PHENOTYPIC VARIATIONS IN SINGLE STOCK WRECKFISH, *POLYPRION AMERICANUS* (TELEOSTEI: POLYPRIONIDAE) FROM THE NORTH EAST ATLANTIC

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With 3 figures, 2 tables and 1 appendix

ABSTRACT. The wreckfish *Polyprion americanus* (SCHNEIDER, 1801) has a wide distribution in both Eastern and Western sides of the Atlantic Ocean. Recent DNA analysis revealed a single stock of the species for the North Atlantic.

This study uses 10 morphometric measurements taken from fish collected from the Madeira Archipelago, the Azores Archipelago, mainland Portugal and North of Africa (Morocco) to determine morphological differences among the fish populations.

Principal component analysis of variance shows no significant variability in morphometric characters among the samples, complementing genetic evidence which also indicates a lack of population structure in North Atlantic wreckfish. The morphometric analyses employed here are useful suplementary data for the discrimination of wreckfish populations.

INTRODUCTION

The wreckfish, *Polyprion americanus* (SCHNEIDER,1801), is a heavy-bodied teleost with a worldwide distribution in temperate and subtropical sea waters.

In the Western North Atlantic, off the Southeastern United States, only large mature fish are caught from deep water aggregations (SEDBERRY *et al*., 1994). Wreckfish spawn off the southeastern U.S. in winter, but juveniles in that area are very rare. The juvenile fish are commonly seen drifting under floating wrecks in the eastern part of the ocean, ranging from Ireland (ROBERTS, 1977), down to Madeira Archipelago (NORONHA and SARMENTO, 1948). Juveniles at the surface are generally under 450 mm length and may be over one year old (ANDRADE, personal observation).

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It seems that North Atlantic currents would disperse the pelagic juveniles from western spawning grounds to eastern latitudes. As a consequence of this assumption there should be no genetic differentiation within North Atlantic wreckfish populations. Evidence to support this hypothesis came from recent preliminary mitochondrial DNA analysis showing no stock separation for wreckfish from off United States, Azores Archipelago and Madeira Archipelago (SEDBERRY *et al*., 1994), but differences between North and South Atlantic separate fish from these two areas.

Morphometric variability is a common and helpful tool to investigate the identification of stocks. Once the size based effects are ruled out, biometric data will reflect intraspecific variations due to geographic, ontogenic, sexual and individual genetic differences (ELLIS and SHACKLEY, 1995). Even within fish species genetically homogeneous phenotypic variation has been found allowing for separation of specimens from different groups or populations (ELLIOT *et al*., 1995; LESLIE and GRANT, 1990; ROBY *et al*., 1991).

The objective of the present work is to use morphometric characters to describe the population structure of wreckfish from Northeastern Atlantic, comparing groups of fish from Madeira and the Azores Archipelagos and the boundary areas of the North Atlantic current, namely mainland Portugal and Morocco. Primarly we examined the morphological variability between groups of fish. If confirmed, the diferences could then be assessed to identify fish from the areas of the study, and to possibly detect separate spawning stocks that could not be detected with genetic methods.

METHODS

Fish were collected from commercial landings at the fishing piers of Funchal, Madeira (118 fish), from February 1993 to September 1995, and Lisbon on September 1995 (the latter sampling including 48 fish from Mainland Portugal, 25 fish from the Azores and 28 fish from Morocco).

The body dimensions used to characterize the fish from the areas of study were: total length (TL), standard length (SL), fork length (FL), head length (HL), pre-dorsal length (PDL), pre-anal fin length (PAL), maximum width (BWmax), maximum heigth (BHmax), superior mandible length (UJL), inferior mandible length (LJL) and eye diameter (ED) as shown in Fig. 1. Measurements were taken from the left side of each specimen with BWmax measured with the fish laying on its back.

Since the morphometric characteristics tend to vary with the allometric growth of fish, the effect of size was eliminated by standardising each measurement according to the formula (*in* ELLIOT *et al*., 1995),

$$Ms = Mo\ (Ls/Lo)b,$$

where, Ms is the standardised measurement, Mo the measured character, Ls the mean standard

length of fish from all of the samples, Lo the standard length of the specimen, b the slope estimated from the regression of log-Mo on log-Lo.

In order to eliminate the influence of first maturation on the characters selected for the study, all the individuals sampled were mature fish. Wreckfish mature at standard length over 400 mm, according to the sampling carried out in Madeira.

