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Zoologia Caboverdiana é uma revista científica com arbitragem científica (*peer-review*) e de acesso livre. Nela são publicados artigos de investigação original, artigos de síntese e notas breves sobre Zoologia, Paleontologia, Biogeografia, Etnozoologia e Conservação nas ilhas de Cabo Verde. Também publicamos artigos originais ou de revisão de uma área geográfica mais ampla desde que debruçados sobre espécies que ocorrem no arquipélago de Cabo Verde.

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Nota editorial

A ciência importa

Neste difícil momento em que enfrentamos uma pandemia, aprendemos a relativizar o que é importante e cresceu a esperança que esta aprendizagem se vincule nas sociedades humanas ditas desenvolvidas. Nestes meses passados apercebemo-nos do valor da saúde, da educação e da compaixão. Aprendemos ainda a reconhecer a ciência como uma parte vital para a solução deste problema. E para a ciência, todo o conhecimento é válido e insuspeito da sua importância futura. Como resultado, esta pandemia reforçou a vontade em manter viva a única revista científica com revisão por pares do país.

Neste número temos dois artigos e uma nota breve. O primeiro artigo, intitulado "*A condição corporal da tartaruga-comum* Caretta caretta *nidificante em Cabo Verde é independente do sucesso reproductor*", resume a variação da massa corporal e do tamanho das fêmeas desta espécie ao longo de quatro épocas de nidificação. Este estudo mostra a necessidade de aprofundar os estudos sobre esta subpopulação Em Perigo dadas as diversas possíveis explicações para a relação não linear entre a condição corporal e o tamanho das fêmeas, bem como para o aumento da massa corporal durante a época de nidificação. Adicionalmente, a relação entre a condição corporal e o sucesso reprodutor parece inexistente, fazendo duvidar, pelo menos, do uso generalizado destes índices de condição corporal.

O segundo artigo refere-se à "*Ética e Biodiversidade: enquadramento teórico da relevância da disciplina para os PALOP"* e revela a necessidade da integração desta unidade curricular nos cursos de pós-graduação nos países africanos de expressão portuguesa para a consecução dos Objectivos de Desenvolvimento Sustentável da Agenda 2030 das Nações Unidas. Este estudo, um dos primeiros da área a ser publicado nesta revista, mostra uma significativa ausência de formação em ética ambiental nos PALOP, necessária para que a estruturação mental que dá proeminência ao valor intrínseco dos ecossistemas naturais seja consolidado.

A nota breve descreve o "*Primeiro avistamento confirmado de uma orca anã* Feresa attenuata *ao largo de Cabo Verde*". Dada a dificuldade em distinguir esta espécie do golfinho-cabeça-de-melão no mar e à falta de registos fotográficos dos passados arrojamentos de cetáceos no arquipélago, este é o primeiro registo oficial da orca anã no país. É também um dos poucos registos desta baleia pouco conhecida nesta zona do Atlântico.

Por último, queria agradecer aos 14 autores, seis revisores e aos dois colegas editores que acreditam que a ciência que se publica em pequenas revistas importa e que permitiram que este número fosse publicado. A eles e a vós, votos de muita saúde!

Doutora Raquel Vasconcelos
Editora-chefe da *Zoologia Caboverdiana*

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Editorial note

Science matters

In this difficult moment in which we are facing a pandemic, we have learned to relativise what is important, and the hope that this learning lingers in the so-called developed human societies has grown. In the past few months we have realized the value of health, education and compassion. We have also learned to recognise science as a vital part for solving this problem. And for science, all knowledge is valid and unaware of its future importance. As a result, this pandemic has strengthened the desire to keep alive the only peer-reviewed scientific journal in the country.

In this issue we have two articles and a short note. The first article, entitled '*Body condition of loggerhead turtles* Caretta caretta *nesting in Cabo Verde is independent of their reproductive output'*, summarizes the variation in body mass and size of females of this species over four nesting seasons. This study shows the need to deepen studies on this Endangered subpopulation given the several possible explanations for the non-linear relationship between body condition and the size of the females, as well as for the increase in body mass during the nesting season. Additionally, the relationship between body condition and reproductive success seems to be lacking, making it doubtful, at least, the widespread use of these body condition indices.

