# A general approach to length-weight relationships for New Caledonian lagoon fishes

by

Michel KULBICKI (1, 2), Nicolas GUILLEMOT (2) & Marion AMAND (2)

**ABSTRACT**. - Most studies involving Pacific reef fishes use underwater visual censusing techniques to estimate their biomass and stock. This requires to know the length-weight relationships of all the species censused. Currently, only a small proportion of these relationships (15.4%) are available for reef fish species in the Pacific area. In the present article we propose length-weight relationships at four organisation levels: species, genera, families and morphological groups. A data base of 53,800 specimens belonging to 788 species from New Caledonia were used to estimate the relationships for 396 species, 185 genera, 75 families. At the genus level, the length-weight relationships cover 76% of the Pacific reef species and the coverage is nearly 85% at the family level. A study of the morphology of 1,100 specimens belonging to 311 species allowed to define 30 morphological groups, for which length-weight relationships were then estimated using 32,551 specimens belonging to these species. Using 3 classes of body thickness, a second clustering of these species defined 20 groups allowing length-weight relationships to be estimated from 2D pictures. These relationships allow to estimate weight from length data for most of the species not covered by the relationships at the species, genus or family level. The error levels increase from the species (average error 9.4%) to the family level (13.5%), the morphological groups yielding errors equivalent to those from the family level equations (13.2%). A graphical analysis of the coefficients from 396 length-weight relationships suggests that there are physical limits to fish shapes.

**RÉSUMÉ**. - Approche généralisée des relations longueur-poids des poissons lagonaires de Nouvelle-Calédonie.

La plupart des études visant à estimer la biomasse ou les stocks de poissons récifaux de l'Indo-Pacifique utilisent des méthodes de recensement visuel en plongée. Cela exige de connaître les relations longueur-poids de toutes les espèces recensées. À l'heure actuelle, seule une faible proportion de ces relations (15,4%) est disponible pour les espèces récifales du Pacifique. Notre article fournit des relations longueur-poids à quatre niveaux d'organisation : espèces, genres, familles et groupes morphométriques. Une base de données comportant 53800 poissons appartenant à 788 espèces de Nouvelle-Calédonie a été utilisée pour estimer les relations pour 396 espèces, 185 genres et 75 familles. Les relations longueur-poids au niveau générique couvrent 76% des espèces récifales du Pacifique et au niveau familial la couverture atteint 85%. Une étude sur la morphologie de 1100 spécimens appartenant à 311 espèces a permis de définir 30 groupes morphométriques pour lesquels des relations longueur-poids ont été estimées sur la base de 32551 spécimens appartenant à ces espèces. Une seconde classification de ces espèces fondée sur 3 classes d'épaisseur du corps permet de définir 20 groupes à partir desquels les relations longueur-poids peuvent être estimées en utilisant des images 2D. Ces relations permettent d'estimer le poids à partir de données de longueur pour la plupart des espèces pour lesquelles on ne dispose pas de relation au niveau espèce, genre ou famille. Les niveaux d'erreur augmentent de l'espèce (erreur moyenne 9,4%) jusqu'à la famille (13,5%), les groupes morphométriques comportant un niveau moyen d'erreur équivalent à celui de la famille (13,2%). L'analyse graphique des coefficients des relations longueur-poids de 396 espèces suggère qu'il existe des limites physiques aux formes que peuvent prendre les poissons.

Key words. - Reef fish - New Caledonia - Lagoon - Length-weight relationships - Morphology.

Our current knowledge on the biological traits of Indo-Pacific shore fishes is still very limited. In particular, length-weight relationships are only known for a restricted number of species. There are 5,480 taxa of inshore fishes reported so far from the tropical Pacific (Kulbicki *et al.*, 2004), but we have length-weight relationships for only 720 of them, i.e. 13% (the main source is Fishbase: Froese and Pauly, 2001; see also Kulbicki *et al.*, 1993; Yanagawa, 1994; Kochzius, 1997; Arias-Gonzales *et al.*, 1997, 1998; Letourneur *et al.*, 1998; Gonzales *et al.*, 2000; Khaironizam and Norma-Rashid, 2002). These values increase only slightly (15.4%) if the search is restricted to reef associated species (excluding the smallest Gobiidae and Trypterygiidae: 3,580 taxa and 553 relationships).

Length-weight relationships have many applications in fish stock assessments and ecological studies. They are of special interest for underwater visual censuses (UVC), in order to transform length data into weight data and, as a result, obtain biomass estimates (Samoilys, 1997). Most UVC surveys are performed on reefs by divers who record visual estimates of fish length. The use of video recordings is on the increase but still marginal. The accuracy of length estimates by divers has been the subject of many studies (e.g., Bell *et al.*, 1985; Bellwood and Alcala, 1988; Kulbicki,

(1) École Pratique des Hautes Études, Université de Perpignan, Avenue de Villeneuve, 66860 Perpignan CEDEX, FRANCE. [michel.kulbicki@univ-perp.fr]

(2) Centre IRD, BP A5, 98848 Nouméa CEDEX, NOUVELLE-CALÉDONIE.

1990, 1997; Darwall and Dulvy, 1996), errors having potentially important consequences on biomass estimates as indicated by Bellwood and Alcala (1988). The precision of these length estimates varies according to authors, the most reliable study (Harvey *et al.*, 2001, 2002) indicating a precision of 8-16% by divers and < 1% by video cameras for a range of three species.

Biomass estimates for reef fish based on length estimates from UVC work are confronted with the problem of the absence of validated length-weight relationships for a large number of species. So far, there is no standardised procedure to attribute a length-weight relationship to a species for which it is lacking. Most authors use the relationship from a species within the genus or the family of the species of interest. At times they also use relationships from species, which have a similar morphology. However, no author follows an explicit protocol. It is difficult to assess the errors on biomass that these procedures will produce. One possible way to consider this problem would be to use length-weight relationships at the genus or family level. Unfortunately, few of these relationships are available because most studies give length-weight relationships only at the species level, and only a few (Bauchot and Bauchot, 1978) indicate relationships at a higher taxonomic level (genus or family). Averaging the values of the regression coefficients of length-weight relationships in order to obtain an average relationship for a genus or a family is statistically erroneous. It is, therefore, necessary to estimate these relationships at the genus or family level by considering the initial data on individuals. Unfortunately, this initial data is not available from the literature.

In the present article, we propose to create classes of fish inside which length-weight relationships are homogenous. Two ways of classification have been considered: according to phylogenic criteria and according to morphological criteria. Such a choice has led to four levels of classification: by species, genera, families or by general morphological characteristics. Our purpose is to enable users to find the best length-weight relationship for any species, for which no validated relationship is available. The three first groups are based on taxonomic relationships because most species within a genus or a family tend to have similar shapes. Unfortunately, there are a number of exceptions to this trend and the data we have available do not cover all families or genera. We propose to use the morphological characteristics of a large number of species to define morphological groups, to which almost all Pacific reef species could be related. To achieve this goal the following steps are taken: (1) estimate species specific length-weight relationships, (2) estimate genus and family specific length-weight relationships, (3) explore the physical limits of these relationships, (4) identify discrete morphological groups using multivariate analysis, and (5) estimate the length-weight relationships for each morphological group.

## MATERIALS AND METHODS

### Morphological parameters

In order to group fish according to their morphology, weight and various morphological measures were taken on each fish specimen, as described on figure 1. This was done on a total of 1,100 fish, representing 311 species, 138 genera and 53 families. Fishes were caught by different methods: rotenone poisoning, spear-fishing, hand-line and gillnet. The sampling was operated from July to September 2003, on various sites and thus various biotopes in the south-eastern lagoon of New Caledonia. Neither geographical nor time influence was taken into consideration. Two to 8 specimens were used for each species. This low number of specimens per species is because morphometric measurements are at the basis of fish taxonomy and are very stable between individuals, as attested by the high correlations between them (e.g., Loubens, 1980).

Several measurements were performed on each fish: CH (Caudal Height), FL (Fork Length), SL (Standard Length), HL (Head Length), H33 (Height at the first third -based on FL- of body, starting from the tail), Hmax (Maximum Height), HH (Head Height), and T (Width or body thickness) (Fig. 1). Species were grouped using the statistical Ward's method, with Euclidian distances, based on the following ratios: SL/Hmax, SL/H33, SL/HT, T/H33, T/HH, T/Hmax, SL/T, SL/FL, SL/CH. The ratios were standardised amongst all species using SL as the common measurement. A second cluster analysis was similarly conducted by using 3 classes of thickness instead of a continuous variable for body thickness (T).

### Length-weight relationships

In addition to the fish sampled for their morphology, data

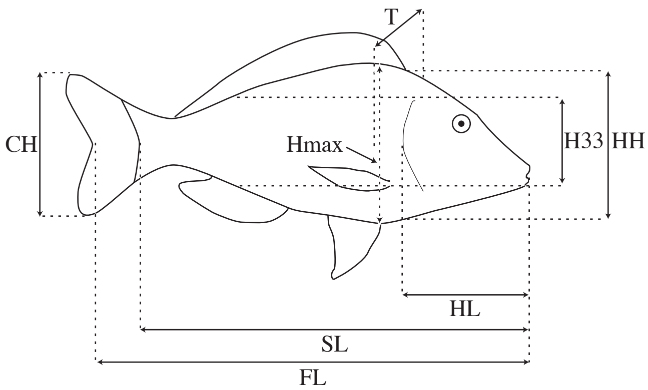


Figure 1. - Measurements performed on each fish. CH: Caudal fin Height; FL: Fork Length; SL: Standard Length; HL: Head Length; H33: Height at the first third (based on FL) of body (starting from the tail); Hmax: Maximum Height; HH: Head Height; T: Width or body thickness. *[Mesures réalisées sur chaque poisson : CH : hauteur de la caudale ; FL : longueur à la fourche ; SL : longueur standard ; HL : longueur de la tête ; H33 : hauteur au premier tiers du corps (en partant de la queue) ; Hmax : hauteur maximale ; HH : hauteur de la tête ; T : épaisseur du corps.]*

Table I. - Class limits for fish shapes. The class "oddly-shaped" regroups all species which do not fall within the other classes. *[Limites des classes pour les formes de poisson. La classe "odd" regroupe toutes les espèces qui ne tombent pas dans une des autres catégories.]*

| Shape | SL/Hmax | T/Hmax |
|---|---|---|
| Very-flat | < 2.0 | < 0.3 |
| Compressed | 2.0 - 3.0 | 0.3-0.45 |
| Cylindrical | 2.5 - 4.8 | > 0.45 |
| Semi-elongated | 5.0 - 10.0 | |
| Elongated | > 10.0 | |
| Odd | Any other combination | |

on a number of lagoon species were used to calculate length-weight relationships. The relationships were thus established from a total of 53,800 specimens, representing 788 species, 191 genera and 77 families. These data were collected between 1985 and 2003. All fishes were caught in the lagoon of New Caledonia, either by rotenone poisoning, spear-fishing, hand-line, gillnet, trawl nets, trammel nets or bottom long-line fishing.

Fork length was the measure used for all species in order to establish these relationships, except for rays, for which disk width is measured instead. The sexes are not differentiated here, although we are aware that males and females may have different length-weight relationships. The parameters *a* and *b* of relationships of the form $W = aL^b$ were estimated through a logarithmic transformation, i.e. $\ln W = \ln a + b \ln L$, with *a* and *b* estimated by ordinary least squares regression. L and W are respectively length in cm and weight in g.

The length-weight relationships were estimated according to taxonomic (species, genera, families) and morphological groupings (as defined above). The relationship for a given group was considered as valid when the measures from at least 8 specimens were available and when the significance level was at least of 0.01. In order to compare these relationships among groups, fish were classified (using a cluster analysis using the statistical Ward's method, with Euclidian distances, followed by an ANOVA) according to the ratios of SL/Hmax and T/Hmax into the following classes or shapes: elongated, semi-elongated, cylindrical, compressed, very-flat and oddly-shaped (Tab. I). Genera or families where several of these fish shapes were present were labelled "heterogeneous".

### Error estimates

Once the length-weight relationships were estimated the weight of each fish entering the estimate was back-calculated, yielding an estimated weight $W_{est}$. This value was compared to the true value W, allowing to have an estimation of the relative error $E_{rel}$:

$E_{rel} = 100\ [W-W_{est}]/\text{maximum}\ (W;W_{est})$

For each species, genus, family or morphological group the $E_{rel}$ were averaged, either for all the specimens or for only the largest ones (the fourth upper quartile) yielding respectively $E_{aver}$ and $E_{75\%}$.

## RESULTS

### Species, genera and families

The results of length-weight analysis and grouping according to taxonomical criteria are presented in annexe 1. The identifications are essentially based on Rivaton *et al*. (1989), with recent updates in the literature being taken into account.

Relationships were not computed if there were less than 8 specimens. At the species level this allowed to estimate length-weight relationships for 444 species, but only 396 were kept. Relationships were rejected if they were not sufficiently significant ($p > 0.01$) or if the length interval for which weights were available was too narrow compared to the usual length of the species. At the genus level, all 191 genera had at least 9 specimens and only 6 relationships were rejected. At the family level, there were at least 11 specimens in each of the 77 families tested. Two families were rejected.

The error rates are given in table II. There is a slight but significant increase ($p < 0.05$) in the error rates from species to families. The average error on all specimens ($E_{aver}$) is higher than the error on the largest ones ($E_{75\%}$) (Tab. II), this difference being significant ($p < 0.05$) only at the species level. The error level was independent of body size within a species or morphological group, as there was no significant relationship between the level of error and the shape or size of the fish. At the genus level, genera with either odd shapes, elongated, compressed or very flat had higher relative errors than other shapes (Tab. III). At the family level the highest error levels were found in families with heterogeneous shapes, odd, elongated and semi-elongated shapes.

The coefficients of the length-weight relationship at the species level are function of the fish shape as indicated by figure 2A. An analysis of covariance indicates that the slopes and intercepts are different ($p < 0.05$) between each shape with the exception of "compressed" and "very flat" which are not significantly different. Similar results are found if one considers the genus or family levels.

One notices that the relationships between the coefficients *a* and *b* may be bounded by two lines (Fig. 2A). These two lines are only approximations, but may be defined by the following equations:

Lower boundary: $\log(a) = -4.86\ b + 7.17$

Upper boundary: $\log(a) = -2.66\ b + 4.92$

These lines could be physical or/and physiological lim-

Table II. - Distribution of the relative errors according to the taxonomic level or group. Confidence intervals are given for $p = 0.05$. $E_{aver}$: error based on average for all individuals, $E_{75\%}$: error based on average for the largest individual (last quartile). *[Distribution des erreurs relatives en fonction du niveau taxinomique ou du groupe. Les intervalles de confiance sont donnés pour p = 0.05. $E_{aver}$ : erreur basée sur la moyenne de tous les individus. $E_{75\%}$ : erreur basée sur la moyenne des plus gros individus (dernier quartile).]*

| | Species | Genera | Families | Groups (I) |
|---|---|---|---|---|
| $E_{aver}$ | 9.4 ± 0.5 | 11.4 ± 1.0 | 13.5 ± 1.5 | 13.2 ± 1.4 |
| $E_{75\%}$ | 8.1 ± 0.4 | 10.2 ± 0.9 | 13.8 ± 1.8 | 13.7 ± 2.0 |

Table III. - Average relative error at the genus and family levels for various fish shapes. "Heterogeneous" refers to genera or families represented by species with different shapes (e.g., Acanthuridae which have "compressed", "very-flat" species as well as "cylindrical" ones). *[Erreur moyenne relative pour différentes formes de poissons au niveau du genre ou de la famille . "Hétérogène" se réfère aux genres ou familles représentés par plusieurs formes (par exemple les Acanthuridae englobent des espèces "comprimées", "très plates" aussi bien que "cylindriques").]*

| Shape | Nb genera | $E_{75\%}$ genera | $E_{aver}$ genera | Nb families | $E_{75\%}$ families | $E_{aver}$ families |
|---|---|---|---|---|---|---|
| Cylindrical | 103 | 9.0 | 9.8 | 28 | 11.4 | 11.5 |
| Compressed | 35 | 9.4 | 10.1 | 12 | 9.6 | 9.4 |
| Elongated | 13 | 11.9 | 14.1 | 4 | 18.6 | 16.0 |
| Semi-elongated | 14 | 11.9 | 20.1 | 9 | 14.9 | 17.9 |
| Very flat | 8 | 13.4 | 12.8 | 4 | 12.0 | 10.5 |
| Oddly shaped | 10 | 19.4 | 17.0 | 5 | 25.9 | 20.4 |
| Heterogeneous | 4 | 9.6 | 10.5 | 13 | 16.5 | 16.0 |

its. To test this, it is possible to assimilate elongated fish as elongated cylinders with a density of 1. In that case if L is the length of the fish and T its thickness, then the weight W of the fish can be approximated by:

$W = \pi T^2L/4$

The most elongated species we observed (a Syngnatidae) had a ratio L/T of 36. This would result in an approximation of its weight by:

$W = \pi L3/(4 \times 36^2)$, or $a = 0.0000596$

If we use $b = 3$ in the equation of the lower boundary (Fig. 2A) we get an *a* of 0.0000654, which corresponds to an L/T ratio of 40 which could be a maximal limit.