Prior to the analysis all the measurements were transformed to natural logarithms. The regressions of each of the characters on the standard length was calculated and the allometric equations compared for differences. The effects of sample size on the standardised measurements was examined by univariate analysis of variance ANOVA and significant differences for each measurement between fish samples checked by pairwise multicomparison *t*-test. Principal Component Analysis (PCA) of variance - covariance was performed to determine the 3 combination characters capable of identifying fish from the sampled groups (following ROHLF, 1993). Statistical analysis were performed with SigmaStat and NTSYS - pc software packages.

RESULTS

Most of the characters for all 4 samples have shown a significant positive correlation with the standard length. The exceptions were the measurements BWmax, BHmax and ED (Table 1).

Significant statistical diferences ($P<0.05$) were found in the mean values for each standardised measurement (Appendix 1) among samples with the exception of measurement BHmax, although for a @=0.28. Multiple *t*-test comparisons repeatedly differentiated Madeira data (other than BHmax) from all the other sampling areas (Table 2). Characters BWmax and ED were the two measurements that have shown variability among most groups and could eventually be tested to identify specimens from the different groups. In BWmax no variability was found for Mainland Portugal and Morocco fish. While in ED measurements there was no difference for mainland Portugal and the Azores specimens.

PCA of the variance covariance matrix extracted the 3 factors that explained the variance among samples (Fig. 3). Factor 1 selected is ED, factor 2 includes a combination of most variables related with growth and factor 3 selected is FL, a variable often associated with measurement errors. This analysis was not successful in grouping the fish originated from distinctive sampling areas (Fig. 4).

DISCUSSION

Most of the measurements used in the present study except for BWmax, BHmax (determined by the condition of the fish) and ED definitely have shown a strong size-based relationship.

Despite univariate ANOVA suggesting distinctive phenotypical characteristics for Madeira fish in general, these results should be analysed caustiously due to sampling effects. The specimens were collected year round thereby allowing for high standard variations of each variable due to the condition of fish, sexual maturation and environmental changes. Different log-log regressions of PDL and PAL on the standard length for Madeira specimens may also be due to seasonal variations and defficient handling procedures as well.

From PCA it is possible to conclude that wreckfish from Madeira, mainland Portugal, Açores, and Morocco present some morphometric differences but not enough to identify fish from a particular site. This supports the suggestion that the influx of drifting juvenile fish to these areas contribute to their genotypic similarities. Although wreckfish is common and reported to spawn in the Mediterranean sea (BINI, 1968) there is no evidence of gene flow to the populations of mainland Portugal and Morocco. Preliminary DNA analysis - based on 6 samples - indicates perhaps a separate stock of wreckfish in the Mediterranean with some influx of Atlantic fish, although Atlantic genotypes do occur in the Mediterranean (SEDBERRY, unpublished data).

The morphometric characters used in this study - with the exception of FL - can be subsequently used to point the phenotypic similarities/differences among wreckfish population or groups and contribute to the knowledge of the stock structure of this species. A fairly good knowledge of the biology of the species (reproduction season, migration/drifting patterns) in each area is needed to achieve certainties from the conclusions taken from this type of study.

ACKNOWLEDGEMENTS

We would like to thank CITMA for sponsoring the participation of M.E. PEREIRA DE GOUVEIA in the Conference.

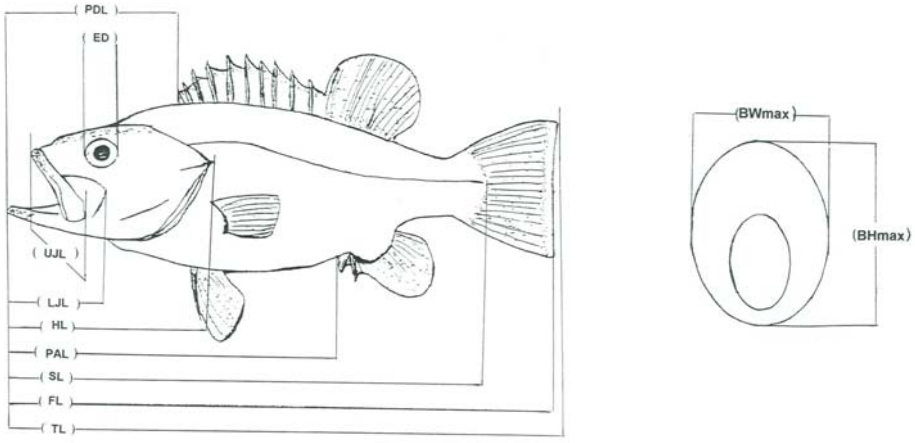


Fig. 1 - Body measurements (variables) taken from wreckfish, *P. americanus*.