The second article refers to '*Ethics and Biodiversity: theoretical framework of the its disciplinary relevance for the PALOP countries*' and reveals the need for the integration of this curricular unit in postgraduate courses in Portuguese-speaking African countries in order to achieve the Sustainable Development Goals of the United Nations 2030 Agenda. This study, one of the first in the field to be published in this journal, indicates a significant lack of training in environmental ethics in the PALOPs, required for the mental structure that gives prominence to the intrinsic value of natural ecosystems to be established.

The brief note describes the '*First confirmed sighting of pygmy killer whale* Feresa attenuata *off Cabo Verde*'. Given the difficulty in distinguishing this species from the melon-headed whale at sea, and the lack of photographic records of the past strings of cetaceans in the archipelago, this is the first official record of the pygmy killer whale in the country. It is also one of the few records of this scarcely known whale in this region of the Atlantic.

Finally, I would like to thank to the 14 authors, six reviewers and two fellow editors who believe that science published in small journals matters and who allowed this issue to be published. To them and to you, my best wishes!

Raquel Vasconcelos, PhD
Editor-in-chief of *Zoologia Caboverdiana*

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Artigo original | Original article

Body condition of loggerhead turtles *Caretta caretta* nesting in Cabo Verde is independent of their reproductive output

Ariete Pina [1], Samir Martins [1], Mara Abu-Raya [2] & Adolfo Marco [3,*]

[1] BIOS.CV, Sal Rei, Boavista, Cabo Verde
[2] Faculdade de Ciências e Tecnologia, Universidade de Cabo Verde, Palmarejo, CP 279, Praia, Cabo Verde
[3] Estación Biológica de Doñana, CSIC, Sevilla, Spain

**Corresponding author e-mail: amarco@ebd.csic.es*

RESUMO

A condição corporal das fêmeas adultas geralmente é um bom indicador da saúde das populações, especialmente importante em espécies ameaçadas. Este parâmetro e a relação deste com o sucesso reprodutor foram estudados na subpopulação Em Perigo da tartaruga-comum *Caretta caretta* do Nordeste Atlântico nidificante em Cabo Verde. O estudo de campo foi realizado durante quatro épocas completas de nidificação entre 2013 e 2016. Um total de 318 fêmeas marcadas foram estudadas. A massa corporal e o comprimento curvo da carapaça variaram de 42–116 kg e 73–99 cm, respectivamente. Apesar do pequeno tamanho corporal e da dieta pelágica de muitos indivíduos, todas as fêmeas apresentavam um índice de condição corporal relativamente elevado, 1,49 10^{-4} kg/ cm^3 em média. Foi detectada uma relação fraca e não linear do tamanho corporal na condição corporal (r^2= 0,18). Adicionalmente, a massa corporal média ao longo da temporada reduziu-se menos que o esperado e 28% das fêmeas aumentaram-na durante o período de nidificação. A condição corporal foi semelhante nos diferentes anos, sugerindo que fêmeas com boas condições corporais possam reproduzir-se a cada estação. Mas não houve influência da condição corporal na taxa reprodutora numa determinada estação nidificante, mostrando a necessidade de mais estudos.

Palavras-chave: ciclo de vida, conservação, Nordeste Atlântico, reprodução, massa corporal

ABSTRACT

The body condition of adult females is generally a good indicator of the physiological status of populations, especially important in threatened species. This parameter and its relationship with the reproductive output were studied in the Endangered loggerhead turtle *Caretta caretta* subpopulation of the Northeast Atlantic Ocean. The field study was conducted during four complete nesting seasons between 2013 and 2016. A total of 318 tagged females were studied. The body mass and curved carapace length varied from 42–116 kg and 73–99 cm, respectively. Despite the small body size and the oceanic diet of many individuals, all females had a relatively high body condition index, which averaged 1.49 10^{-4} kg/ cm^3. There was a weak and non-linear influence of body size on the body condition (r^2= 0.18). Furthermore, the reduction on mean body mass throughout the season was lower than expected and 28% of the females increased their body mass throughout the nesting period. The body condition was similar along the different years, suggesting that females with high body condition may breed every season. However, there was no influence of body condition in the reproductive output within a given season, showing the need of further studies.