If one considers the upper boundary one could assimilate a fish to a three dimensional volume with a length L, a height H and a thickness T. Assuming in a very simplistic manner that these dimensions are linearly related and the fish density equal to 1, we would get a crude approximation of the weight W by:

$W = LHT/2$

Replacing H and T by their relationship to L by respectively:

$H = kL$ and $T = qL$

one would then get: $W = kqL^3/2$

Looking at the value of a in the upper boundary equation (Fig. 2A) for $b = 3$ one finds $a = 0.047$. This means that the value *kq* is lower than 0.1 if our crude hypothesis on general fish shape is respected. Interestingly, out of 298 values of *kq* only 14 were found over 0.1 and only one above 0.15.

Another way to consider the constraints on fish shapes is to analyse the variations of relative (using standard length as the reference) thickness and relative height (Fig. 2B). Fish belonging to the same shape are grouped, the separation between groups following a gradient according to the relative diameter of the species (from the most elongated to the most compact species). The overlap tends to increase as one goes towards the upper limits due to the log scaling. The values are again clearly bounded by an upper and a lower line, indicating that fish shapes are bounded by some physical limits.

## Morphological groups

A first cluster analysis allowed to define 16 groups. Eight of these groups were either very large or not homogeneous, containing species with different shapes. In order to have homogeneous groups, a second cluster analysis was performed within each of these 8 heterogeneous groups resulting in a total of 30 groups (Group-I in Tab. IV). Differences in the ratios used to define the groups were tested by ANOVAs. All ratios were significantly different between groups (i.e. each ratio discriminated at least one group from the others). A MANOVA indicates that groups were statistically different from one another when considering all the ratios together. The most discriminating ratios were SL/Hmax, T/H33, T/HT, SL/T and the least discriminating ones were SL/FL, SL/CH. The length-weight relationships for the fish within each group were estimated from a total of 32,551 specimens of fish. The specifications of these relationships along with the characteristics of each group (Group-I) are given in table IV.

The error estimates for the groups are similar to those for families but larger than for genera or species (Tab. II). Errors within groups are always higher than for genera or species (Fig. 3). Compared to families, in the lower error ranges (less than 13% error), groups have larger errors on average, and on the opposite, past the 13% error rate groups yield lower estimates than families (Fig. 3).

To use this grouping to obtain the length-weight relationship for a new species supposes that one has access to at least one specimen in order to take the measurements as indicated on figure 1. As specimens are not necessarily available we propose an alternative method. There are pictures available for most species in Fishbase (Froese and Pauly, 2001) and FAO guides (Carpenter and Niem, 1998). From these pictures we can take all measurements of figure 1 except body thickness (T). This latter parameter may be estimated in 3 major classes: flat (or compressed), i.e. fish for which the

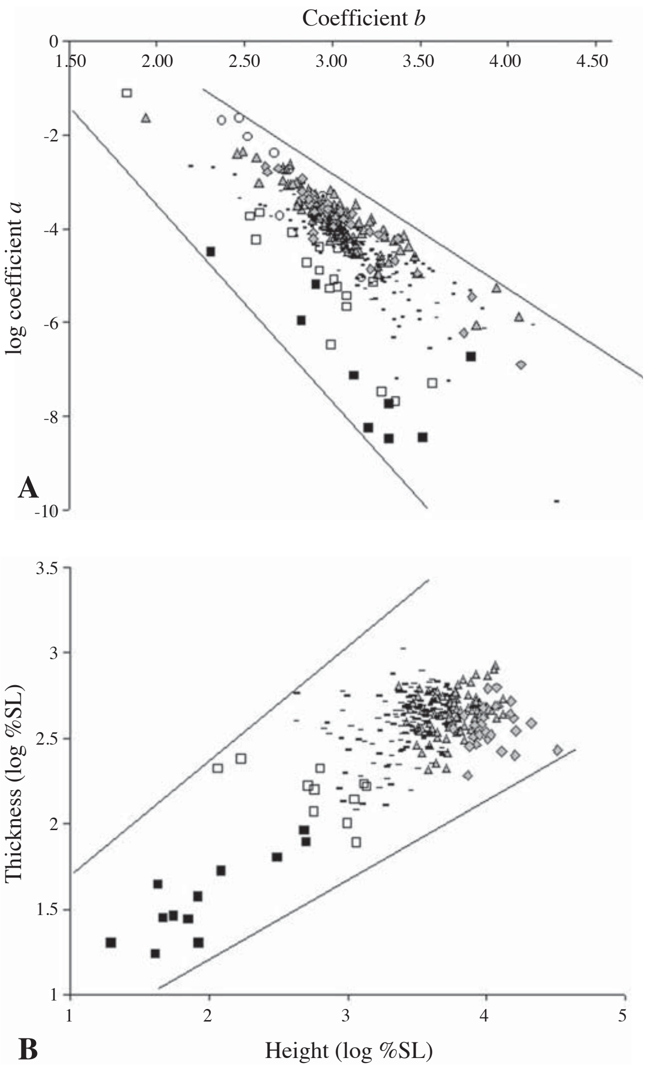


Figure 2. - **A**: Relationship between the regression coefficients *a* and *b* for various fish shapes at the species level. The upper and lower boundary lines are only approximate (see text). **B**: Relationship (on a log-log scale) between the relative (SL: standard length) thickness and relative height of fish for the various fish shapes at the species level. The upper and lower boundary lines are only approximate (see text). △ Compressed, ■ Elongated, - Cylindrical, ○ Odd, □ Semi-elongated, ◇ Very-flat. *[**A** : Relation au niveau spécifique entre les coefficients de régression* a *et* b *pour différentes formes de poisson. Les droites de limite supérieures et inférieures sont approximatives (voir texte). **B** : Relation (échelle log) entre l'épaisseur relative (SL: longueur standard) et la hauteur relative des poissons de différentes formes au niveau spécifique. Les droites limite supérieures et inférieures sont approximatives (voir texte). △ Comprimé, ■ Allongé, - Cylindrique, ○ Divers, □ Semi-allongé, ◇ Très plat.]*

ratio of body thickness to body height (T/Hmax) is less than 35%; normal fish for which this ratio is between 35 and 50%; round fish for which this ratio is above 50%. Using these 3 classes in table V as a proxy of body thickness will reduce the number of valid groups from 30 to 21 (Group-II), ANOVAs on the remaining ratios (SL/Hmax, SL/HH, SL/H33, SL/FL, SL/CH) indicating that each group is significantly different from at least one other group. The error estimates for this new grouping is almost identical to the one for the grouping with 30 classes and is therefore not given on the graphs or tables.

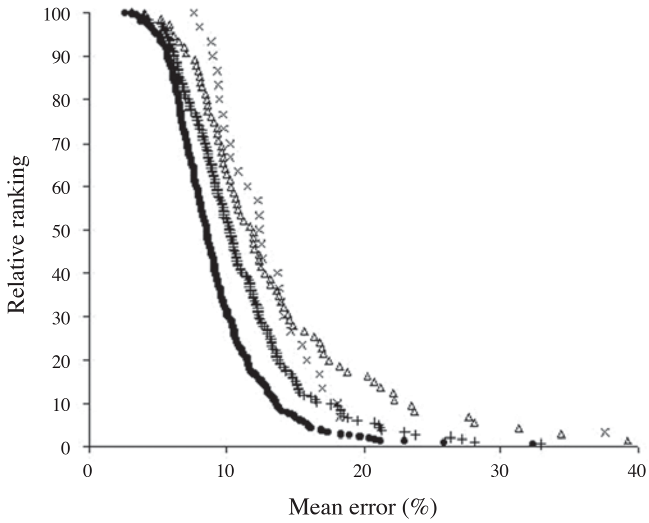


Figure 3. - Distribution of the mean error per species, genus, family or group. Errors are ranked from the lowest to the highest, the highest being given the relative rank 100 and the lowest the relative rank 1. ● Species, + Genus, △ Family, X Group. *[Distribution de l'erreur moyenne par espèce, genre, famille ou groupe. Les erreurs sont rangées de la plus petite à la plus grande, la plus grande se voyant attribuer le rang relatif 100 et la plus petite le rang relatif 1. ● Espèce, + Genre, △ Famille, X Groupe.]*

## DISCUSSION

Length-weight relationships are in great need for estimating the weight of fish for underwater visual censuses (UVC). UVCs are the most reliable and wide spread method to sample reef fish (e.g., English *et al*., 1994; Cappo and Brown, 1996; Samoilys, 1997; Samoilys and Carlos, 2000; Labrosse *et al*., 2001). Even so there are a number of problems linked to UVCs in particular estimating fish length accurately. Harvey *et al*. (2001, 2002) found that divers have a precision of approximately 10% on estimating fish lengths, which is much less accurate compared to stereo video camera systems which yield estimates within 1%. Several other studies have considered the precision of fish length estimates (see Kulbicki, 1998 for a review). Kulbicki (1997) found that this precision did not change much with the shape of the fish. On the opposite the precision is highly dependent on the training of the diver (Dalwall and Dulvy, 1996). These errors on length estimates may lead to a much higher error in weight. For instance, if one considers a 50 cm grouper, according to our equations (Annexe 1) its real weight would be 1,900 g, if underestimated at 45 cm its estimated weight would be 1,400 g, and over-

Table IV. - Groups defined from the analysis of the fish shapes. The notations used are similar to those from figure 1. The intervals are confidence limits with a probability level of 95%. N: number of species in group; n-LW: number of specimens used to estimate *a* and *b*. *[Groupes définis à partir de l'analyse des formes de poisson. Les notations utilisées sont similaires à celles de la figure 1. Les intervalles sont les intervalles de confiance au niveau 95%. N : nombre d'espèces dans un groupe; n-LW : nombre de spécimens utilisés pour estimer* a *et* b.*]*