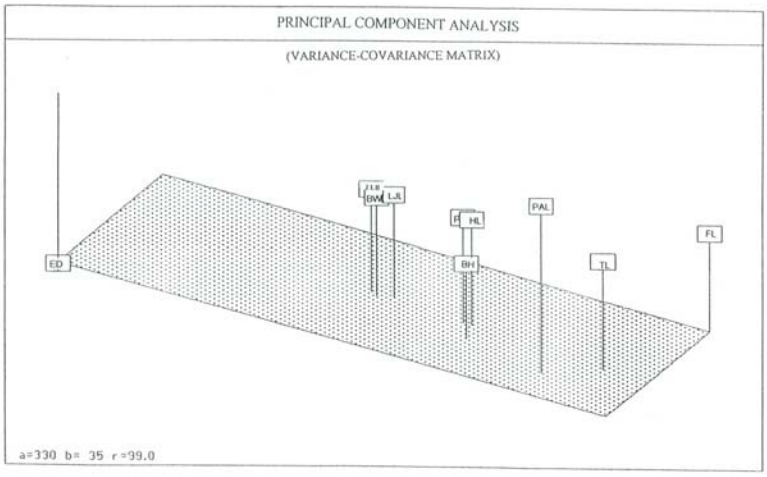


Fig. 2 - Plot of the three principal component axes selected to discriminate the wreckfish from the different areas of study.

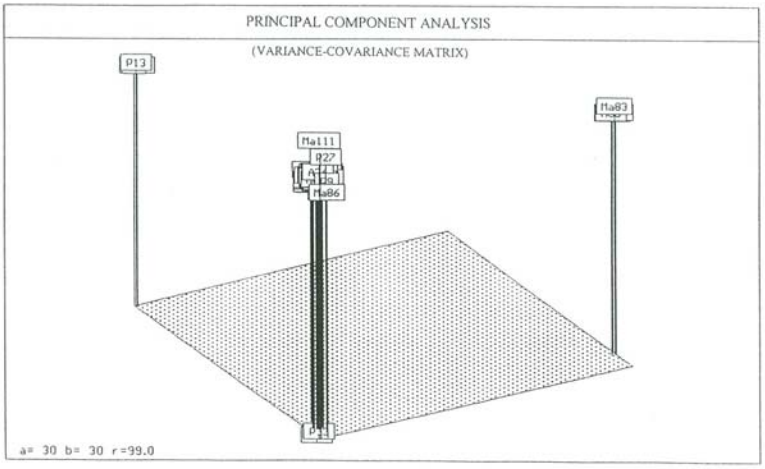


Fig. 3 - Principal component analysis carried out for the wreckfish from the different areas of study. This analysis was unable to distinguish fish according to their origin.