Keywords: conservation, life cycle, Northeast Atlantic, reproduction

INTRODUCTION

Life history traits are constrained by the allocation of limited resources to multiple processes, generating life history trade-offs (Doughty & Shine 1997, Sinervo & Svensson 1998). Individuals better able to acquire or manage endogenous resources are expected to optimize these trade-offs more efficiently (Doughty & Shine 1997, Sinervo & Svensson 1998). A good external indicator of the energetic efficiency and nutritional status of many individuals is the body condition index, BCI (Schulte-Hostedde *et al.* 2001, 2005). A significant difference in the BCI among individuals of the same population is associated to changes in fitness in different vertebrates, including mammals (Schulte-Hostedde *et al.* 2001, 2005), amphibians (Lowe *et al.* 2006), birds (O'Dwyer *et al.* 2006) and reptiles (Willemsen & Hailey 2002, Litzgus *et al.* 2008). A wild animal with a good BCI reflects a better energetic status (Schulte-Hostedde *et al.* 2005). Furthermore, body condition is positively correlated with fecundity because energetic reserves limit the amount of energy that can be allocated to reproduction and can provide valuable information about fitness and health. This information can be especially relevant for threatened populations in order to identify priorities to improve conservation actions (Schulte-Hostedde *et al.* 2005).

Sea turtles can be sensitive to significant decrease of their body condition because they are highly migratory and do not reproduce every year (Bjorndal *et al.* 2003). Females concentrate their reproduction in specific years followed by non-nesting years, thus reducing the number of breeding migrations between their distant nesting and feeding grounds (Bjorndal *et al.* 2000, Marco *et al.* 2011).

Although the loggerhead turtle is considered Vulnerable as a species by the IUCN (Casale & Tucker 2017), the subpopulation reproducing in Cabo Verde is considered Endangered (Casale & Marco 2015) and one of the most threatened subpopulations in the world and the second most threatened in the Atlantic (Wallace *et al.* 2011). Additionally, the existence in this subpopulation of three different trophic phenotypes, including one type with a poor oceanic diet (Eder *et al.* 2012, Cardona *et al.* 2017, Cameron *et al.* 2019), makes it very interesting to determine the influence of the

type and quality of diet and trophic habitat in the body condition and reproductive output.

The main goal of the present study was to evaluate the body condition of nesting females of the Northeast Atlantic subpopulation of loggerhead turtles in order to estimate their physiological status and the relationship with their reproductive output.

MATERIAL AND METHODS

The study was conducted in the Northeastern Atlantic, on Boavista Island, Cabo Verde Archipelago (16°01'N; 22°44'W). Experienced researchers daily conducted nocturnal patrols on the southeastern beaches of João Barrosa (Turtle Nature Reserve) during four consecutive nesting seasons (from mid-June to mid-October, from 2013 to 2016). We identified and studied 318 females tagged with passive integrated transponders. Eighteen of these were studied in two different occasions during the same year. All selected females were retained *in situ* on the beach after nesting and weighted with a digital balance (PCE-ES300) with an accuracy of 0.05 kg. Sand was carefully removed from the carapaces to reduce bias in the body mass (BM) measures. Each female was wrapped in a sand-free net square (1.5 x 1.5 m), hooked to a balance and hung using a 2-meter carbon fibre bar supported horizontally by at least two field assistants. All the weighting process took less than 5 min per female without apparent damage to the turtles. The curved carapace length from the nuchal notch to the posterior notch (CCL) was measured with a plastic tape (± 0.5 cm).

The clutch size was counted in 206 egg masses during oviposition, and 96 of these were carefully extracted from the nest chamber immediately after egg laying. The eggs were carefully weighed within a fabric bag. The methodology of the relocation and study of eggs, incubation, and hatchlings was conducted following Marco *et al.* (2012b).

There are several methods to estimate BCI in sea turtles (Stevenson & Woods 2006, Li *et al.* 2015). Since we are studying an Endangered population, we selected a less invasive method than tissue/ blood collection based on the measurement of body length and mass (Green 2001), the Fulton's condition factor (Bolger & Conolly, 1989). We chose this BCI because of its simplicity and historical precedence (Stevenson & Woods 2006) and its previous use in sea turtles (Bjorndal *et al.* 2000, Seminoff *et al.* 2003). Several studies have correlated BCI with biochemical and physiological parameters (Barco *et al.* 2016, Stacy *et al.* 2018).

The BCI was calculated using Bjorndal *et al.* (2000)'s formula: BCI= (BM x 10000)/ SCL^3 (kg/ cm^3). Values of CCL were converted in straight carapace length (SCL) using a sample of 1067 females from Boavista, from whose both measurements (CCL and SCL) were taken, and the equation: SCL= 0.8456 x CCL + 5.6372 (Varo-Cruz *et al.*, 2007). For repeated measures, we used mean values of each variable in the population analysis. For each nest, we calculated a mean value for all used variables of eggs and hatchlings. We calculated descriptive statistics for all parameters. We compared pairs of continuous variables using Pearson correlation. We evaluated seasonal variation among years and fortnights using General Linear Model.