| Group-I | N | n-LW | r | a | b | SL/Hmax | SL/H33 | SL/HH | SL/HL | SL/CH | T/H33 | T/HH | T/Hmax | SL/T | Thickness | Group-II | r | a | b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 23 | 2069 | 0.985 | 0.0412 | 2.8590 | 1.6 ± 0 | 2.4 ± 0.7 | 3 ± 0.4 | 3.3 ± 0.4 | 3.1 ± 0.5 | 0.33 ± 0.02 | 0.41 ± 0.02 | 0.22 ± 0.06 | 7.31 ± 1.17 | flat | a | 0.985 | 0.04128 | 2.8590 |
| 21 | 11 | 598 | 0.991 | 0.0406 | 2.8679 | 2.0 ± 0 | 3.6 ± 0.6 | 3 ± 0.4 | 3.5 ± 0.4 | 3.5 ± 0.9 | 0.64 ± 0.02 | 0.53 ± 0.03 | 0.35 ± 0.02 | 5.71 ± 0.49 | flat | b | 0.983 | 0.03984 | 2.8752 |
| 23 | 9 | 192 | 0.989 | 0.0235 | 3.1220 | 1.9 ± 0.1 | 2.8 ± 0.4 | 3.2 ± 0.2 | 3.4 ± 0.2 | 2.9 ± 0.5 | 0.5 ± 0.02 | 0.57 ± 0.01 | 0.34 ± 0.03 | 5.59 ± 0.44 | flat | b | | | |
| 26 | 24 | 1518 | 0.992 | 0.0340 | 2.9415 | 1.9 ± 0 | 3.3 ± 0.5 | 2.9 ± 0.3 | 3.5 ± 0.4 | 3.1 ± 0.7 | 0.51 ± 0.02 | 0.46 ± 0.01 | 0.29 ± 0.04 | 6.4 ± 0.48 | flat | b | | | |
| 25 | 11 | 1927 | 0.991 | 0.0199 | 3.0442 | 2.2 ± 0.1 | 3.4 ± 0.4 | 3.5 ± 0.3 | 3.9 ± 0.3 | 2.5 ± 0.3 | 0.44 ± 0.01 | 0.46 ± 0.01 | 0.28 ± 0.02 | 7.69 ± 0.8 | flat | c | 0.991 | 0.01990 | 3.0442 |
| 11 | 15 | 1009 | 0.996 | 0.0373 | 2.7496 | 2.2 ± 0.2 | 5.5 ± 1.4 | 3.1 ± 0.5 | 3.5 ± 0.5 | 3.9 ± 1.5 | 0.81 ± 0.04 | 0.46 ± 0.02 | 0.33 ± 0.04 | 6.72 ± 0.85 | flat | d | 0.993 | 0.04037 | 2.7227 |
| 24 | 5 | 381 | 0.966 | 0.0374 | 2.7630 | 2.3 ± 0.1 | 5.1 ± 0.4 | 3.1 ± 0.1 | 3.3 ± 0.4 | 3.3 ± 2.2 | 0.61 ± 0.05 | 0.37 ± 0.03 | 0.28 ± 0.04 | 8.41 ± 0.53 | flat | d | | | |
| 19 | 3 | 123 | 0.985 | 0.0253 | 2.9455 | 2.6 ± 0.2 | 4.2 ± 1 | 4.4 ± 0.6 | 4.8 ± 0.7 | 2.5 ± 0.5 | 0.52 ± 0.08 | 0.56 ± 0.06 | 0.33 ± 0.02 | 7.98 ± 0.92 | flat | e | 0.985 | 0.02538 | 2.9455 |
| 6 | 7 | 104 | 0.992 | 0.0197 | 3.0153 | 2.4 ± 0 | 4.6 ± 0.2 | 4 ± 0.3 | 4.2 ± 0.2 | 2.2 ± 0.3 | 0.72 ± 0.03 | 0.62 ± 0.05 | 0.38 ± 0.03 | 6.51 ± 0.27 | normal | f | 0.992 | 0.01976 | 3.0153 |
| 2 | 6 | 715 | 0.992 | 0.0178 | 3.1304 | 2.6 ± 0.1 | 3.7 ± 0.3 | 3.4 ± 0.2 | 3.1 ± 0.3 | 4.2 ± 1.9 | 0.63 ± 0.04 | 0.57 ± 0.02 | 0.44 ± 0.02 | 5.97 ± 0.35 | normal | g | | | |
| 20 | 16 | 4717 | 0.998 | 0.0250 | 2.9258 | 2.7 ± 0.1 | 4.3 ± 0.5 | 3.5 ± 0.4 | 3.4 ± 0.4 | 3.2 ± 1.1 | 0.58 ± 0.02 | 0.47 ± 0.01 | 0.37 ± 0.01 | 7.42 ± 0.75 | normal | g | 0.994 | 0.02855 | 2.8931 |
| 22 | 4 | 210 | 0.998 | 0.0214 | 3.0146 | 2.6 ± 0 | 3.2 ± 0.4 | 3.8 ± 0.6 | 3.3 ± 0.5 | 3.9 ± 0.8 | 0.49 ± 0.06 | 0.59 ± 0.06 | 0.4 ± 0.03 | 6.49 ± 0.53 | normal | g | | | |
| 4 | 17 | 5255 | 0.99 | 0.0149 | 3.0803 | 2.8 ± 0 | 4.8 ± 0.4 | 3.5 ± 0.2 | 3.2 ± 0.2 | 3.7 ± 2.6 | 0.71 ± 0.02 | 0.52 ± 0.01 | 0.41 ± 0.03 | 6.78 ± 0.55 | normal | h | 0.984 | 0.02066 | 2.9681 |
| 14 | 23 | 3518 | 0.995 | 0.0232 | 2.9163 | 2.8 ± 0.1 | 5.6 ± 0.5 | 3.5 ± 0.3 | 3.2 ± 0.4 | 3.7 ± 1 | 0.91 ± 0.03 | 0.56 ± 0.02 | 0.44 ± 0.04 | 6.26 ± 0.41 | normal | h | | | |
| 12 | 7 | 132 | 0.985 | 0.0089 | 3.4046 | 2.8 ± 0.2 | 7.2 ± 0.4 | 3.6 ± 0.3 | 3.5 ± 0.5 | 5.4 ± 3.7 | 1.04 ± 0.08 | 0.52 ± 0.03 | 0.41 ± 0.04 | 6.96 ± 0.36 | normal | i | 0.985 | 0.00892 | 3.4046 |
| 5 | 9 | 1151 | 0.996 | 0.0193 | 2.9695 | 3 ± 0.1 | 5.2 ± 0.4 | 3.9 ± 0.1 | 3.3 ± 0.2 | 3.8 ± 1.3 | 0.7 ± 0.03 | 0.53 ± 0.01 | 0.41 ± 0.03 | 7.43 ± 0.47 | normal | j | 0.996 | 0.01933 | 2.9695 |
| 13 | 7 | 354 | 0.986 | 0.0123 | 3.1365 | 3.2 ± 0.3 | 6.4 ± 0.6 | 4.5 ± 0.3 | 4 ± 0.5 | 3.6 ± 1 | 0.88 ± 0.02 | 0.62 ± 0.05 | 0.44 ± 0.04 | 7.29 ± 0.71 | normal | k | 0.986 | 0.01236 | 3.1365 |
| 8 | 3 | 150 | 0.969 | 0.0198 | 2.9042 | 3.2 ± 1.3 | 6.2 ± 0.4 | 5.4 ± 0.5 | 3.2 ± 0.1 | 5.7 ± 0.9 | 0.85 ± 0.09 | 0.71 ± 0.17 | 0.49 ± 0.08 | 7.08 ± 0.17 | normal | l | 0.969 | 0.01984 | 2.9042 |
| 3 | 16 | 851 | 0.987 | 0.0194 | 2.9790 | 3.4 ± 0.2 | 4.7 ± 0.5 | 4.3 ± 0.3 | 3.5 ± 0.3 | 4.5 ± 1.8 | 0.59 ± 0.03 | 0.53 ± 0.05 | 0.41 ± 0.08 | 7.91 ± 0.87 | normal | m | 0.987 | 0.01940 | 2.9790 |
| 1 | 13 | 543 | 0.989 | 0.0205 | 2.7353 | 4.5 ± 0.4 | 6.9 ± 0.9 | 6.1 ± 0.6 | 4.3 ± 0.3 | 6.3 ± 2.7 | 0.6 ± 0.06 | 0.53 ± 0.05 | 0.39 ± 0.06 | 11.7 ± 1.69 | normal | n | 0.989 | 0.02057 | 2.7353 |
| 30 | 10 | 82 | 0.958 | 0.0132 | 2.4060 | > 10 | > 10 | > 10 | 7.2 | > 10 | 1.08 ± 0.33 | 1.09 ± 0.38 | 0.75 ± 0.1 | 28.0 ± 3.67 | round | o | 0.958 | 0.01322 | 2.4060 |
| 28 | 1 | 342 | 0.982 | 0.00075 | 3.3577 | 13.2 ± 0 | 24.7 ± 0 | 13.5 ± 0 | 5.4 ± 0 | 7.6 ± 0 | 2.47 ± 0 | 1.35 ± 0 | 1.32 ± 0 | 10 ± 0 | round | p | 0.982 | 0.00075 | 3.3577 |
| 17 | 3 | 28 | 0.994 | 0.00733 | 3.5978 | 3.0 ± 0.8 | 4.2 ± 1.7 | 4.5 ± 1.3 | 2.9 ± 0.8 | 3.6 ± 0.3 | 1.05 ± 0.28 | 1.12 ± 0.03 | 0.78 ± 0.15 | 4.02 ± 1.32 | round | q | 0.994 | 0.00733 | 3.5978 |
| 9 | 5 | 204 | 0.994 | 0.0114 | 3.0936 | 3.3 ± 0.1 | 4.9 ± 0.4 | 3.7 ± 0.1 | 2.8 ± 0.3 | 3.7 ± 0.7 | 0.86 ± 0.03 | 0.67 ± 0.06 | 0.58 ± 0.02 | 5.7 ± 0.45 | round | r | 0.986 | 0.01921 | 2.9718 |
| 10 | 11 | 2542 | 0.993 | 0.0175 | 3.0023 | 3.1 ± 0.1 | 5 ± 0.4 | 3.8 ± 0.1 | 3.1 ± 0.2 | 3.5 ± 0.9 | 0.8 ± 0.03 | 0.61 ± 0.01 | 0.5 ± 0.01 | 6.21 ± 0.32 | round | r | | | |
| 7 | 11 | 939 | 0.997 | 0.0203 | 2.9194 | 3.8 ± 0.3 | 5.6 ± 0.6 | 4.9 ± 0.3 | 3.6 ± 0.6 | 3.1 ± 0.7 | 0.77 ± 0.05 | 0.68 ± 0.03 | 0.52 ± 0.04 | 7.28 ± 0.55 | round | s | 0.993 | 0.02183 | 2.8856 |
| 16 | 12 | 1181 | 0.995 | 0.0191 | 2.9174 | 3.9 ± 0.6 | 6.5 ± 1.3 | 4.7 ± 0.8 | 3.3 ± 0.6 | 4.9 ± 2.1 | 1.08 ± 0.04 | 0.78 ± 0.05 | 0.64 ± 0.09 | 6.02 ± 0.85 | round | s | | | |
| 15 | 8 | 585 | 0.987 | 0.00599 | 3.0064 | 6.8 ± 0.9 | 8 ± 1.2 | 9.3 ± 0.9 | 4.6 ± 0.7 | 5.6 ± 5.3 | 0.64 ± 0.06 | 0.74 ± 0.08 | 0.54 ± 0.05 | 12.9 ± 2.49 | round | t | 0.962 | 0.02109 | 2.6979 |
| 18 | 5 | 1096 | 0.989 | 0.00889 | 3.0250 | 6.4 ± 0.8 | 9.6 ± 1 | 7.9 ± 1.4 | 4.6 ± 0.4 | 6.7 ± 2.7 | 1.34 ± 0.1 | 1.1 ± 0.2 | 0.89 ± 0.07 | 7.16 ± 0.5 | round | t | | | |
| 29 | 3 | 35 | 0.992 | 0.0061 | 3.0818 | 7.4 ± 0.9 | 12.1 ± 1 | 9.9 ± 1.1 | 3.1 ± 0 | 7.3 ± 4.1 | 2.17 ± 0.27 | 1.78 ± 0.38 | 1.33 ± 0.12 | 5.58 ± 0.18 | round | u | 0.992 | 0.0061 | 3.0818 |

estimated at 55 cm it would yield 2,500 g. In other words, a 10% error estimate on length may generate an error on weight of approximately 25%. On top of this error linked to the length estimate there is the error linked to the choice in the length-weight relationship. The number of relationships available for reef fish species in the Pacific is rather limited. Before this work there were relationships for only 15.4% of the species (Fishbase: Froese and Pauly, 2001). We are adding relationships for a few more species (59 species in our list had no relationship available in Fishbase 2000), but what is new is that we provide relationships at higher taxonomic levels. Our data covers 92% of the 100 most speciose genera (amongst the 405 genera of shore fish in the tropical Pacific). In other words the data presented here allows to attribute length-weight relationships at the genus level for 75.6% of the reef species. At the family level, the coverage is nearly 85% and most of the missing families are usually not taken into account during UVC work (e.g., Carapidae, Ophichtidae, Tripterygiidae,…). Unfortunately the precision of the estimates from length-weight relationships at the family level and for some genera is not always satisfactory, in particular for those which have odd shapes or are elongated or semi-elongated or those which have heterogeneous shapes (Tab. III, Fig. 3). The group approach proposed in this article allows to close the gap in giving relationships which may be useful for either species for which no other relationship are available at present, or for species for which the existing relationships at either the genus or family level are not satisfactory. It may also provide a relationship when the observed fish is out of the length range for which the species, genus or family equation is provided for.

The present work by giving estimates of the relative error shows that: (i) the differences between species, genus, family and groups is on average small (less than 5% - Tab. II); (ii) there is much dispersion in these errors within an organisation level, the range being between 3 and 40% (Fig. 3) and (iii) the error level is linked to the shape of the fish (Tab. III). Looking at the very high values of the correlation coefficient (r) one tends to think that length-weight relationships yield excellent predictions. This is true if one considers the average of a large number of estimates, but our data shows that the dispersion of the estimates may be important in some cases and that it is not predictable from looking at r. A number of authors indicate that length-weight relationships vary with regions (see Écoutin and Albaret, 2002) or with season or year (e.g., Cucalon-Zenck, 1999; Anibeze, 2000). We have not investigated this matter, even though we have enough material to do so, but the level of difference found by most authors suggest that for UVC purposes these differences would remain minor compared to the error made on length estimates by divers. There are also differences according to sexes, but sex is very seldom taken into account during UVC work and the differences due to sex are much lower than those from other sources.

A number of length-weight relationships are available in the literature. Unfortunately for some of them, there are either errors or the types of measure are not indicated (e.g. fork length, standard length or total length). Figure 2A is a convenient way to check that the values available fall within an acceptable range. More interesting, the upper and lower boundaries on the values of the relationship between the coefficients a and b appear to be some physical limits to the dimensions of fish as suggested by our crude approach (Fig. 2B) on general fish shapes (see Pauly (1997), for a discussion on such physical limits). More refined modelling on these limits with more realistic equations of fish volumes could represent a path in understanding some of the physical constraints on fish shapes and connected capacities such as speed or energy consumption (see O'Dor and Hoar (2000) for a comparison between squids and fish; and Blier *et al*. (1997) for a discussion on fish capacities in this domain), which are useful in bounding some estimates in ecological modelling such as ECOPATH (Christensen and Walters, 2004).

**Acknowledgements**. - The authors wish to thank the crews of the O.V. ALIS, CORIS and DAWA, and also Gérard Mou-Tham, Pierre Labrosse, Yves Letourneur, Pierre Boblin and Nicolas Audran for their assistance in the field and the laboratory. The authors wish also to thank the referees for their useful comments.

## REFERENCES

ANIBEZE C.I.P., 2000. - Length-weight relationship and relative condition of *Heterobranchus longifilis* (Valenciennes) from Idodo River, Nigeria. *NAGA*, 23: 34-35.

ARIAS-GONZALES E., DELESALLES B., SALVAT B. & R. GALZIN, 1997. - Trophic functioning of the Tiahura reef sector, Moorea Island, French Polynesia. *Coral Reefs*, 16: 231-246

ARIAS-GONZALES E., HERTEL O. & R. GALZIN, 1998. - Fondement trophique d'un écosystème récifal en Polynésie Française. *Cybium*, 22(1): 1-24.

BAUCHOT R. & M.L. BAUCHOT, 1978. - Coefficient de condition et indice pondéral chez les téléostéens. *Cybium*, 4(1): 3-16.

BELL J.D., CRAIK G.J.S., POLLARD D.A. & B.C. RUSSELL, 1985. - Estimating length frequency distributions of large reef fish underwater. *Coral Reefs*, 4: 41-44.

BELLWOOD D.R. & A.C. ALCALA, 1988. - The effect of a minimum length specification on visual estimates of density and biomass of coral reef fishes. *Coral Reefs*, 7: 23-27.

BLIER P.U., PELLETIER D. & J.D. DUTIL, 1997. - Does aerobic capacity set a limit on fish growth rate? *Rev. Fish. Sci*., 5: 323-340.

CAPPO M. & I.W. BROWN, 1996. - Evaluation of sampling methods for reef fish populations of commercial and recreational interest. *CRC Reef Res. Cent., Townsville, Tech. Rep.*, 6: 1-72.

CARPENTER K.E. & V.H. NIEM (eds), 1998. - FAO Species Identification Guide for Fishery Purposes. The living Marine Resources of the Western Central Pacific. Vol. 2-6. Rome: FAO.

CHRISTENSEN V. & C. WALTERS, 2004. - Ecopath with Ecosim, methods, capabilities and limitations. *Ecol. Model.*, 172: 109-139.

CUCALON-ZENCK E., 1999. - Growth and length-weight parameters of the Pacific Mackerel (*Scomber japonicus*) in the Gulf of Guayaquil (Ecuador). *NAGA*, 22: 32-36.

DARWALL W.R.T. & N.K. DULVY, 1996. - An evaluation of the suitability of non-specialist volunteer researchers for coral reef fish surveys, Mafia Island, Tanzania. A case study. *Biol. Conserv.*, 78: 223-231.

ÉCOUTIN J.-M. & J.-J. ALBARET, 2002. - Relations longueur-poids pour 52 espèces de poissons des estuaires et lagunes de l'Afrique de l'Ouest. *Cybium*, 27(1): 3-9.

ENGLISH S.C., WILKINSON C. & V. BAKER (eds), 1994. - Survey Manual for Tropical Marine Resources. 368 p. Townsville, Australia: ASEAN-Australia Science Project, AIMS.

FROESE R. & D. PAULY, 2001. - Fishbase. World Wide Web electronic publication. www.fishbase.org.

GONZALES B.J., PALLA H.P. & H. MISHINA, 2000. - Length-weight relationships of five Serranids from Palawan Island, Philippines. *NAGA*, 23: 26-28.

HARVEY E., FLETCHER, D. & M.R. SHORTIS, 2001. - A comparison of the precision and accuracy of estimates of reef fish length made by divers and a stereo-video system. *Fish Bull.*, 99: 63-71.

HARVEY E., FLETCHER D. & M.R. SHORTIS, 2002. - Estimation of reef fish length by divers and by stereo-video. A first comparison of the accuracy and precision in the field on living fish under operational conditions. *Fish. Res.*, 57: 255-265.

KHAIRONIZAM M.Z. & Y. NORMA-RASHID, 2002. - Length-weight relationship of mudskippers (Gobiidae: Oxudercinae) in the coastal areas of Selangor, Malaysia. *NAGA*, 25: 20-22.

KOCHZIUS M., 1997. - Length-weight relationship of fishes from a sea-grass meadow in Negros Oriental, Philippines. *NAGA*, 20: 64-65.

KULBICKI M., 1990. - Comparisons between rotenone poisoning and visual counts for density and biomass estimates of coral reef fish populations. *In*: Proc. Congr. Int. Soc. Reef Studies, Noumea (Ricard M., ed.), pp. 105-112. Nouméa: Univ. Française du Pacifique.

KULBICKI M., 1997. - Bilan de 10 ans de recherche (1985-1995) par l'Orstom sur la structure des communautés des poissons lagonaires et récifaux en Nouvelle-Calédonie. *Cybium*, 21(suppl.): 47-79.

KULBICKI M., 1998. - How acquired behaviour of commercial reef fish may influence results obtained from visual censuses. *J. Exp. Mar. Biol. Ecol.*, 222: 11-30.

KULBICKI M., MOU-THAM G., THOLLOT P. & L. WANTIEZ, 1993. - Length-weight relationships of fish from the lagoon of New Caledonia. *NAGA*, 16: 26-30.

KULBICKI M., LABROSSE P. & J. FERRARIS, 2004. - Basic principles underlying research projects on the links between the ecology and the uses of coral reef fishes in the Pacific. *In*: Challenging Coasts. Transdisciplinary Excursions into Integrated Coastal Zone Development (Visser L.E., ed.), pp. 119-158. Amsterdam: Amsterdam Univ. Press.

LABROSSE P., KULBICKI M. & J. FERRARIS, 2001. - Underwater Visual Fish Census Surveys Proper Use and Implementation. 54 p. Noumea, New Caledonia: Secretariat of the Pacific Community.

LETOURNEUR Y., KULBICKI M. & P. LABROSSE, 1998. - Length-weight relationships of fish from coral reefs of New Caledonia, Southwestern Pacific Ocean. An update. *NAGA*, 1998(4): 39-46.

LOUBENS G., 1980. - Biologie de quelques espèces de poissons du lagon néo-calédonien. III Croissance. *Cah. Indo-Pac.*, 2: 101-153.

O'DOR R.K. & J.A. HOAR, 2000. - Does geometry limit squid growth? *ICES J. Mar. Sci.*, 57: 8-14.

PAULY D., 1997. - Geometric constraints on body size. *Trends Ecol. Evol.*, 12: 442-443.

RIVATON J., FOURMANOIR P., BOURRET P. & M. KULBICKI, 1989. - Catalogue des poissons de Nouvelle-Calédonie. Vol. 2, 170 p. Orstom Nouméa: Catalogues des Sciences de la Mer.

