanese Journal of Ichthyology,* **39,** 371-377.

Leis, J.M. & Carson-Ewart, B.M. (2000) *The larvae of Indo-Pacific coastal fishes: an identification guide to marine fish larvae*: Brill.

Leu, M.-Y., Liou, C.-H. & Fang, L.-S. (2005) Embryonic and larval development of the malabar grouper, Epinephelus malabaricus (Pisces: Serranidae). *Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom,* **85,** 1249.

Lim, L. (1993) Larviculture of the greasy grouper Epinephelus tauvina F. and the brown‐marbled grouper E. fuscoguttatus F. in Singapore. *Journal of the World Aquaculture Society,* **24,** 262-274.

Ma, Z., Guo, H., Zhang, N. & Bai, Z. (2013) State of art for larval rearing of grouper. *International Journal of Aquaculture,* **3**.

Masuma, S., Tezuka, N. & Teruya, K. (1993) Embryonic and morphological development of larval and juvenile coral trout, Plectropomus leopardus. *Japanese Journal of Ichthyology,* **40,** 333-342.

May, R.C., Popper, D. & Mcvey, J.P. (1974) Rearing and larval development of Siganus canaliculatus (Park)(Pisces: Siganidae). *Micronesica,* **10,** 285-298.

Mccormick, M.I. (1999) Delayed metamorphosis of a tropical reef fish (Acanthurus triostegus): a field experiment. *Marine Ecology Progress Series,* **176,** 25-38.

Panfili, J., De Pontual, H., Troadec, H. & Wright, P.J. (2002) *Manuel de sclérochronologie des poissons.,* Coédition Ifremer-IRD, Panfili J, de Pontual H, Troadec H, Wright PJ (eds), France, 464 pp.

Pavlov, D., Emel’yanova, N., Thuan, L.T.B. & Ha, V.T. (2011) Reproduction and initial development of manybar goatfish Parupeneus multifasciatus (Mullidae). *Journal of ichthyology,* **51,** 604.

Popper, D., May, R. & Lichatowich, T. (1976) An experiment in rearing larval Siganus vermiculatus (Valenciennes) and some observations on its spawning cycle. *Aquaculture,* **7,** 281-290.

Shadrin, A. & Emel’yanova, N. (2007) Embryonic-larval development and some data on the reproductive biology of Abudefduf sexfasciatus (Pomacentridae: Perciformes). *Journal of Ichthyology,* **47,** 67-80.

Suzuki, K. & Hioki, S. (1979) Spawning behavior, eggs, and larvae of the lutjanid fish, Lutjanus kasmira, in an aquarium. *Japanese Journal of Ichthyology,* **26,** 161-166.

Ukawa, M., Higuchi, M. & Mito, S. (1966) Spawning habits and early life history of a serranid fish, Epinephelus akaara (Temminck et Schlegel). *Japanese Journal of Ichthyology,* **13,** 156-161.

Vigliola, L., Harmelin-Vivien, M. & Meekan, M.G. (2000) Comparison of techniques of back-calculation of growth and settlement marks from the otoliths of three species of Diplodus from the Mediterranean Sea. *Canadian Journal of Fisheries and Aquatic Sciences,* **57,** 1291-1299.

Vigliola, L. & Meekan, M.G. (2009) The back-calculation of fish growth from otoliths. *Tropical fish otoliths: information for assessment, management and ecology***,** 174-211.

Yoseda, K., Dan, S., Sugaya, T., Yokogi, K., Tanaka, M. & Tawada, S. (2006) Effects of temperature and delayed initial feeding on the growth of Malabar grouper (Epinephelus malabaricus) larvae. *Aquaculture,* **256,** 192-200.