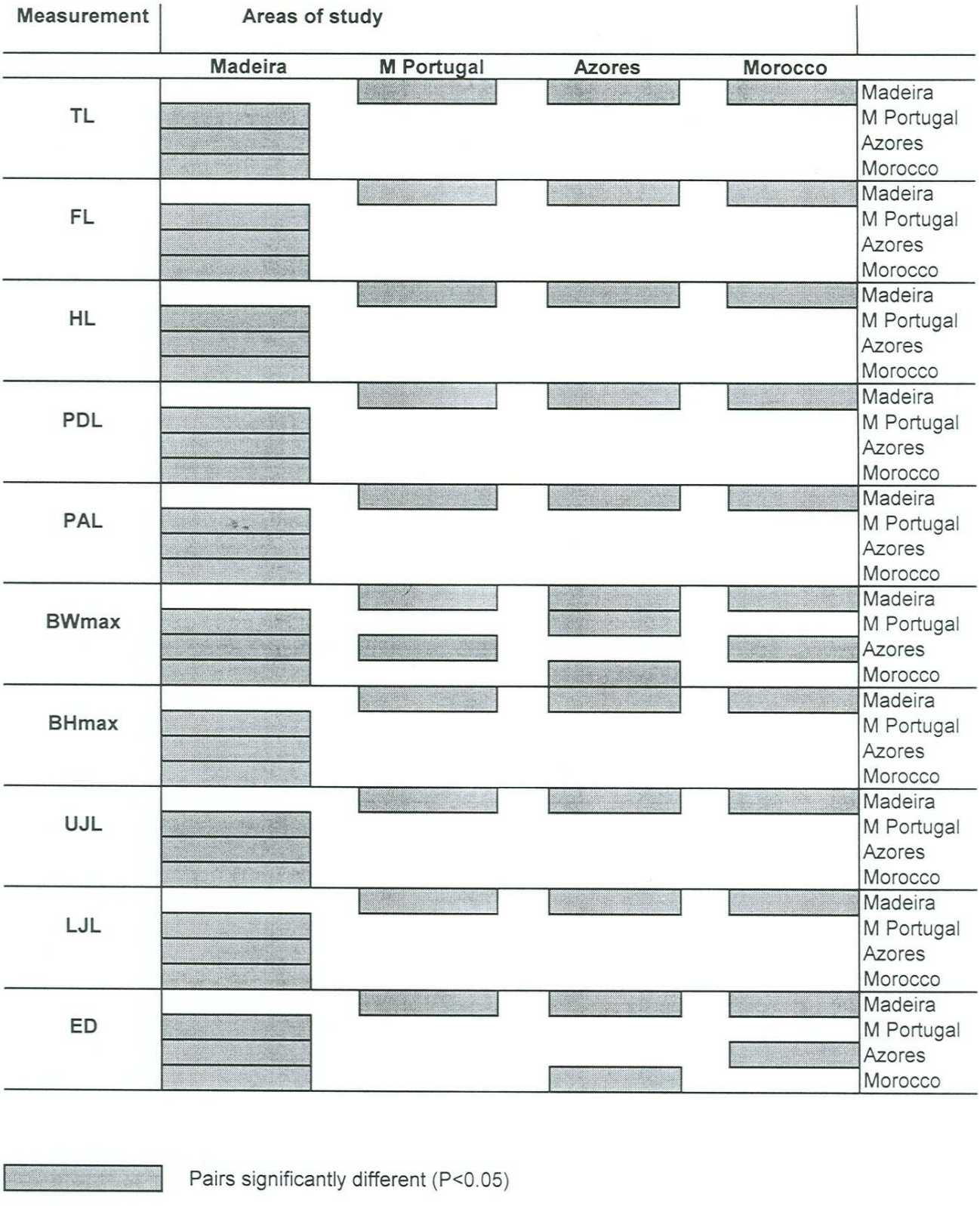
Measurement	Mean / ± standard deviation (mm)							
	Madeira		M Portugal		Azores		Morocco	
TL	699.3	23.9	629.8	6.4	631.5	5.6	627.6	6.4
FL	677.8	26.9	620.4	6.5	622.9	4.3	616.8	5.5
HL	229.9	15.1	209.0	7.3	205.4	8.8	207.1	5.4
PDL	218.0	15.3	193.7	7.0	191.0	7.7	190.8	5.9
PAL	409.7	29.4	388.2	20.3	392.9	9.6	384.9	9.1
Bwmax	111.6	10.4	87.5	9.0	96.8	7.5	87.1	5.2
BHmax	214.2	16.4	219.4	12.9	222.3	12.3	216.5	8.1
UJL	99.2	10.5	91.7	3.4	92.2	3.4	92.0	2.1
LJL	130.6	13.5	98.9	3.9	98.3	3.0	99.8	3.2
ED	38.4	6.7	28.2	2.4	27.3	2.1	28.8	1.4

Appendix 1 - Mean and standard deviation for the 10 variables of wreckfish, *P. americanus*

TABLE 1 - Allometric equations (log variable on log standard length) for wreckfish, *P. americanus*.