SAMOILYS M.A., 1997. - Manual for Assessing Fish Stocks on Pacific Coral Reefs. Training Series QE97009. 75 p. Townsville: Queensland Department of Primary Industries.

SAMOILYS M.A. & G. CARLOS, 2000. - Determining methods of underwater visual census for estimating the abundance of coral reef fishes. *Env. Biol. Fish.*, 57: 289-304.

YANAGAWA H., 1994. - Length-weight relationships of Gulf of Thailand fishes. *NAGA*, 17: 48-52.

*Reçu le 10 mai 2004.*
*Accepté pour publication le 06 novembre 2004.*

## ANNEXE 1

Species are arranged by families in alphabetical order; species and genera within each family are presented alphabetically. For each family, each genus and each taxa, the estimation of parameters *a* and *b*, the number of specimens used (N), the correlation coefficient (r), maximum and minimum length (cm), and % of error are given. Name: if no name given, all specimens within the family were considered; "spp." after the genus name indicates that all specimens within the genus were considered. *[Les espèces sont rangées par ordre alphabétique au sein des familles et genres, les familles étant elles-mêmes ordonnées alphabétiquement. Pour chaque famille, genre et taxon les estimations des paramètres* a *et* b, *le nombre de spécimens utilisés (N), le coefficient de corrélation (r), les longueurs maximum et minimum (cm) et le % d'erreur sont donnés. Nom: si aucun nom n'est donné, tous les spécimens au sein d'une famille sont considérés; "spp." après le nom de genre indique que tous les spécimens au sein du genre sont considérés.]*

