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A MACHINE LEARNING APPROACH TO THE STUDY OF A RED CORAL *CORALLIUM RUBRUM* (L.) POPULATION

UN'APPLICAZIONE DEL MACHINE LEARNING PER LO STUDIO DI UNA POPOLAZIONE DI CORALLO ROSSO CORALLIUM RUBRUM *(L.)*

Abstract *– This study deals with the application of a machine learning algorithm (a classification tree) to assess the weight of* Corallium rubrum *(Cnidaria, Octocorallia) ramifications on the basis of the number of apices. Our approach can be easily applied to obtain in situ estimates of weight and basal diameter of colonies. Future developments include the integration with image acquisition and processing hardware.*

Key-words: Corallium rubrum, *biometry, machine learning.*

Introduction – Due to their trophic role, biomass and biogenic activities, long-lived species play a major role in benthic marine ecosystems (Garrabou & Harmelin, 2002).

The Mediterranean red coral (*Corallium rubrum* (L.) is certainly among these species, but it is also a heavily exploited species (Santangelo *et al.*, 2007). This study aims at using red coral colonies as models for searching a non-destructive method for the assessment of weight and basal diameters of the ramifications based on the number of apices, using a machine learning approach (Fielding, 1999). This could be helpful for registered divers in order to prevent fishing colonies below the legal size.

Materials and methods – The study area is located 7 nm SSW of Alghero (Italy) (40° 23.668' N - 8° 13.418' E) at a depth of nearly 120 m. The fishing grounds of this area were already investigated (Cudoni & Chessa, 1991). The coral was fished by a registered professional diver. 123 colonies were used for model calibration, 63 for validation only. Linear models were computed for the following relationships: wet weight (W) *vs.* basal diameter (D), basal diameter *vs.* number of apices (A) and wet weight *vs.* number of apices. A Classification Tree (Breiman *et al.*, 1984) was then trained to predict wet weight on the basis of the number of apices. This method allows to overcome some limitations that may hinder statistical models (e.g. normality, linearity, etc.).

Results – The correlation between W and A was quite good (r=0.77**), while the one between D and A was somewhat weaker (r=0.50**). This could be due to the fact that the W *vs.* A correlation depends on colony shape, which in turn depends on D. This means that the relation that links A to the other parameters is not a simple one. The log-log linear correlation between W and D ($W=0.4634 \cdot D^{1.9125}$, MSE=369.2) (Fig. 1), was a rather good one. According to it, the ramifications that can be fished on the basis of local regulations are those with a minimum weight of 37.9 g (10 mm diameter). Colonies of 24.7 g (8 mm diameter) can be fished with some limitations. The correlation between predicted and observed wet weight, based on the validation set, was r=0.76**, thus showing that using A to assess W was a viable solution for red coral colonies. Using the

Classification Tree (see a sample branch in Fig. 2) not only provided slightly better weight estimates (MSE=355.7), but it also allows obtaining those estimates with no calculations, using a simple table. For instance, the expected weight of a colony with 18 apices is 26 g (see second "leaf" from left in Fig. 2) and therefore its expected basal diameter is larger than 8 mm (see Fig. 1). This way even a diver in action can easily decide whether a colony can be harvested or not.

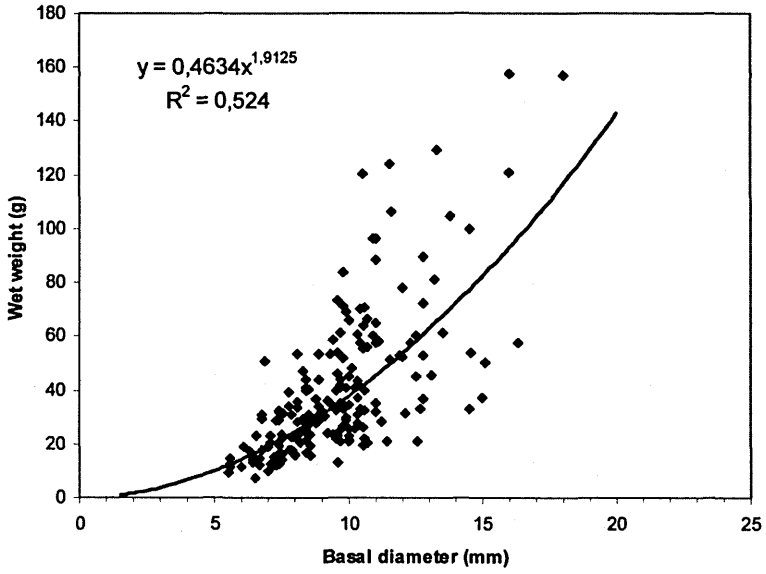

Fig. 1 - Regression of wet weight *vs.* basal diameter.
Regressione del peso umido sul diametro basale.

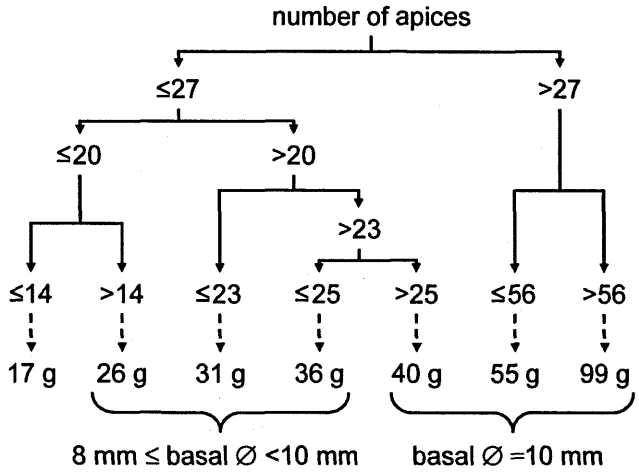

Fig. 2 - A Classification Tree that predicts the weight of red coral colonies on the basis of the number of apices.
Un Classification tree che predice il peso delle colonie di corallo rosso sulla base del numero di apici.

Conclusions – Our approach makes it possible to define a simple table that summarizes the apices *vs.* weight *vs.* basal diameter relationships, thus supporting the diver's decision about which colonies can be harvested according to Sardinian regulations. This Machine Learning approach can be easily improved in case more predictive information is used (eg. exposition; depth; local ecological conditions). In particular, future work will be aimed at refining the Classification Tree for small colonies because the basal diameter estimates are critical for colonies that are close to the lower size limit for legal harvesting. Moreover, we aim at integrating our approach into a complete hardware solution for underwater image acquisition and real time processing.

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