The morphological traits of 1203 selected species were analysed.

**Results and Discussion**

Evaluate the relative importance of each predictive variable. A sensitivity analysis of the neural network model was conducted to evaluate general behaviour of experimental data. The model results reacted in a similar way when the warp length/depth or towing speed was changed. We found the average relative difference to be less than 11% between model results and experimental data.

**Figure 1**: Horizontal door spread HDS (m) and total drag TD (kg) as a function of towing speed V (kn). Solid line/dashed line from results of the model and diamonds/stars from experimental data (WL450/WL200 resp.).

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**References**


**LINKING SHAPE, TAXONOMY AND FUNCTION IN TELEOST FISH: A MACHINE LEARNING APPROACH**

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**1. Introduction**

Teleosts, with an estimated 23,600 extant species [1], are the most diverse group of vertebrates. Teleosts have a great taxonomic diversity which is accompanied by a wide variety of morphological patterns and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2]. The form constrains the use of resources and adaptations to different freshwater, brackish, and marine habitats all over the world [2].

**2. Results and Discussion**

The morphological traits of 1203 selected species were analysed with two types of statistical comparative and quantitative analysis: the geometric morphometry and the artificial neural networks (ANN) (Multilayer Perceptron). The ANN training was performed using the most common training algorithm, i.e. the error back-propagation algorithm. The best architecture of the ANN was empirically defined after a set of test runs in which different numbers of hidden layers and nodes were used. The final ANNs, had 38+n input nodes (19 x y landmarks coordinates + n grouping variables), 20 nodes in the hidden layer and n output nodes (n grouping variables) [5]. For each species a total number of 19 landmarks were identified (Fig. 1) as reported by Costa and Cataudella (2006). Landmarks are defined as homologous points which bear information on the geometry of biological forms [6]. Points were digitized using the software TPSdig [7] applied to the left side of each specimen.

Results on the relationship between body shape and phylogeny show their co-variation according to morpho-functional aspects described by Webb [8]. ANN sensitivity analysis on the taxonomical order suggests that this variable is especially influenced by the relative position of three morphological characters: the pectoral, the dorsal and the anal fins (Fig. 2).
Body shape differences between groups were visualized and described through the deformation grids (splines). Figure 3 shows the splines of the extreme values of CAN1 of Canonical Variates Analysis (CVA) of the Ecology variable. The spline of the negative side of CAN1 axis (left side of Fig.3) corresponds to a pelagic fish: this shape has a narrower and longer body, a larger mouth gap and a longer and narrower caudal peduncle. The spline of the positive side of CAN1 (right side of Fig.3) corresponds to a reef-associated fish with a shorter body, a narrower mouth gap and a shorter caudal peduncle.

3. Conclusions
This study suggests: 1) the use of new tools to understand phylogenetic relationships of Teleosts based on a morpho-functional approach. 2) at a larger scale a non phylogenetically based relationships between shape and ecology in Teleosts. Among the potential applications of this study the most promising is probably the automatic recognition of fish shapes in filed conditions, e.g. for monitoring fish assemblage composition.

4. References