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Acanthuridae | | heterogeneous | 1141 | 0.995 | 2.0 | 60.0 | 0.0301 | 2.946 | 13.3 |
| | *Acanthurus* spp. | compressed | 639 | 0.996 | 2.5 | 57.0 | 0.0280 | 2.983 | 10.2 |
| | *Acanthurus blochii* | compressed | 249 | 0.996 | 2.5 | 38.0 | 0.0251 | 3.032 | 9.8 |
| | *Acanthurus dussumieri* | compressed | 95 | 0.993 | 2.5 | 51.5 | 0.0426 | 2.868 | 10.7 |
| | *Acanthurus nigricauda* | compressed | 51 | 0.995 | 4.6 | 22.5 | 0.0168 | 3.168 | 8.8 |
| | *Acanthurus mata* | compressed | 48 | 0.990 | 10.0 | 29.5 | 0.0222 | 3.008 | 6.9 |
| | *Acanthurus nigrofuscus* | compressed | 124 | 0.990 | 4.5 | 18.7 | 0.0264 | 3.028 | 8.7 |
| | *Acanthurus triostegus* | compressed | 22 | 0.972 | 6.5 | 16.5 | 0.0831 | 2.570 | 9.1 |
| | *Acanthurus xanthopterus* | compressed | 35 | 0.999 | 8.0 | 57.0 | 0.0267 | 2.984 | 5.9 |
| | *Ctenochaetus* spp. | compressed | 198 | 0.994 | 3.8 | 21.0 | 0.0237 | 3.056 | 6.5 |
| | *Ctenochaetus binotatus* | compressed | 18 | 0.969 | 8.5 | 15.3 | 0.0392 | 2.875 | 9.3 |
| | *Ctenochaetus striatus* | compressed | 180 | 0.995 | 3.8 | 21.0 | 0.0231 | 3.063 | 7.7 |
| | *Naso* spp. | heterogeneous | 123 | 0.996 | 2.0 | 60.0 | 0.0085 | 3.250 | 15.1 |
| | *Naso annulatus* | compressed | 9 | 0.989 | 28.0 | 42.0 | 0.0510 | 2.715 | 3.6 |
| | *Naso brevirostris* | cylindrical | 27 | 0.991 | 2.0 | 33.0 | 0.0107 | 3.243 | 32.3 |
| | *Naso hexacanthus* | compressed | 9 | 0.996 | 18.5 | 46.0 | 0.0202 | 2.956 | 6.6 |
| | *Naso unicornis* | compressed | 66 | 0.989 | 18.5 | 60.0 | 0.0179 | 3.035 | 6.8 |
| | *Zebrasoma* spp. | very-flat | 181 | 0.991 | 4.0 | 26.5 | 0.0378 | 2.857 | 14.4 |
| | *Zebrasoma scopas* | very-flat | 104 | 0.989 | 4.0 | 16.0 | 0.0291 | 2.993 | 9.1 |
| | *Zebrasoma veliferum* | very-flat | 77 | 0.995 | 4.0 | 24.0 | 0.0343 | 2.866 | 8.0 |
| Albulidae | *Albula* spp. | cylindrical | 31 | 0.995 | 35.5 | 78.0 | 0.0205 | 2.869 | 7.7 |
| Antennariidae | *Antennarius* spp. | odd | 17 | 0.982 | 4.0 | 11.0 | 0.0236 | 3.293 | 9.5 |
| Apogonidae | | heterogeneous | 1873 | 0.970 | 2.0 | 18.5 | 0.0143 | 3.143 | 17.2 |
| | *Apogon* spp. | cylindrical | 1381 | 0.975 | 2.0 | 16.0 | 0.0155 | 3.121 | 17.3 |
| | *Apogon angustatus* | cylindrical | 59 | 0.938 | 2.6 | 9.0 | 0.0049 | 3.780 | 15.6 |
| | *Apogon aureus* | cylindrical | 116 | 0.980 | 6.2 | 12.0 | 0.0064 | 3.509 | 8.4 |
| | *Apogon bandanensis* | cylindrical | 72 | 0.959 | 3.5 | 10.0 | 0.0140 | 3.250 | 12.9 |
| | *Apogon catalai* | compressed | 9 | 0.962 | 5.0 | 7.0 | 0.0052 | 3.935 | 8.8 |
| | *Apogon compressus* | cylindrical | 13 | 0.941 | 6.0 | 10.4 | 0.0186 | 2.984 | 10.1 |
| | *Apogon cookii* | cylindrical | 15 | 0.950 | 4.8 | 7.0 | 0.0058 | 3.689 | 11.3 |
| | *Apogon cyanosoma* | cylindrical | 42 | 0.873 | 4.0 | 6.9 | 0.0074 | 3.563 | 16.9 |
| | *Apogon doderleini* | cylindrical | 74 | 0.963 | 3.5 | 9.4 | 0.0090 | 3.460 | 15.0 |
| | *Apogon ellioti* | cylindrical | 23 | 0.975 | 5.5 | 13.0 | 0.0172 | 2.991 | 9.8 |
| | *Apogon exostigma* | cylindrical | 62 | 0.972 | 4.0 | 10.3 | 0.0164 | 3.069 | 14.0 |
| | *Apogon fraenatus* | cylindrical | 218 | 0.982 | 3.5 | 11.0 | 0.0130 | 3.165 | 9.2 |
| | *Apogon fuscus* | cylindrical | 53 | 0.981 | 4.0 | 15.0 | 0.0407 | 2.699 | 9.4 |
| | *Apogon hyalosoma* | cylindrical | 42 | 0.983 | 6.0 | 15.0 | 0.0071 | 3.449 | 8.6 |
| | *Apogon kallopterus* | cylindrical | 66 | 0.980 | 4.5 | 12.0 | 0.0101 | 3.314 | 9.2 |
| | *Apogon lateralis* | cylindrical | 106 | 0.970 | 3.5 | 8.5 | 0.0184 | 3.051 | 15.2 |
| | *Apogon lineolatus* | cylindrical | 11 | 0.901 | 6.0 | 7.5 | 0.0045 | 3.683 | 10.7 |
| | *Apogon nigrofasciatus* | cylindrical | 28 | 0.973 | 3.5 | 8.0 | 0.0086 | 3.510 | 10.9 |
| | *Apogon norfolcensis* | cylindrical | 74 | 0.942 | 5.8 | 12.0 | 0.0102 | 3.277 | 10.0 |
| | *Apogon novemfasciatus* | cylindrical | 17 | 0.971 | 3.0 | 9.5 | 0.0086 | 3.414 | 11.6 |
| Apogonidae | *Apogon trimaculatus* | cylindrical | 55 | 0.977 | 2.0 | 16.0 | 0.0217 | 2.971 | 12.7 |
| | *Archamia* spp. | cylindrical | 105 | 0.924 | 5.2 | 8.5 | 0.0084 | 3.395 | 10.3 |
| | *Archamia fucata* | compressed | 49 | 0.954 | 5.2 | 8.5 | 0.0089 | 3.323 | 9.6 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Apogonidae | *Archamia leai* | compressed | 17 | 0.957 | 5.2 | 8.2 | 0.0072 | 3.480 | 9.2 |
| | *Archamia lineolata* | compressed | 16 | 0.924 | 6.0 | 8.0 | 0.0485 | 2.586 | 7.1 |
| | *Cheilodipterus* spp. | cylindrical | 282 | 0.978 | 3.0 | 18.5 | 0.0132 | 3.085 | 8.1 |
| | *Cheilodipterus artus* | cylindrical | 21 | 0.976 | 4.7 | 14.4 | 0.0038 | 3.590 | 14.6 |
| | *Cheilodipterus lachneri* | cylindrical | 51 | 0.963 | 6.0 | 12.5 | 0.0022 | 3.858 | 8.6 |
| | *Cheilodipterus macrodon* | cylindrical | 16 | 0.996 | 8.0 | 18.5 | 0.0054 | 3.433 | 6.6 |
| | *Cheilodipterus quinquelineatus* | cylindrical | 194 | 0.974 | 3.0 | 11.0 | 0.0161 | 2.999 | 11.6 |
| | *Fowleria* spp. | cylindrical | 70 | 0.938 | 3.0 | 8.2 | 0.0082 | 3.567 | 17.3 |
| | *Fowleria aurita* | cylindrical | 12 | 0.997 | 4.1 | 8.2 | 0.0376 | 2.776 | 4.3 |
| | *Fowleria marmorata* | cylindrical | 13 | 0.959 | 4.0 | 7.5 | 0.0024 | 4.136 | 17.4 |
| | *Fowleria variegata* | cylindrical | 35 | 0.960 | 3.0 | 8.0 | 0.0134 | 3.350 | 19.7 |
| Atherinidae | *Atherinomorus lacunosus* | cylindrical | 49 | 0.968 | 6.5 | 13.0 | 0.0064 | 3.298 | 9.7 |
| Aulostomidae | *Aulostomus chinensis* | elongated | 11 | 0.989 | 31.8 | 68.0 | 0.0002 | 3.514 | 9.8 |
| Balistidae | | heterogeneous | 595 | 0.994 | 5.0 | 61.0 | 0.0057 | 3.393 | 18.3 |
| | *Abalistes stellaris* | compressed | 111 | 0.991 | 14.0 | 53.5 | 0.0472 | 2.760 | 5.7 |
| | *Balistoides* spp. | compressed | 12 | 0.994 | 27.4 | 61.0 | 0.0190 | 3.078 | 6.6 |
| | *Balistoides viridescens* | compressed | 10 | 0.998 | 27.4 | 61.0 | 0.0244 | 3.018 | 3.9 |
| | *Pseudobalistes fuscus* | compressed | 76 | 0.989 | 16.3 | 58.0 | 0.0726 | 2.760 | 6.2 |
| | *Sufflamen* spp. | compressed | 122 | 0.982 | 16.6 | 36.5 | 0.0324 | 2.929 | 6.0 |
| | *Sufflamen fraenatus* | compressed | 118 | 0.980 | 18.5 | 36.5 | 0.0287 | 2.966 | 6.5 |
| Belonidae | | semi-elongated | 81 | 0.974 | 16.5 | 88.0 | 0.0008 | 3.203 | 10.6 |
| | *Strongylura* spp. | semi-elongated | 51 | 0.957 | 29.0 | 75.0 | 0.0011 | 3.101 | 10.3 |
| | *Strongylura incisa* | semi-elongated | 11 | 0.950 | 36.5 | 72.5 | 0.0016 | 2.996 | 11.8 |
| | *Strongylura urvilli* | semi-elongated | 23 | 0.991 | 29.0 | 73.5 | 0.0005 | 3.361 | 8.4 |
| | *Tylosurus crocodilus* | semi-elongated | 29 | 0.985 | 29.5 | 88.0 | 0.0006 | 3.285 | 10.1 |
| Blenniidae | | heterogeneous | 246 | 0.860 | 3.5 | 16.6 | 0.0022 | 3.901 | 29.9 |
| | *Atrosalarias fuscus* | cylindrical | 50 | 0.926 | 3.6 | 10.2 | 0.0149 | 3.018 | 16.2 |
| | *Cirripectes* spp. | cylindrical | 41 | 0.981 | 5.5 | 10.0 | 0.0130 | 3.150 | 7.8 |
| | *Cirripectes chelomatus* | cylindrical | 19 | 0.949 | 7.0 | 10.0 | 0.0147 | 3.099 | 7.3 |
| | *Cirripectes stigmaticus* | cylindrical | 17 | 0.989 | 5.5 | 9.0 | 0.0183 | 2.969 | 5.7 |
| | *Ecsenius* spp. | cylindrical | 49 | 0.939 | 4.0 | 9.5 | 0.0239 | 2.584 | 7.5 |
| | *Ecsenius bicolor* | cylindrical | 46 | 0.930 | 4.0 | 9.5 | 0.0239 | 2.583 | 10.6 |
| | *Meiacanthus* spp. | semi-elongated | 9 | 0.866 | 4.5 | 6.0 | 0.0009 | 4.470 | 13.7 |
| | *Petroscirtes* spp. | semi-elongated | 15 | 0.885 | 3.5 | 10.5 | 0.0097 | 3.016 | 29.7 |
| | *Plagiotremus* spp. | elongated | 33 | 0.854 | 5.0 | 9.5 | 0.0018 | 3.581 | 22.8 |
| | *Plagiotremus rhinorhynchos* | elongated | 20 | 0.913 | 6.0 | 9.5 | 0.0012 | 3.792 | 13.9 |
| | *Plagiotremus tapeinosoma* | elongated | 10 | 0.921 | 5.5 | 9.0 | 0.0057 | 2.908 | 15.9 |
| | *Salarias fasciatus* | cylindrical | 25 | 0.922 | 4.0 | 11.0 | 0.0138 | 2.980 | 13.6 |
| Bothidae | | very-flat | 260 | 0.962 | 5.5 | 20.5 | 0.0072 | 3.213 | 13.4 |
| | *Arnoglossus* spp. | very-flat | 32 | 0.894 | 6.0 | 11.5 | 0.0002 | 4.811 | 27.2 |
| | *Asterorhombus intermedius* | very-flat | 59 | 0.914 | 7.0 | 12.5 | 0.0010 | 4.075 | 15.7 |
| | *Bothus pantherinus* | very-flat | 21 | 0.963 | 8.0 | 18.0 | 0.0020 | 3.751 | 18.3 |
| | *Engyprosopon grandisquama* | very-flat | 108 | 0.979 | 5.5 | 12.0 | 0.0168 | 2.894 | 7.1 |
| | *Grammatobothus polyophthalmus* | very-flat | 39 | 0.969 | 11.0 | 20.5 | 0.0148 | 2.895 | 6.8 |
| Bythitidae | *Dinematichthys* spp. | elongated | 55 | 0.869 | 4.0 | 10.2 | 0.0072 | 3.155 | 18.0 |
| Caesionidae | | cylindrical | 377 | 0.986 | 6.0 | 24.3 | 0.0085 | 3.278 | 5.3 |
| | *Caesio* spp. | cylindrical | 195 | 0.986 | 6.7 | 24.3 | 0.0093 | 3.253 | 7.1 |
| | *Caesio caerulaurea* | cylindrical | 90 | 0.996 | 6.7 | 21.4 | 0.0200 | 2.991 | 6.1 |
| | *Caesio cuning* | cylindrical | 9 | 0.989 | 19.5 | 24.3 | 0.0149 | 3.121 | 2.6 |
| | *Pterocaesio* spp. | cylindrical | 182 | 0.988 | 6.0 | 15.5 | 0.0092 | 3.234 | 5.2 |
| | *Pterocaesio diagramma* | cylindrical | 82 | 0.991 | 8.0 | 15.5 | 0.0069 | 3.341 | 5.2 |
| | *Pterocaesio trilineata* | cylindrical | 94 | 0.987 | 6.0 | 15.0 | 0.0107 | 3.178 | 6.8 |
| Callionymidae | | cylindrical | 35 | 0.972 | 3.5 | 16.0 | 0.0329 | 2.466 | 15.1 |
| | *Synchiropus* spp. | cylindrical | 25 | 0.989 | 3.5 | 16.0 | 0.0491 | 2.317 | 12.2 |
| | *Synchiropus rameus* | cylindrical | 13 | 0.930 | 10.0 | 16.0 | 0.0687 | 2.184 | 9.4 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Callionymidae | *Synchiropus splendidus* | cylindrical | 12 | 0.935 | 3.5 | 6.0 | 0.0109 | 3.341 | 14.8 |
| Carangidae | | heterogeneous | 988 | 0.984 | 3.3 | 93.0 | 0.0083 | 3.197 | 17.9 |
| | *Atule mate* | cylindrical | 62 | 0.985 | 10.0 | 27.7 | 0.0166 | 2.949 | 11.1 |
| | *Carangoides* spp. | compressed | 352 | 0.994 | 8.5 | 86.0 | 0.0361 | 2.812 | 9.4 |
| | *Carangoides armatus* | compressed | 12 | 0.990 | 32.0 | 51.0 | 0.0115 | 3.126 | 4.9 |
| | *Carangoides chrysophrys* | compressed | 130 | 0.997 | 12.5 | 60.0 | 0.0267 | 2.902 | 7.5 |
| | *Carangoides ferdau* | compressed | 31 | 0.990 | 24.5 | 60.5 | 0.0368 | 2.851 | 6.6 |
| | *Carangoides fulvoguttatus* | compressed | 54 | 0.993 | 16.0 | 81.0 | 0.0329 | 2.808 | 8.8 |
| | *Carangoides gymnostethus* | compressed | 23 | 0.999 | 8.5 | 86.0 | 0.0463 | 2.746 | 5.6 |
| | *Carangoides hedlandensis* | compressed | 16 | 0.996 | 9.5 | 32.0 | 0.0381 | 2.864 | 6.0 |
| | *Carangoides orthogrammus* | compressed | 34 | 0.994 | 28.0 | 62.0 | 0.0156 | 3.026 | 6.3 |
| | *Carangoides uii* | compressed | 19 | 0.994 | 12.0 | 30.5 | 0.0321 | 2.902 | 7.7 |
| | *Caranx* spp. | compressed | 267 | 0.998 | 5.5 | 93.0 | 0.0198 | 2.986 | 13.9 |
| | *Caranx ignobilis* | compressed | 94 | 0.998 | 7.0 | 93.0 | 0.0164 | 3.059 | 8.1 |
| | *Caranx melampygus* | compressed | 25 | 0.999 | 5.5 | 54.0 | 0.0234 | 2.918 | 6.9 |
| | *Caranx papuensis* | compressed | 135 | 0.997 | 6.5 | 65.0 | 0.0235 | 2.923 | 10.2 |
| | *Decapterus russellii* | cylindrical | 17 | 0.993 | 11.5 | 30.0 | 0.0139 | 2.963 | 6.9 |
| | *Gnathanodon speciosus* | compressed | 20 | 0.999 | 4.0 | 74.5 | 0.0199 | 2.995 | 10.9 |
| | *Pseudocaranx dentex* | compressed | 11 | 0.998 | 27.0 | 59.0 | 0.0271 | 2.886 | 3.1 |
| | *Scomberoides lysan* | cylindrical | 14 | 0.995 | 11.5 | 55.5 | 0.0109 | 2.923 | 6.2 |
| | *Scomberoides tol* | cylindrical | 189 | 0.993 | 3.3 | 37.0 | 0.0154 | 2.787 | 9.6 |
| | *Selar crumenophthalmus* | cylindrical | 34 | 0.966 | 18.0 | 27.5 | 0.0097 | 3.194 | 6.0 |
| Carcharhinidae | | cylindrical | 159 | 0.949 | 45.1 | 120.0 | 0.0010 | 3.566 | 15.9 |
| | *Carcharhinus* spp. | cylindrical | 131 | 0.970 | 45.1 | 120.0 | 0.0013 | 3.508 | 9.3 |
| | *Carcharhinus albimarginatus* | cylindrical | 10 | 0.921 | 61.0 | 76.0 | 0.0001 | 4.268 | 7.3 |
| | *Carcharhinus amblyrhynchos* | cylindrical | 54 | 0.951 | 45.1 | 120.0 | 0.0023 | 3.373 | 9.3 |
| | *Carcharhinus limbatus* | cylindrical | 26 | 0.977 | 47.5 | 86.0 | 0.0033 | 3.283 | 7.7 |
| | *Carcharhinus sorrah* | cylindrical | 27 | 0.982 | 52.0 | 91.0 | 0.0007 | 3.656 | 6.6 |
| Centropomidae | *Ambassis interruptus* | cylindrical | 12 | 0.899 | 5.5 | 7.5 | 0.0079 | 3.543 | 12.4 |
| Chaetodontidae | | very-flat | 2097 | 0.983 | 2.0 | 23.5 | 0.0421 | 2.847 | 12.9 |
| | *Chaetodon* spp. | very-flat | 1927 | 0.982 | 2.0 | 19.0 | 0.0450 | 2.814 | 11.7 |
| | *Chaetodon auriga* | very-flat | 246 | 0.992 | 2.4 | 19.0 | 0.0404 | 2.829 | 10.3 |
| | *Chaetodon bennetti* | very-flat | 20 | 0.994 | 3.0 | 12.6 | 0.0384 | 2.885 | 7.9 |
| | *Chaetodon citrinellus* | very-flat | 74 | 0.986 | 3.0 | 10.5 | 0.0353 | 2.834 | 9.6 |
| | *Chaetodon ephippium* | very-flat | 63 | 0.995 | 3.4 | 17.5 | 0.0225 | 3.061 | 6.7 |
| | *Chaetodon flavirostris* | very-flat | 174 | 0.994 | 2.6 | 16.5 | 0.0251 | 3.113 | 8.4 |
| | *Chaetodon lineolatus* | very-flat | 89 | 0.987 | 2.0 | 20.0 | 0.0693 | 2.622 | 13.3 |
| | *Chaetodon melannotus* | very-flat | 138 | 0.988 | 2.0 | 11.1 | 0.0267 | 3.049 | 9.9 |
| | *Chaetodon mertensii* | very-flat | 15 | 0.983 | 7.0 | 10.0 | 0.0043 | 3.793 | 5.4 |
| | *Chaetodon pelewensis* | very-flat | 26 | 0.967 | 5.0 | 9.0 | 0.0153 | 3.297 | 11.2 |
| | *Chaetodon plebeius* | very-flat | 283 | 0.980 | 2.0 | 10.0 | 0.0606 | 2.628 | 9.0 |
| | *Chaetodon speculum* | very-flat | 444 | 0.984 | 2.0 | 11.5 | 0.0664 | 2.693 | 8.9 |
| | *Chaetodon trifascialis* | very-flat | 23 | 0.985 | 3.0 | 14.0 | 0.0258 | 2.969 | 10.2 |
| | *Chaetodon trifasciatus* | very-flat | 189 | 0.983 | 3.5 | 12.1 | 0.0311 | 2.976 | 8.0 |
| | *Chaetodon ulietensis* | very-flat | 36 | 0.995 | 3.3 | 12.1 | 0.0311 | 2.874 | 6.9 |
| | *Chaetodon unimaculatus* | very-flat | 13 | 0.998 | 4.5 | 18.0 | 0.0533 | 2.833 | 5.2 |
| | *Chaetodon vagabundus* | very-flat | 65 | 0.990 | 4.0 | 14.0 | 0.0278 | 2.973 | 6.4 |
| | *Heniochus* spp. | very-flat | 146 | 0.991 | 3.5 | 21.4 | 0.0252 | 3.082 | 11.2 |
| | *Heniochus acuminatus* | very-flat | 85 | 0.990 | 3.5 | 17.5 | 0.0247 | 3.106 | 11.6 |
| | *Heniochus chrysostomus* | very-flat | 24 | 0.981 | 5.0 | 14.0 | 0.0161 | 3.262 | 12.8 |
| | *Heniochus monoceros* | very-flat | 29 | 0.991 | 9.0 | 21.0 | 0.0170 | 3.211 | 9.1 |
| Chanidae | *Chanos chanos* | cylindrical | 85 | 0.978 | 14.5 | 35.0 | 0.0047 | 3.389 | 9.1 |
| Chirocentridae | *Chirocentrus dorab* | semi-elongated | 30 | 0.926 | 32.5 | 63.0 | 0.0051 | 2.987 | 10.5 |
| Cirrhitidae | | cylindrical | 22 | 0.985 | 4.3 | 15.0 | 0.0093 | 3.268 | 8.0 |
| | *Cirrhitichtys falco* | cylindrical | 17 | 0.939 | 4.3 | 8.0 | 0.0033 | 3.849 | 12.6 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Clinidae | | semi-elongated | 34 | 0.893 | 3.5 | 8.9 | 0.0021 | 3.855 | 9.0 |
| | *Heteroclinus roseus* | semi-elongated | 10 | 0.914 | 3.5 | 8.0 | 0.0168 | 2.775 | 76.3 |
| Clupeidae | | cylindrical | 896 | 0.987 | 3.5 | 24.0 | 0.0093 | 3.314 | 19.8 |
| | *Anodontostoma chacunda* | cylindrical | 691 | 0.994 | 3.5 | 24.0 | 0.0202 | 3.049 | 7.4 |
| | *Herklotsichthys quadrimaculatus* | cylindrical | 70 | 0.946 | 5.0 | 14.5 | 0.0065 | 3.317 | 9.2 |
| | *Sardinella fijiensis* | cylindrical | 36 | 0.992 | 5.5 | 15.5 | 0.0163 | 2.971 | 9.4 |