Measure	Madeira		M Portugal		Azores		Morocco		*t - test*
	Allometric equation	r	Allometric equation	r	Allometric equation	r	Allometric equation	r	P
TL	log y = 0,16 + 0,98 log x	0.98	log y = 0,01 + 1,02 log x	1.00	log y = 0,05 + 1,00 log x	0.99	log y = 0,06 + 1,00 log x	0.99	0.0001
FL	log y = 0,34 + 0,91 log x	0.96	log y = 0,10 + 0,98 log x	1.00	log y = 0,12 + 0,97 log x	1.00	log y = 0,11 + 0,98 log x	1.00	0.0003
HL	log y = - 0,45 + 1,02 log x	0.94	log y = - 0,46 + 1,01 log x	0.98	log y = - 0,74 + 1,11 log x	0.91	log y = - 0,15 + 0,90 log x	0.97	< 0,0001
PDL	log y = - 0,55 + 1,05 log x	0.93	log y = - 0,32 + 0,95 log x	0.98	log y = - 0,51 + 1,02 log x	0.91	log y = - 0,16 + 0,89 log x	0.95	< 0,0001
PAL	log y = 0,13 + 0,91 log x	0.89	log y = - 0,42 + 1,10 log x	0.96	log y = 0,19 + 0,87 log x	0.96	log y = - 0,39 + 1,09log x	0.98	< 0,0001
BWmax	log y = - 0,45 + 0,91 log x	0.85	log y = - 0,76 + 0,98 log x	0.87	log y = 1,08 + 0,33 log x	0.45	log y = - 0,23 + 0,79 log x	0.79	< 0,0001
BHmax	log y = - 0,06 + 0,87 log x	0.82	log y = - 0,32 + 0,97 log x	0.95	log y = - 0,10 + 0,89 log x	0.81	log y = - 0,03 + 0,86 log x	0.90	< 0,0001
UJL	log y = - 0,89 + 1,05 log x	0.96	log y = - 0,89 + 1,04 log x	0.98	log y = - 0,75 + 0,99 log x	0.92	log y = - 0,80 + 1,01 log x	0.97	< 0,0001
LJL	log y = - 0,64 + 1,00 log x	0.96	log y = - 0,93 + 1,07 log x	0.98	log y = - 0,77 + 1,01 log x	0.95	log y = - 0,70 + 0,98 log x	0.95	< 0,0001
ED	log y = - 1,02 + 0,95 log x	0.86	log y = - 0,70 + 0,78 log x	0.88	log y = - 1,38 + 1,03 log x	0.75	log y = - 0,46 + 0,69 log x	0.85	< 0,0001

TABLE 2 - Results of the pairwise multiple comparison t-test for the areas of study.



REFERENCES

BINI, G.:

1968. *Atlante dei pesci delle coste italiane*. Osteitti, **4**, Ed. Mondo Sommerso, Roma.

ELLIOTT, N.G., K. HASKARD AND J.A. KOSLOW:

1995. Morphometric analysis of orange roughy (Hoplostethus atlanticus) off the continental slope of southern Australia. *J. Fish. Biol*., **46**: 202-220.

ELLIS, J.R. AND S.E. SHACKLEY:

1995. Ontogenic changes and sexual dimorfism in the head, mouth and teeth of the lesser spotted dogfish. *J. Fish. Biol*., **47**: 155-164.

LESLIE, R.W., AND W.S. GRANT:

1990. Lack of congruence between genetic and morphological stock structure of the southern African anglerfish *Lophius vomerinus*. *South African Journal of Marine Science* **9**: 379-398.

NORONHA, A.C. AND A.A. SARMENTO:

1948. *Vertebrados da Madeira. Peixes*, **2**, Ed. Junta Geral do Distrito do Funchal.

ROBERTS, C.D.:

1977. The wreckfish *Polyprion americanus* (Schneider, 1801) in Irish waters: an underwater sighting and review of the Irish records. *Ir. Nat. J*., **19**: 108-112.

ROBY, D., J.D. LAMBERT AND J.M. SEVIGNY:

1991. Morphometric and electrophoretic approaches to discrimination of capelin (Mallotus villosus) populations in the Estuary and Gulf of St. Laurence. *Canadian Journal of Fisheries and Aquatic Sciences* **48**: 2040-2050.

ROHLF, F.J.:

1990. *NTSYS-pc Numerical taxonomy and multivariate analysis system (version 1.60)*. Ed. Exeter Software, New York.

SEDBERRY, G.R., D.M. WYANSKI AND C. ANDRADE:

1994. The role of the Gulf Stream in the zoogeography of the wreckfish, *Polyprion americanus* (TELEOSTEI: POLYPRIONIDAE). *1st Biennial Conference on Southeast Coastal Ocean Research*. "Interactions Across Boundaries". Program & Abstracts: 25.

SEDBERRY, G.R., G.F. ULRICH AND A.J. APPLEGATE:

1994. Development and status of the fishery for wreckfish *(Polyprion americanus)* in the southeastern United States. *Proc. Gulf Carib. Fish Inst*., **43**: 168-192.