| Congridae | *Conger cinereus* | elongated | 14 | 0.999 | 10.9 | 110.0 | 0.0008 | 3.127 | 9.7 |
| | *Muraenesox bagio* | elongated | 14 | 0.989 | 56.0 | 106.0 | 0.0026 | 2.824 | 6.5 |
| Dasyatidae | | very-flat | 82 | 0.990 | 17.0 | 49.5 | 0.0094 | 3.352 | 16.0 |
| | *Dasyatis* spp. | very-flat | 82 | 0.990 | 17.0 | 49.5 | 0.0094 | 3.352 | 16.0 |
| | *Dasyatis kuhlii* | very-flat | 78 | 0.992 | 17.0 | 49.5 | 0.0092 | 3.357 | 7.9 |
| Diodontidae | *Diodon* spp. | odd | 25 | 0.969 | 1.0 | 75.0 | 0.0678 | 2.784 | 37.6 |
| | *Diodon hystrix* | odd | 22 | 0.982 | 28.0 | 75.0 | 0.1934 | 2.472 | 9.5 |
| Echeneididae | *Echeneis naucrates* | cylindrical | 342 | 0.982 | 12.0 | 84.5 | 0.0008 | 3.358 | 9.4 |
| Eleotrididae | *Butis amboinensis* | cylindrical | 14 | 0.919 | 4.5 | 8.5 | 0.0075 | 3.029 | 15.3 |
| Elopidae | *Elops machnata* | semi-elongated | 68 | 0.953 | 18.5 | 85.0 | 0.0125 | 2.927 | 21.2 |
| Engraulidae | | cylindrical | 96 | 0.961 | 5.0 | 12.5 | 0.0034 | 3.492 | 14.3 |
| | *Stolephorus* spp. | cylindrical | 11 | 0.829 | 8.5 | 12.5 | 0.0252 | 2.600 | 13.8 |
| | *Thryssina baelama* | cylindrical | 85 | 0.966 | 5.0 | 11.5 | 0.0028 | 3.586 | 10.6 |
| Ephippidae | *Platax* spp. | very-flat | 11 | 0.999 | 4.5 | 50.0 | 0.0443 | 2.951 | 12.4 |
| Fistulariidae | *Fistularia* spp. | elongated | 47 | 0.976 | 18.5 | 44.0 | 0.0005 | 3.048 | 10.1 |
| | *Fistularia petimba* | elongated | 43 | 0.993 | 19.0 | 44.0 | 0.0003 | 3.205 | 5.7 |
| Gerreidae | *Gerres* spp. | compressed | 1590 | 0.989 | 3.0 | 34.0 | 0.0194 | 3.070 | 9.0 |
| | *Gerres filamentosus* | compressed | 273 | 0.995 | 5.0 | 21.5 | 0.0240 | 3.011 | 8.6 |
| | *Gerres ovatus* | compressed | 963 | 0.992 | 3.0 | 19.0 | 0.0229 | 3.005 | 8.1 |
| | *Gerres oyena* | cylindrical | 339 | 0.979 | 4.0 | 20.0 | 0.0095 | 3.337 | 12.8 |
| Gobiidae | | cylindrical | 296 | 0.951 | 2.3 | 36.5 | 0.0264 | 2.623 | 24.0 |
| | *Amblygobius phalaena* | cylindrical | 57 | 0.958 | 3.0 | 11.7 | 0.0184 | 2.834 | 13.6 |
| | *Exyrias* spp. | cylindrical | 28 | 0.984 | 4.5 | 13.5 | 0.0120 | 2.921 | 12.7 |
| | *Exyrias bellissimus* | cylindrical | 23 | 0.969 | 7.0 | 13.5 | 0.0130 | 2.882 | 8.8 |
| | *Gnatholepis* spp. | cylindrical | 13 | 0.925 | 3.5 | 8.5 | 0.0175 | 2.827 | 9.7 |
| | *Gobiodon citrinus* | cylindrical | 12 | 0.932 | 2.8 | 5.2 | 0.0577 | 2.439 | 11.4 |
| | *Istigobius* spp. | cylindrical | 51 | 0.961 | 3.0 | 11.0 | 0.0183 | 2.782 | 9.9 |
| | *Istigobius decoratus* | cylindrical | 24 | 0.978 | 5.5 | 11.0 | 0.0180 | 2.777 | 8.9 |
| | *Istigobius ornatus* | cylindrical | 14 | 0.949 | 3.8 | 9.0 | 0.0098 | 3.108 | 20.5 |
| | *Oxyurichthys* spp. | cylindrical | 23 | 0.949 | 7.0 | 14.5 | 0.0134 | 2.903 | 13.9 |
| | *Oxyurichthys papuensis* | cylindrical | 12 | 0.968 | 8.0 | 14.0 | 0.0126 | 2.910 | 10.4 |
| | *Priolepis cinctus* | cylindrical | 13 | 0.951 | 3.5 | 7.0 | 0.0153 | 3.008 | 11.6 |
| | *Valenciennea* spp. | cylindrical | 17 | 0.989 | 4.5 | 12.5 | 0.0104 | 2.859 | 4.5 |
| | *Valenciennea longipinnis* | cylindrical | 9 | 0.980 | 7.5 | 12.5 | 0.0054 | 3.136 | 6.5 |
| Grammistidae | | heterogeneous | 22 | 0.987 | 1.0 | 27.0 | 0.0124 | 3.234 | 30.8 |
| | *Diploprion bifasciatum* | compressed | 16 | 0.942 | 13.4 | 20.0 | 0.0089 | 3.278 | 10.1 |
| Haemulidae | | heterogeneous | 1530 | 0.997 | 4.0 | 75.0 | 0.0217 | 2.898 | 10.5 |
| | *Diagramma pictus* | compressed | 547 | 0.997 | 7.0 | 75.0 | 0.0144 | 2.988 | 5.8 |
| | *Plectorhinchus* spp. | compressed | 106 | 0.988 | 7.0 | 55.5 | 0.0197 | 2.969 | 9.2 |
| | *Plectorhinchus chaetodonoides* | compressed | 17 | 0.998 | 14.0 | 53.5 | 0.0173 | 3.040 | 6.1 |
| | *Plectorhinchus gibbosus* | compressed | 14 | 0.975 | 7.0 | 38.0 | 0.0226 | 2.962 | 13.8 |
| | *Plectorhinchus lineatus* | cylindrical | 22 | 0.994 | 19.5 | 44.0 | 0.0126 | 3.079 | 4.8 |
| | *Plectorhinchus obscurus* | compressed | 27 | 0.995 | 17.5 | 55.5 | 0.0270 | 2.885 | 6.9 |
| | *Plectorhinchus picus* | compressed | 16 | 0.990 | 36.0 | 54.5 | 0.0115 | 3.089 | 3.8 |
| | *Pomadasys argenteus* | cylindrical | 875 | 0.997 | 4.0 | 43.0 | 0.0188 | 2.954 | 6.6 |
| Hemigaleidae | *Triaenodon obesus* | cylindrical | 20 | 0.971 | 52.0 | 108.0 | 0.0018 | 3.344 | 10.7 |
| Hemiramphidae | | semi-elongated | 92 | 0.896 | 13.0 | 44.5 | 0.0000 | 4.920 | 35.4 |
| | *Hemiramphus affinis* | semi-elongated | 12 | 0.985 | 13.5 | 27.5 | 0.0007 | 3.575 | 13.3 |
| | *Hemirhamphus far* | semi-elongated | 69 | 0.921 | 22.0 | 44.5 | 0.3298 | 1.831 | 9.0 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Holocentridae | | heterogeneous | 1533 | 0.988 | 2.9 | 31.5 | 0.0222 | 3.059 | 11.1 |
| | *Myripristis* spp. | cylindrical | 504 | 0.990 | 3.5 | 22.5 | 0.0276 | 3.030 | 8.7 |
| | *Myripristis amaena* | cylindrical | 22 | 0.995 | 5.0 | 17.0 | 0.0158 | 3.261 | 5.1 |
| | *Myripristis berndti* | cylindrical | 87 | 0.994 | 4.5 | 22.5 | 0.0277 | 3.003 | 8.2 |
| | *Myripristis hexagona* | cylindrical | 16 | 0.997 | 4.6 | 19.0 | 0.0250 | 3.089 | 7.9 |
| | *Myripristis kuntee* | cylindrical | 81 | 0.953 | 6.0 | 14.0 | 0.0099 | 3.468 | 13.5 |
| | *Myripristis melanosticta* | cylindrical | 61 | 0.993 | 4.0 | 19.5 | 0.0292 | 3.024 | 9.8 |
| | *Myripristis pralinia* | cylindrical | 41 | 0.996 | 5.0 | 15.0 | 0.0227 | 3.095 | 5.8 |
| | *Myripristis violacea* | cylindrical | 138 | 0.991 | 3.5 | 19.2 | 0.0364 | 2.940 | 8.4 |
| | *Neoniphon* spp. | cylindrical | 196 | 0.995 | 3.5 | 19.0 | 0.0288 | 2.867 | 8.7 |
| | *Neoniphon argenteus* | cylindrical | 57 | 0.993 | 4.5 | 18.2 | 0.0317 | 2.823 | 7.0 |
| | *Neoniphon sammara* | cylindrical | 138 | 0.995 | 3.5 | 19.0 | 0.0276 | 2.888 | 7.3 |
| | *Plectrypops lima* | cylindrical | 11 | 0.963 | 5.5 | 10.5 | 0.0177 | 3.139 | 11.7 |
| | *Sargocentron* spp. | cylindrical | 822 | 0.993 | 2.9 | 31.5 | 0.0219 | 3.047 | 8.7 |
| | *Sargocentron diadema* | cylindrical | 322 | 0.989 | 5.0 | 15.0 | 0.0251 | 2.955 | 8.3 |
| | *Sargocentron rubrum* | cylindrical | 371 | 0.993 | 2.9 | 23.0 | 0.0275 | 2.998 | 7.4 |
| | *Sargocentron spiniferum* | compressed | 122 | 0.975 | 11.5 | 31.5 | 0.0154 | 3.119 | 9.0 |
| Kuhliidae | *Kuhlia* spp. | cylindrical | 36 | 0.997 | 4.0 | 24.0 | 0.0160 | 3.034 | 5.0 |
| | *Kuhlia marginata* | cylindrical | 31 | 0.996 | 4.0 | 17.5 | 0.0146 | 3.083 | 7.8 |
| Kyphosidae | *Kyphosus* spp. | compressed | 22 | 0.987 | 17.7 | 53.5 | 0.0129 | 3.151 | 5.1 |
| | *Kyphosus vaigiensis* | compressed | 12 | 0.997 | 17.7 | 48.0 | 0.0200 | 3.037 | 6.1 |
| Labridae | | heterogeneous | 1382 | 0.995 | 2.5 | 93.0 | 0.0107 | 3.178 | 15.9 |
| | *Anampses* spp. | cylindrical | 13 | 0.980 | 4.5 | 13.6 | 0.0226 | 2.793 | 10.6 |
| | *Bodianus* spp. | cylindrical | 510 | 0.994 | 8.0 | 59.0 | 0.0108 | 3.173 | 5.5 |
| | *Bodianus perditio* | cylindrical | 496 | 0.991 | 16.5 | 59.0 | 0.0119 | 3.149 | 5.9 |
| | *Cheilinus* spp. | cylindrical | 111 | 0.996 | 4.2 | 93.0 | 0.0155 | 3.058 | 15.5 |
| | *Cheilinus bimaculatus* | cylindrical | 28 | 0.967 | 5.0 | 13.0 | 0.0679 | 2.317 | 10.9 |
| | *Cheilinus chlorourus* | compressed | 44 | 0.994 | 4.2 | 32.0 | 0.0197 | 2.993 | 11.7 |
| | *Cheilinus trilobatus* | compressed | 9 | 0.997 | 8.5 | 24.0 | 0.0162 | 3.059 | 8.5 |
| | *Cheilinus undulatus* | compressed | 16 | 0.998 | 23.0 | 93.0 | 0.0113 | 3.136 | 4.4 |
| | *Cheilio inermis* | semi-elongated | 12 | 0.997 | 5.8 | 23.7 | 0.0035 | 3.082 | 8.5 |
| | *Choerodon graphicus* | cylindrical | 140 | 0.998 | 4.0 | 51.5 | 0.0151 | 3.122 | 9.3 |
| | *Coris* spp. | cylindrical | 20 | 0.998 | 5.2 | 55.0 | 0.0065 | 3.254 | 8.3 |
| | *Coris aygula* | cylindrical | 11 | 0.992 | 32.5 | 55.0 | 0.0027 | 3.489 | 5.2 |
| | *Epibulus insidiator* | compressed | 19 | 0.985 | 8.7 | 35.0 | 0.0161 | 3.081 | 11.6 |
| | *Gomphosus varius* | odd | 22 | 0.995 | 5.0 | 21.2 | 0.0244 | 2.703 | 8.6 |
| | *Halichoeres* spp. | cylindrical | 80 | 0.980 | 3.1 | 19.3 | 0.0160 | 2.987 | 13.7 |
| | *Halichoeres argus* | cylindrical | 18 | 0.965 | 3.1 | 10.1 | 0.0175 | 2.957 | 14.9 |
| | *Halichoeres melanurus* | cylindrical | 26 | 0.949 | 3.6 | 10.6 | 0.0093 | 3.262 | 19 |
| | *Halichoeres trimaculatus* | cylindrical | 22 | 0.994 | 3.5 | 16.0 | 0.0275 | 2.736 | 10.8 |
| | *Hemigymnus melapterus* | cylindrical | 22 | 0.997 | 6.2 | 34.5 | 0.0242 | 2.923 | 7.1 |
| | *Labroides dimidiatus* | semi-elongated | 36 | 0.981 | 4.5 | 11.3 | 0.0059 | 3.231 | 10.1 |
| | *Stethojulis* spp. | cylindrical | 170 | 0.959 | 2.5 | 11.5 | 0.0185 | 2.892 | 7.1 |
| | *Stethojulis bandanensis* | cylindrical | 23 | 0.922 | 3.0 | 10.0 | 0.0304 | 2.581 | 25.9 |
| | *Stetholulis interrupta* | cylindrical | 24 | 0.960 | 3.1 | 9.0 | 0.0292 | 2.608 | 23.1 |
| | *Stethojulis strigiventer* | cylindrical | 147 | 0.971 | 2.5 | 11.5 | 0.0191 | 2.876 | 12.6 |
| | *Thalassoma* spp. | cylindrical | 158 | 0.956 | 2.8 | 17.6 | 0.0123 | 3.097 | 24.4 |
| | *Thalassoma hardwicke* | cylindrical | 10 | 0.997 | 5.5 | 16.3 | 0.0178 | 2.978 | 7.0 |
| | *Thalassoma lunare* | cylindrical | 85 | 0.977 | 2.8 | 16.5 | 0.0211 | 2.832 | 15.4 |
| | *Thalassoma lutescens* | cylindrical | 51 | 0.994 | 4.5 | 17.6 | 0.0130 | 3.042 | 7.6 |
| Leiognathidae | | very-flat | 1024 | 0.985 | 2.5 | 21.0 | 0.0187 | 3.110 | 13 |
| | *Gazza minuta* | very-flat | 151 | 0.993 | 2.5 | 21.0 | 0.0327 | 2.876 | 8.8 |
| | *Leiognathus* spp. | very-flat | 856 | 0.983 | 2.5 | 20.0 | 0.0157 | 3.187 | 11.8 |
| | *Leiognathus bindus* | very-flat | 127 | 0.959 | 3.0 | 9.0 | 0.0263 | 2.897 | 8.9 |
| | *Leiognathus equulus* | very-flat | 380 | 0.993 | 2.5 | 20.0 | 0.0270 | 2.980 | 9.2 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Leiognathidae | *Leiognathus fasciatus* | very-flat | 61 | 0.994 | 5.0 | 15.5 | 0.0200 | 3.102 | 8.2 |
| | *Leiognathus leuciscus* | very-flat | 59 | 0.977 | 5.0 | 9.0 | 0.0070 | 3.488 | 7.5 |
| | *Leiognathus rivulatus* | very-flat | 39 | 0.961 | 6.0 | 10.0 | 0.0192 | 3.008 | 6.5 |
| | *Leiognathus splendens* | very-flat | 161 | 0.974 | 4.5 | 11.5 | 0.0288 | 2.949 | 8.3 |
| | *Secutor ruconius* | very-flat | 17 | 0.921 | 3.5 | 6.5 | 0.0268 | 2.969 | 13.3 |
| Lethrinidae | | heterogeneous | 8527 | 0.996 | 2.5 | 86 | 0.0169 | 3.040 | 9.4 |
| | *Gnathodentex aurolineatus* | cylindrical | 53 | 0.983 | 8.5 | 20.5 | 0.0180 | 3.063 | 6.2 |
| | *Gymnocranius* spp. | compressed | 814 | 0.995 | 6.5 | 69.0 | 0.0302 | 2.909 | 5.9 |
| | *Gymnocranius euanus* | compressed | 372 | 0.991 | 10.0 | 49.0 | 0.0225 | 3.001 | 5.3 |
| | *Gymnocranius grandocculis* | compressed | 243 | 0.995 | 16.0 | 69.0 | 0.0320 | 2.885 | 6.5 |
| | *Gymnocranius* sp. *FAO* | compressed | 120 | 0.998 | 9.0 | 53.0 | 0.0276 | 2.933 | 4.5 |
| | *Lethrinus* spp. | heterogeneous | 7597 | 0.996 | 2.5 | 86.0 | 0.0165 | 3.043 | 9.6 |
| | *Lethrinus atkinsoni* | compressed | 2038 | 0.991 | 4.2 | 45.5 | 0.0178 | 3.057 | 6.3 |
| | *Lethrinus genivittatus* | cylindrical | 877 | 0.992 | 2.5 | 22.0 | 0.0179 | 2.995 | 8.3 |
| | *Lethrinus harak* | cylindrical | 111 | 0.997 | 6.0 | 32.0 | 0.0170 | 3.042 | 6.1 |
| | *Lethrinus lentjan* | compressed | 380 | 0.995 | 6.5 | 44.5 | 0.0197 | 2.986 | 5.5 |
| | *Lethrinus miniatus* | cylindrical | 59 | 0.991 | 18.5 | 54.5 | 0.0066 | 3.277 | 7.2 |
| | *Lethrinus nebulosus* | compressed | 2980 | 0.996 | 3.5 | 69.5 | 0.0187 | 2.996 | 6.1 |
| | *Lethrinus obsoletus* | cylindrical | 133 | 0.992 | 11.0 | 31.0 | 0.0173 | 3.026 | 7.5 |
| | *Lethrinus olivaceus* | cylindrical | 135 | 0.992 | 22.5 | 72.5 | 0.0294 | 2.851 | 8.8 |
| | *Lethrinus ravus* | cylindrical | 9 | 0.997 | 11.0 | 53.2 | 0.0141 | 3.065 | 9.5 |
| | *Lethrinus rubrioperculatus* | cylindrical | 661 | 0.985 | 16.5 | 39.5 | 0.0128 | 3.108 | 5.7 |
| | *Lethrinus semicinctus* | cylindrical | 155 | 0.993 | 3.0 | 29.0 | 0.0118 | 3.117 | 8.6 |
| | *Lethrinus xanthochilus* | cylindrical | 59 | 0.992 | 22.0 | 62.5 | 0.0201 | 2.964 | 7.7 |
| | *Monotaxis grandoculis* | compressed | 63 | 0.999 | 4.0 | 45.0 | 0.0230 | 3.022 | 7.3 |
| Lutjanidae | | heterogeneous | 5281 | 0.994 | 4.0 | 92.0 | 0.0167 | 3.022 | 11.6 |
| | *Aprion virescens* | cylindrical | 121 | 0.980 | 22.5 | 88.0 | 0.0230 | 2.886 | 8.3 |
| | *Lutjanus* spp. | heterogeneous | 5107 | 0.993 | 4.0 | 77.0 | 0.0151 | 3.057 | 10.8 |
| | *Lutjanus adetii* | compressed | 269 | 0.991 | 18.5 | 47.0 | 0.0071 | 3.261 | 7.1 |
| | *Lutjanus argentimaculatus* | cylindrical | 308 | 0.997 | 5.5 | 68.0 | 0.0280 | 2.844 | 5.6 |
| | *Lutjanus bohar* | cylindrical | 510 | 0.997 | 4.0 | 75.0 | 0.0156 | 3.059 | 6.0 |
| | *Lutjanus fulviflammus* | cylindrical | 867 | 0.994 | 5.0 | 32.5 | 0.0205 | 2.960 | 6.6 |
| | *Lutjanus fulvus* | cylindrical | 318 | 0.994 | 4.0 | 31.0 | 0.0211 | 2.974 | 8.3 |
| | *Lutjanus gibbus* | compressed | 515 | 0.991 | 14.2 | 40.5 | 0.0131 | 3.138 | 6.3 |
| | *Lutjanus kasmira* | cylindrical | 127 | 0.983 | 4.0 | 26.0 | 0.0084 | 3.247 | 7.8 |
| | *Lutjanus lutjanus* | cylindrical | 68 | 0.994 | 8.5 | 28.0 | 0.0182 | 2.969 | 5.8 |
| | *Lutjanus monostigma* | cylindrical | 15 | 0.986 | 25.0 | 53.5 | 0.0222 | 2.913 | 9.4 |
| | *Lutjanus quinquelineatus* | cylindrical | 864 | 0.969 | 5.5 | 23.0 | 0.0146 | 3.100 | 9.9 |
| | *Lutjanus rivulatus* | compressed | 12 | 0.994 | 15.5 | 76.0 | 0.0084 | 3.260 | 11.8 |
| | *Lutjanus russelli* | cylindrical | 171 | 0.993 | 9.5 | 37.0 | 0.0166 | 2.978 | 7.8 |
| | *Lutjanus sebae* | compressed | 34 | 0.996 | 24.5 | 77.0 | 0.0116 | 3.152 | 4.8 |
| | *Lutjanus semicinctus* | cylindrical | 31 | 0.976 | 18.0 | 35.0 | 0.0040 | 3.428 | 8.1 |
| | *Lutjanus vittus* | cylindrical | 998 | 0.992 | 9.0 | 38.5 | 0.0125 | 3.075 | 7.5 |
| | *Symphorus nematophorus* | cylindrical | 41 | 0.983 | 44.5 | 92.0 | 0.0147 | 3.046 | 5.7 |
| Megalopidae | *Megalops cyprinoides* | semi-elongated | 35 | 0.993 | 17.0 | 47.0 | 0.0122 | 3.033 | 7.1 |
| Microcanthidae | *Microcanthus strigatus* | compressed | 14 | 0.956 | 9.2 | 15.0 | 0.0526 | 2.818 | 9.7 |
| | *Paramonacanthus japonicus* | compressed | 48 | 0.953 | 5.0 | 17.0 | 0.0219 | 2.889 | 13 |
| Monacanthidae | *Pseudalutarius nasicornis* | compressed | 209 | 0.955 | 8.0 | 13.5 | 0.0070 | 3.262 | 6.9 |
| Monodactylidae | *Monodactylus argenteus* | compressed | 203 | 0.993 | 2.0 | 18.5 | 0.0303 | 2.964 | 8.0 |
| Mugilidae | | cylindrical | 2825 | 0.993 | 4.0 | 60.0 | 0.0127 | 3.046 | 7.0 |
| | *Liza* spp. | cylindrical | 1544 | 0.991 | 4.0 | 35.5 | 0.0141 | 3.023 | 6.5 |
| | *Liza macrolepis* | cylindrical | 806 | 0.992 | 6.0 | 29.0 | 0.0144 | 3.014 | 6.7 |
| | *Liza melinoptera* | cylindrical | 735 | 0.984 | 4.0 | 35.5 | 0.0133 | 3.045 | 6.7 |
| | *Mugil cephalus* | cylindrical | 182 | 0.996 | 6.5 | 48.5 | 0.0109 | 3.089 | 6.5 |
| | *Valamugil* spp. | cylindrical | 919 | 0.995 | 5.0 | 60.0 | 0.0088 | 3.148 | 10.7 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Mugilidae | *Valamugil buchanani* | cylindrical | 680 | 0.995 | 7.0 | 60.0 | 0.0101 | 3.104 | 7.6 |
| | *Valamugil engeli* | cylindrical | 196 | 0.991 | 6.5 | 26.0 | 0.0058 | 3.287 | 8.9 |
| | *Valamugil seheli* | cylindrical | 38 | 0.996 | 11.5 | 43.5 | 0.0061 | 3.275 | 6.1 |
| Mullidae | | cylindrical | 2902 | 0.987 | 3.5 | 41.0 | 0.0104 | 3.224 | 9.7 |
| | *Mulloides* spp. | cylindrical | 29 | 0.979 | 10 | 21.5 | 0.0074 | 3.293 | 12.9 |
| | *Mulloides flavolineatus* | cylindrical | 24 | 0.951 | 10 | 19.5 | 0.0120 | 3.101 | 7.6 |
| | *Parupeneus* spp. | cylindrical | 816 | 0.993 | 3.5 | 41.0 | 0.0145 | 3.130 | 10.1 |
| | *Parupeneus barberinus* | cylindrical | 19 | 0.998 | 8.0 | 41.0 | 0.0131 | 3.122 | 5.4 |
| | *Parupeneus ciliatus* | cylindrical | 92 | 0.997 | 3.5 | 24.5 | 0.0116 | 3.220 | 9.0 |
| | *Parupeneus heptacanthus* | cylindrical | 522 | 0.989 | 5.5 | 23.5 | 0.0169 | 3.078 | 6.9 |
| | *Parupeneus indicus* | cylindrical | 91 | 0.997 | 3.5.0 | 36.0 | 0.0142 | 3.114 | 11.7 |
| | *Parupeneus multifasciatus* | cylindrical | 53 | 0.981 | 3.5 | 22.8 | 0.0114 | 3.211 | 17 |
| | *Parupeneus spilurus* | cylindrical | 19 | 0.995 | 11.4 | 29.5 | 0.0192 | 3.022 | 4.6 |
| | *Upeneus* spp. | cylindrical | 2057 | 0.984 | 3.5 | 24.0 | 0.0103 | 3.215 | 7.5 |
| | *Upeneus moluccensis* | cylindrical | 955 | 0.975 | 6.5 | 17.0 | 0.0170 | 3.022 | 6.7 |
| | *Upeneus guttatus* | cylindrical | 21 | 0.990 | 8.0 | 13.5 | 0.0218 | 2.883 | 5.1 |
| | *Upeneus australiae* | cylindrical | 332 | 0.978 | 7.5 | 15.5 | 0.0130 | 3.112 | 7.2 |
| | *Upeneus sulphureus* | cylindrical | 38 | 0.948 | 11.0 | 17.0 | 0.0081 | 3.322 | 6.9 |
| | *Upeneus tragula* | cylindrical | 380 | 0.988 | 3.5 | 24.0 | 0.0137 | 3.068 | 8.0 |
| | *Upeneus vittatus* | cylindrical | 329 | 0.988 | 6.0 | 24.0 | 0.0072 | 3.354 | 8.5 |
| Muraenidae | | elongated | 175 | 0.943 | 3.7 | 256.0 | 0.0047 | 2.614 | 43.4 |
| | *Echidna* spp. | elongated | 22 | 0.969 | 11.0 | 64.0 | 0.0003 | 3.352 | 13.9 |
| | *Gymnothorax* spp. | elongated | 99 | 0.922 | 3.7 | 120.0 | 0.0005 | 3.303 | 20 |
| | *Gymnothorax fimbriatus* | elongated | 20 | 0.993 | 11.0 | 44.0 | 0.0004 | 3.324 | 10.6 |
| | *Thyrsoidea* spp. | elongated | 40 | 0.995 | 22.0 | 223.5 | 0.0115 | 2.305 | 9.8 |
| | *Thyrsoidea macrura* | elongated | 37 | 0.995 | 22.0 | 223.5 | 0.0113 | 2.311 | 13.2 |
| Nemipteridae | | cylindrical | 1539 | 0.984 | 3.5 | 27.0 | 0.0171 | 3.004 | 13.1 |
| | *Nemipterus* spp. | cylindrical | 869 | 0.974 | 11.5 | 27.0 | 0.0068 | 3.307 | 7.9 |
| | *Nemipterus furcosus* | cylindrical | 598 | 0.976 | 11.5 | 27.0 | 0.0060 | 3.357 | 8.7 |
| | *Nemipterus peroni* | cylindrical | 271 | 0.936 | 15.5 | 26.5 | 0.0079 | 3.251 | 8.2 |
| | *Scolopsis* spp. | cylindrical | 669 | 0.981 | 3.5 | 22.0 | 0.0157 | 3.054 | 17.1 |
| | *Scolopsis bilineatus* | cylindrical | 104 | 0.996 | 3.5 | 19.4 | 0.0138 | 3.174 | 8.3 |
| | *Scolopsis taeniopterus* | cylindrical | 563 | 0.980 | 7.0 | 22.0 | 0.0185 | 2.981 | 7.4 |
| Opistognathidae | *Opisthognathus* spp. | cylindrical | 28 | 0.897 | 3.5 | 7.5 | 0.0231 | 2.452 | 13.9 |
| Ostraciidae | | odd | 67 | 0.962 | 2.5 | 41.0 | 0.0853 | 2.577 | 26.4 |
| | *Lactoria* spp. | odd | 24 | 0.890 | 7.5 | 30.0 | 0.4029 | 1.928 | 35.2 |
| | *Lactoria cornuta* | odd | 15 | 0.925 | 20.5 | 30.0 | 0.0065 | 3.168 | 7.6 |
| | *Ostracion cubicus* | odd | 20 | 0.998 | 2.5 | 41.0 | 0.1288 | 2.519 | 10.5 |
| | *Tetrosomus gibbosus* | odd | 23 | 0.970 | 5.0 | 26.0 | 0.1820 | 2.369 | 11.7 |
| Pinguipedidae | *Parapercis* spp. | cylindrical | 202 | 0.982 | 2.5 | 23.0 | 0.0133 | 2.943 | 9.5 |
| | *Parapercis cylindrica* | cylindrical | 159 | 0.971 | 2.5 | 13.0 | 0.0124 | 3.000 | 14.4 |
| | *Parapercis hexophtalma* | cylindrical | 15 | 0.996 | 7.0 | 23.0 | 0.0068 | 3.157 | 7.8 |
| | *Parapercis xanthozona* | cylindrical | 19 | 0.983 | 3.5 | 17.5 | 0.0133 | 2.890 | 14.1 |
| Platycephalidae | | cylindrical | 113 | 0.988 | 6.0 | 52.0 | 0.0112 | 2.917 | 12.1 |
| | *Cymbacephalus beauforti* | cylindrical | 14 | 0.998 | 19.5 | 52.0 | 0.0040 | 3.211 | 4.5 |
| | *Onigocia macrolepis* | cylindrical | 39 | 0.988 | 6.0 | 17.0 | 0.0239 | 2.646 | 6.3 |
| | *Onigocia spinosa* | cylindrical | 26 | 0.990 | 6.0 | 19.0 | 0.0352 | 2.465 | 9.1 |
| | *Thysanophrys chiltonae* | cylindrical | 20 | 0.989 | 7.5 | 22.1 | 0.0027 | 3.347 | 9.9 |
| Plesiopidae | | cylindrical | 57 | 0.923 | 3.5 | 10.5 | 0.0033 | 3.856 | 13.5 |
| | *Assessor macneili* | cylindrical | 27 | 0.934 | 3.7 | 7.0 | 0.0181 | 2.791 | 12.4 |
| | *Plesiops coeruleolineatus* | cylindrical | 23 | 0.943 | 3.5 | 10.5 | 0.0067 | 3.496 | 18.3 |
| Polynemidae | *Polydactylus microstoma* | cylindrical | 112 | 0.981 | 10.5 | 24.5 | 0.0135 | 3.117 | 6.5 |
| Pomacanthidae | | compressed | 232 | 0.983 | 2.0 | 36.4 | 0.0584 | 2.718 | 15.5 |
| | *Centropyge* spp. | compressed | 210 | 0.968 | 2.0 | 13.5 | 0.0745 | 2.577 | 17.2 |
| | *Centropyge bispinosus* | compressed | 117 | 0.964 | 2.0 | 11.5 | 0.0920 | 2.458 | 15.3 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Pomacanthidae | *Centropyge tibicen* | compressed | 77 | 0.979 | 2.0 | 13.5 | 0.0492 | 2.795 | 10.6 |
| | *Pomacanthus sextriatus* | compressed | 20 | 0.999 | 3.5 | 36.4 | 0.0669 | 2.724 | 3.7 |
| Pomacentridae | | heterogeneous | 2262 | 0.969 | 1.5 | 17.8 | 0.0209 | 3.191 | 15.1 |
| | *Abudefduf* spp. | compressed | 135 | 0.987 | 5.0 | 15.5 | 0.0226 | 3.132 | 8.2 |
| | *Abudefduf sexfasciatus* | compressed | 98 | 0.981 | 5.0 | 15.0 | 0.0213 | 3.152 | 10.9 |
| | *Abudefduf whitleyi* | compressed | 34 | 0.996 | 5.0 | 15.5 | 0.0254 | 3.093 | 7.7 |
| | *Amblyglyphidodon* spp. | compressed | 34 | 0.952 | 4.5 | 10.5 | 0.0144 | 3.330 | 13.7 |
| | *Amblyglyphidodon curacao* | compressed | 18 | 0.986 | 4.5 | 10.5 | 0.0126 | 3.435 | 8.2 |
| | *Amblyglyphidodon leucogaster* | compressed | 14 | 0.926 | 6.5 | 10.4 | 0.0297 | 2.936 | 9.8 |
| | *Amphiprion* spp. | compressed | 71 | 0.978 | 2.2 | 12.9 | 0.0189 | 3.190 | 10.9 |
| | *Amphiprion akindynos* | compressed | 21 | 0.989 | 4.0 | 12.9 | 0.0316 | 2.930 | 9.9 |
| | *Amphiprion melanopus* | compressed | 32 | 0.961 | 2.2 | 10.8 | 0.0155 | 3.298 | 12.3 |
| | *Amphiprion tricinctus* | compressed | 13 | 0.984 | 5.5 | 12.0 | 0.0385 | 2.904 | 12.3 |
| | *Chromis* spp. | compressed | 373 | 0.971 | 2.0 | 12.0 | 0.0229 | 3.175 | 13.3 |
| | *Chromis atripectoralis* | compressed | 24 | 0.989 | 3.5 | 9.0 | 0.0179 | 3.291 | 10.4 |
| | *Chromis chrysura* | compressed | 58 | 0.979 | 5.5 | 12.0 | 0.0228 | 3.222 | 8.1 |
| | *Chromis fumea* | compressed | 61 | 0.975 | 4.5 | 9.0 | 0.0144 | 3.351 | 8.6 |
| | *Chromis iomelas* | compressed | 9 | 0.986 | 3.5 | 6.5 | 0.0151 | 3.383 | 7.9 |
| | *Chromis lepidolepis* | compressed | 16 | 0.898 | 5.0 | 6.8 | 0.1950 | 1.939 | 6.3 |
| | *Chromis ternatensis* | compressed | 30 | 0.921 | 5.0 | 7.5 | 0.0160 | 3.408 | 8.7 |
| | *Chromis viridis* | compressed | 144 | 0.932 | 2.0 | 7.0 | 0.0351 | 2.900 | 16.0 |
| | *Chrysiptera* spp. | cylindrical | 107 | 0.931 | 3.5 | 8.2 | 0.0260 | 2.926 | 12.6 |
| | *Chrysiptera taupou* | cylindrical | 85 | 0.946 | 3.5 | 8.2 | 0.0220 | 3.001 | 13.5 |
| | *Dascyllus* spp. | compressed | 138 | 0.976 | 2.4 | 13.5 | 0.0462 | 2.911 | 9.8 |
| | *Dascyllus aruanus* | compressed | 112 | 0.944 | 2.4 | 6.5 | 0.0415 | 2.989 | 12.9 |
| | *Dascyllus reticulatus* | compressed | 16 | 0.971 | 3.3 | 8.0 | 0.0311 | 3.133 | 13.6 |
| | *Dascyllus trimaculatus* | compressed | 10 | 0.997 | 5.5 | 13.5 | 0.0313 | 3.043 | 5.7 |
| | *Neoglyphidodon* spp. | compressed | 50 | 0.981 | 4.0 | 10.8 | 0.0175 | 3.212 | 5.8 |
| | *Neoglyphidodon nigroris* | compressed | 10 | 0.991 | 6.5 | 10.6 | 0.0178 | 3.182 | 3.8 |
| | *Neoglyphidodon polyacanthus* | compressed | 37 | 0.980 | 4.0 | 10.8 | 0.0206 | 3.146 | 11.2 |
| | *Neopomacentrus* spp. | cylindrical | 171 | 0.944 | 1.5 | 7.0 | 0.0258 | 2.933 | 10.2 |
| | *Neopomacentrus azysron* | cylindrical | 21 | 0.974 | 3.5 | 6.9 | 0.0258 | 2.943 | 8.1 |
| | *Neopomacentrus nemurus* | cylindrical | 101 | 0.901 | 4.5 | 7.0 | 0.0259 | 2.913 | 9.4 |
| | *Pomacentrus* spp. | compressed | 898 | 0.955 | 2.0 | 14.5 | 0.0280 | 3.024 | 12.1 |
| | *Pomacentrus adelus* | compressed | 143 | 0.937 | 2.0 | 8.0 | 0.0176 | 3.292 | 10.6 |
| | *Pomacentrus amboinensis* | compressed | 128 | 0.974 | 2.5 | 10.5 | 0.0439 | 2.824 | 11.3 |
| | *Pomacentrus chrysurus* | compressed | 54 | 0.972 | 2.5 | 14.5 | 0.0264 | 3.083 | 12.1 |
| | *Pomacentrus imitator* | compressed | 10 | 0.952 | 6.3 | 9.2 | 0.0102 | 3.469 | 11.2 |
| | *Pomacentrus lepidogenys* | compressed | 36 | 0.977 | 4.5 | 8.0 | 0.0215 | 3.210 | 9.2 |
| | *Pomacentrus melanopterus* | compressed | 13 | 0.989 | 4.0 | 9.5 | 0.0116 | 3.387 | 10.5 |
| | *Pomacentrus moluccensis* | compressed | 38 | 0.903 | 5.0 | 7.6 | 0.0305 | 3.012 | 10.4 |
| | *Pomacentrus pavo* | cylindrical | 172 | 0.977 | 2.5 | 9.5 | 0.0252 | 2.972 | 10.4 |
| | *Pomacentrus philippinus* | compressed | 73 | 0.972 | 3.5 | 9.5 | 0.0231 | 3.058 | 10.8 |
| | *Pomacentrus vaiuli* | compressed | 84 | 0.973 | 2.5 | 8.5 | 0.0472 | 2.775 | 13.1 |
| | *Teixeirichthys jordani* | cylindrical | 50 | 0.970 | 7.0 | 10.0 | 0.0197 | 3.072 | 5.4 |
| | *Stegastes* spp. | compressed | 205 | 0.983 | 2.5 | 15.5 | 0.0395 | 2.989 | 10.3 |
| | *Stegastes fasciatus* | compressed | 11 | 0.897 | 8.5 | 12.0 | 0.0028 | 4.063 | 11.7 |
| | *Stegastes lividus* | compressed | 12 | 0.943 | 7.5 | 15.5 | 0.0652 | 2.741 | 13.8 |
| | *Stegastes nigricans* | compressed | 182 | 0.986 | 2.5 | 12.5 | 0.0384 | 3.010 | 9.4 |
| Priacanthidae | | compressed | 119 | 0.996 | 4.5 | 38.0 | 0.0294 | 2.807 | 7.7 |
| | *Heteropriacanthus cruentatus* | compressed | 10 | 0.990 | 9.0 | 20.0 | 0.0279 | 2.823 | 8.2 |
| | *Priacanthus hamrur* | compressed | 106 | 0.995 | 4.5 | 33.0 | 0.0300 | 2.801 | 5.7 |
| Pseudochromidae | | cylindrical | 106 | 0.923 | 2.7 | 8.1 | 0.0192 | 2.812 | 8.1 |
| | *Pseudochromis* spp. | cylindrical | 97 | 0.951 | 4.0 | 8.1 | 0.0096 | 3.167 | 8.4 |
| | *Pseudochromis purpurascens* | cylindrical | 72 | 0.954 | 4.0 | 8.1 | 0.0099 | 3.145 | 13.7 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Pseudochromidae | *Pseudochromis salvati* | cylindrical | 22 | 0.885 | 4.9 | 7.7 | 0.0218 | 2.752 | 9.1 |
| Scaridae | | cylindrical | 668 | 0.996 | 2.3 | 68.0 | 0.0222 | 2.971 | 12.6 |
| | *Chlorurus sordidus* | cylindrical | 158 | 0.997 | 2.3 | 37.0 | 0.0243 | 2.969 | 7.6 |
| | *Leptoscarus vaigiensis* | cylindrical | 21 | 0.996 | 3.5 | 19.6 | 0.0163 | 2.991 | 8.7 |
| | *Scarus* spp. | cylindrical | 637 | 0.996 | 2.3 | 68.0 | 0.0234 | 2.956 | 13.3 |
| | *Scarus altipinnis* | cylindrical | 19 | 0.997 | 11.0 | 44.5 | 0.0184 | 3.029 | 6.4 |
| | *Scarus ghobban* | cylindrical | 247 | 0.997 | 6.0 | 49.5 | 0.0165 | 3.041 | 6.7 |
| | *Scarus niger* | cylindrical | 13 | 0.997 | 15.0 | 43.0 | 0.0134 | 3.160 | 6.0 |
| | *Scarus psittacus* | cylindrical | 21 | 0.970 | 6.1 | 15.0 | 0.0105 | 3.319 | 12.9 |
| | *Scarus rivulatus* | cylindrical | 37 | 0.999 | 5.0 | 41.5 | 0.0175 | 3.074 | 6.8 |
| | *Scarus schlegeli* | cylindrical | 75 | 0.983 | 4.5 | 37.0 | 0.0231 | 2.969 | 9.7 |
| Scatophagidae | *Scatophagus argus* | compressed | 45 | 0.998 | 5.0 | 36.0 | 0.0345 | 2.948 | 5.3 |
| Scombridae | *Scomberomorus commersoni* | cylindrical | 49 | 0.996 | 19.0 | 100.0 | 0.0162 | 2.856 | 6.6 |
| Scorpaenidae | | heterogeneous | 140 | 0.984 | 3.0 | 31.0 | 0.0246 | 2.908 | 15.1 |
| | *Dendrochirus brachypterus* | cylindrical | 32 | 0.990 | 4.0 | 12.0 | 0.0097 | 3.337 | 6.8 |
| | *Pterois* spp. | cylindrical | 10 | 0.995 | 3.5 | 31.0 | 0.0358 | 2.697 | 14.2 |
| | *Scorpaenodes* spp. | heterogeneous | 77 | 0.976 | 3.0 | 15.7 | 0.0169 | 3.138 | 7.4 |
| | *Scorpaenodes guamensis* | cylindrical | 38 | 0.971 | 3.5 | 10.8 | 0.0196 | 3.038 | 13.0 |
| | *Scorpaenodes parvipinnis* | cylindrical | 11 | 0.983 | 3.0 | 15.7 | 0.0254 | 2.999 | 16.1 |
| | *Scorpaenodes scabra* | cylindrical | 15 | 0.969 | 3.0 | 9.5 | 0.0245 | 2.960 | 16.0 |
| | *Scorpaenopsis* spp. | heterogeneous | 15 | 0.948 | 3.5 | 10.0 | 0.0131 | 3.261 | 24.0 |
| Serranidae | | heterogeneous | 3403 | 0.996 | 3.5 | 128.0 | 0.0134 | 3.031 | 11.7 |
| | *Anyperodon leucogrammicus* | cylindrical | 10 | 0.980 | 30.5 | 51.0 | 0.0014 | 3.548 | 8.3 |
| | *Cephalopholis* spp. | cylindrical | 378 | 0.995 | 4.8 | 50.0 | 0.0115 | 3.109 | 11.2 |
| | *Cephalopholis argus* | cylindrical | 15 | 0.988 | 21.5 | 44.0 | 0.0093 | 3.181 | 7.2 |
| | *Cephalopholis boenack* | cylindrical | 149 | 0.988 | 4.8 | 30.5 | 0.0146 | 3.019 | 9. |
| | *Cephalopholis miniata* | cylindrical | 94 | 0.973 | 23.0 | 46.0 | 0.0107 | 3.114 | 8.0 |
| | *Cephalopholis sonnerati* | cylindrical | 96 | 0.968 | 24.0 | 50.0 | 0.0066 | 3.277 | 8.9 |
| | *Cephalopholis urodeta* | cylindrical | 17 | 0.953 | 15.0 | 25.5 | 0.0282 | 2.818 | 8.4 |
| | *Cromileptes altivelis* | compressed | 10 | 0.983 | 13.0 | 45.0 | 0.0962 | 2.489 | 12.1 |
| | *Epinephelus* spp. | heterogeneous | 2712 | 0.996 | 3.5 | 128.0 | 0.0122 | 3.053 | 10.3 |
| | *Epinephelus areolatus* | cylindrical | 268 | 0.990 | 6.0 | 42.5 | 0.0114 | 3.048 | 8.0 |
| | *Epinephelus caeruleopunctatus* | cylindrical | 24 | 0.997 | 3.5 | 61.0 | 0.0180 | 2.938 | 10.5 |
| | *Epinephelus cyanopodus* | compressed | 232 | 0.994 | 9.5 | 76.0 | 0.0111 | 3.114 | 7.9 |
| | *Epinephelus fasciatus* | cylindrical | 165 | 0.985 | 8.9 | 36.5 | 0.0138 | 3.041 | 9.6 |
| | *Epinephelus fuscoguttatus* | cylindrical | 22 | 0.997 | 18.5 | 100.0 | 0.0134 | 3.057 | 6.1 |
| | *Epinephelus howlandi* | cylindrical | 83 | 0.997 | 5.7 | 39.0 | 0.0153 | 2.999 | 9.6 |
| | *Epinephelus macrospilos* | cylindrical | 56 | 0.994 | 11.0 | 41.0 | 0.0132 | 3.031 | 7.8 |
| | *Epinephelus maculatus* | cylindrical | 775 | 0.989 | 6.5 | 60.5 | 0.0110 | 3.062 | 7.5 |
| | *Epinephelus malabaricus* | cylindrical | 172 | 0.998 | 8.5 | 128.0 | 0.0121 | 3.052 | 7.8 |
| | *Epinephelus merra* | cylindrical | 291 | 0.995 | 5.5 | 25.0 | 0.0158 | 2.966 | 9.5 |
| | *Epinephelus ongus* | cylindrical | 43 | 0.995 | 8.5 | 37.0 | 0.0190 | 2.928 | 7.1 |
| | *Epinephelus polyphekadion* | cylindrical | 359 | 0.992 | 8.5 | 61.5 | 0.0083 | 3.166 | 7.8 |
| | *Epinephelus rivulatus* | cylindrical | 158 | 0.965 | 16.0 | 40.5 | 0.0114 | 3.086 | 7.3 |
| | *Epinephelus coioides* | cylindrical | 44 | 0.997 | 6.5 | 111.0 | 0.0099 | 3.102 | 10.8 |
| | *Plectropomus* spp. | cylindrical | 212 | 0.996 | 10.7 | 95.0 | 0.0107 | 3.086 | 7.2 |
| | *Plectropomus laevis* | cylindrical | 17 | 0.996 | 18.1 | 95.0 | 0.0059 | 3.238 | 8.6 |
| | *Plectropomus leopardus* | cylindrical | 191 | 0.995 | 10.7 | 91.0 | 0.0118 | 3.060 | 7.1 |
| | *Pseudanthias hypselosoma* | cylindrical | 35 | 0.990 | 5.0 | 9.5.0 | 0.0137 | 3.149 | 7.0 |
| | *Variola louti* | cylindrical | 41 | 0.995 | 20.0 | 66.0 | 0.0122 | 3.079 | 5.8 |
| Siganidae | *Siganus* spp. | compressed | 2065 | 0.987 | 2.0 | 38.0 | 0.0145 | 3.122 | 12.2 |
| | *Siganus argenteus* | compressed | 31 | 0.991 | 10.0 | 32.0 | 0.0109 | 3.154 | 8.5 |
| | *Siganus corallinus* | compressed | 9 | 0.996 | 9.0 | 19.0 | 0.0023 | 3.821 | 6.4 |
| | *Siganus doliatus* | compressed | 669 | 0.981 | 2.0 | 22.5 | 0.0104 | 3.272 | 6.1 |
| | *Siganus fuscescens* | compressed | 481 | 0.996 | 3.0 | 29.5 | 0.0137 | 3.068 | 7.2 |

| Family | Name | Shape | N | r | L.min | L.max | a | b | %error |
|---|---|---|---|---|---|---|---|---|---|
| Siganidae | *Siganus lineatus* | compressed | 817 | 0.997 | 5.5 | 35.0 | 0.0219 | 2.998 | 5.9 |
| | *Siganus puellus* | compressed | 11 | 0.998 | 5.5 | 24.0 | 0.0176 | 3.028 | 4.7 |
| | *Siganus punctatus* | compressed | 27 | 0.994 | 10.0 | 36.5 | 0.0095 | 3.276 | 7.7 |
| | *Siganus spinus* | compressed | 9 | 0.993 | 6.5 | 14.0 | 0.0150 | 3.093 | 6.7 |
| Sillaginidae | *Sillago* spp. | cylindrical | 469 | 0.991 | 3.5 | 31.0 | 0.0040 | 3.264 | 6.3 |
| | *Sillago ciliata* | cylindrical | 169 | 0.988 | 15.5 | 31.0 | 0.0028 | 3.396 | 7.2 |
| | *Sillago sihama* | cylindrical | 249 | 0.992 | 3.5 | 29.0 | 0.0051 | 3.180 | 9.1 |
| Soleidae | | very-flat | 12 | 0.999 | 4.5 | 28.0 | 0.0064 | 3.286 | 6.6 |
| | *Pardachirus pavoninus* | very-flat | 10 | 0.999 | 4.5 | 28.0 | 0.0078 | 3.218 | 4.4 |
| Sparidae | *Acanthopagrus berda* | compressed | 295 | 0.996 | 5.0 | 36.0 | 0.0224 | 3.044 | 6.9 |
| Sphyraenidae | | semi-elongated | 646 | 0.990 | 5.5 | 104.0 | 0.0058 | 3.013 | 10.9 |
| | *Sphyraena* spp. | semi-elongated | 646 | 0.990 | 5.5 | 104.0 | 0.0058 | 3.013 | 10.9 |
| | *Sphyraena barracuda* | semi-elongated | 179 | 0.981 | 19.0 | 63.0 | 0.0062 | 3.011 | 7.4 |
| | *Sphyraena flavicauda* | semi-elongated | 43 | 0.961 | 5.5 | 35.5 | 0.0044 | 3.083 | 11.2 |
| | *Sphyraena forsteri* | semi-elongated | 95 | 0.995 | 8.5 | 60.0 | 0.0053 | 3.034 | 6.3 |
| | *Sphyraena novaehollandiae* | semi-elongated | 23 | 0.987 | 19.0 | 28.0 | 0.0240 | 2.530 | 4.2 |
| | *Sphyraena obtusata* | semi-elongated | 23 | 0.940 | 19.0 | 26.5 | 0.0257 | 2.588 | 7.7 |
| | *Sphyraena putnamiae* | semi-elongated | 226 | 0.994 | 19.5 | 104.0 | 0.0075 | 2.931 | 6.6 |
| | *Sphyraena waitei* | semi-elongated | 34 | 0.992 | 19.0 | 31.0 | 0.0089 | 2.855 | 3.8 |
| Sphyrnidae | *Sphyrna lewini* | cylindrical | 30 | 0.991 | 38.0 | 91.0 | 0.0042 | 3.239 | 7.6 |
| Synanceiidae | | heterogeneous | 19 | 0.980 | 5.0 | 29.5 | 0.0044 | 3.694 | 35.5 |
| | *Inimicus didactylus* | cylindrical | 14 | 0.994 | 6.5 | 21.5 | 0.0232 | 2.865 | 6.3 |
| Syngnathidae | *Hippocampus* spp. | odd | 9 | 0.882 | 7.0 | 13.0 | 0.0004 | 4.120 | 36.1 |
| Synodontidae | | cylindrical | 1188 | 0.988 | 4.0 | 33.0 | 0.0089 | 3.028 | 15 |
| | *Saurida* spp. | cylindrical | 1038 | 0.986 | 4.8 | 33.0 | 0.0080 | 3.059 | 9.1 |
| | *Saurida gracilis* | cylindrical | 95 | 0.991 | 4.8 | 23.0 | 0.0066 | 3.165 | 10.1 |
| | *Saurida nebulosa* | cylindrical | 11 | 0.996 | 8.0 | 18.5 | 0.0058 | 3.214 | 6.8 |
| | *Saurida undosquamis* | cylindrical | 932 | 0.976 | 6.5 | 33.0 | 0.0063 | 3.134 | 9.2 |
| | *Synodus* spp. | cylindrical | 145 | 0.980 | 4.0 | 22.0 | 0.0085 | 3.078 | 16.1 |
| | *Synodus dermatogenys* | cylindrical | 43 | 0.984 | 8.0 | 16.5 | 0.0047 | 3.346 | 8.9 |
| | *Synodus hoshinonis* | cylindrical | 45 | 0.965 | 9.0 | 19.0 | 0.0018 | 3.662 | 11.6 |
| | *Synodus variegatus* | cylindrical | 37 | 0.992 | 5.0 | 22.2 | 0.0031 | 3.484 | 10.6 |
| Teraponidae | *Terapon jarbua* | cylindrical | 87 | 0.988 | 2.0 | 28.5 | 0.0132 | 3.131 | 10.8 |
| Tetraodontidae | | odd | 282 | 0.993 | 2.0 | 76.0 | 0.0397 | 2.788 | 20.8 |
| | *Arothron* spp. | odd | 96 | 0.996 | 2.5 | 76.0 | 0.0352 | 2.901 | 12.5 |
| | *Arothron hispidus* | odd | 19 | 0.997 | 6.5 | 52.0 | 0.0634 | 2.756 | 10.4 |
| | *Arothron immaculatus* | odd | 10 | 0.993 | 4.0 | 32.5 | 0.0351 | 2.845 | 19.8 |
| | *Arothron manillensis* | odd | 32 | 0.992 | 3.5 | 33.0 | 0.0299 | 2.907 | 13.8 |
| | *Arothron stellatus* | odd | 24 | 0.998 | 5.0 | 75.0 | 0.0915 | 2.672 | 8.6 |
| | *Canthigaster* spp. | odd | 87 | 0.947 | 2.0 | 9.5 | 0.0424 | 2.822 | 10.0 |
| | *Canthigaster solandri* | odd | 10 | 0.990 | 3.0 | 7.5 | 0.0299 | 2.979 | 10.1 |
| | *Canthigaster valentini* | odd | 66 | 0.915 | 2.0 | 8.6 | 0.0367 | 2.943 | 20.9 |
| | *Lagocephalus sceleratus* | cylindrical | 94 | 0.997 | 9.0 | 72.0 | 0.0182 | 2.924 | 11.8 |
| Trichiuruidae | *Trichiurus lepturus* | elongated | 105 | 0.974 | 18.0 | 110.5 | 0.0002 | 3.324 | 12.3 |
| Trypauchenidae | *Ctenotrypauchen microcephalus* | semi-elongated | 23 | 0.898 | 4.5 | 11.5 | 0.0144 | 2.568 | 13.7 |
| Zanclidae | *Zanclus cornutus* | very-flat | 11 | 0.985 | 6.5 | 15.0 | 0.0147 | 3.370 | 2.0 |