RESULTS

The mean BM of the loggerhead females was 63.3 kg and their mean CCL was 82.1 cm (Table 1). There was a strong correlation between BM and CCL ($r^2 = 0.80$, $p < 0.0001$, Fig. 1A). The correlation between SCL and CCL in the females were both measurements

were taken was statistically significant (r^2= 0.90, p< 0.0001). Over 99% of females had BCI larger than 1.2 and less than 22% of females had a BCI lower than 1.4. There was a weak though significant negative linear relationship between BCI and CCL (r^2= 0.05, p< 0.0001), and a significant and stronger non-linear correlation (r^2= 0.18, p< 0.0001), with medium-sized females presenting lower BCI than large and small ones (Fig. 1B).

Table 1. Descriptive statistics of the different parameters measured to females, clutches, eggs and hatchlings of the studied loggerhead turtle population. Mean values of eggs and hatchlings were calculated using mean values of each clutch. For females with several measurements, the mean value is provided. N stands for sample size, SD for standard deviation, Min for minimum, Max for maximum, BM for body mass, BCI for body condition index, and CCL/ SCL for curved/ straight carapace length, respectively.

	N	Mean	SD	Min	Max
Female CCL (cm)	315	82.14	4.70	73.0	99.0
Female BM (kg)	316	63.30	11.31	42.00	116.00
BCI (kg/cm^3)	315	1.49	0.13	1.16	1.99
Clutch size	195	82.4	17.0	22	138
Clutch mass (kg)	96	3.48	1.24	1.45	12.80
Egg diameter (mm)	80	38.92	2.19	32.64	42.79
Egg mass (g)	81	33.02	6.74	20.69	43.85
Hatchling SCL (mm)	58	42.62	1.26	39.53	45.79
Hatchling BM (g)	58	17.51	1.95	11.59	24.12

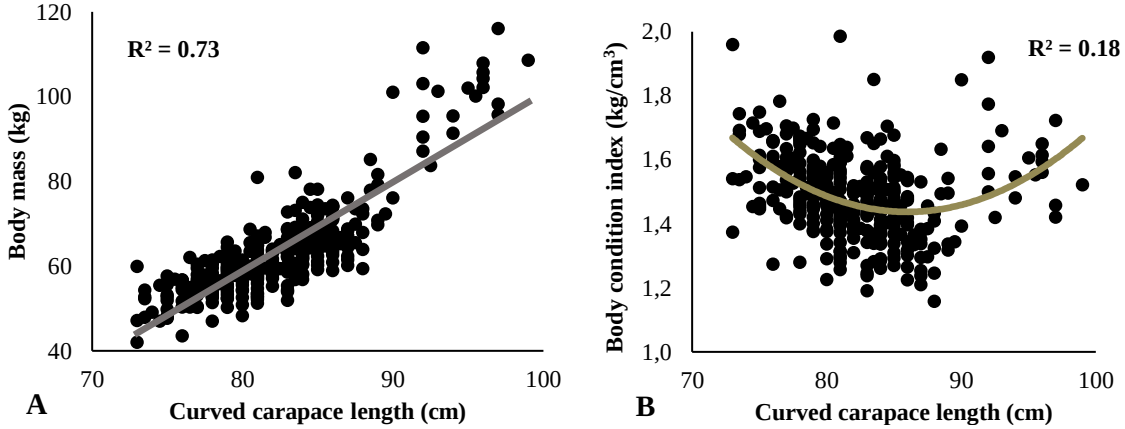

Fig. 1. Health status of loggerhead turtles nesting in Cabo Verde. **A**) Relationship between curved carapace length and body mass **B**) and body condition index. Values refer to four nesting seasons (2013–2016).

The mean annual BM varied from 60.8 to 69.3 kg (Table 2) and varied among years (ANOVA: $F_{(3,335)}$= 7.589, p< 0.001), but there was no significant difference in mean BCI among years (ANOVA: $F_{(3,333)}$= 1.501, p= 0.214). Thus, data from the four years were analysed together. There were significant differences in mean BM (ANOVA: $F_{(7,333)}$= 2.527, p= 0.015) and BCI (ANOVA: $F_{(5,323)}$= 3.070, p= 0.010) throughout the nesting season. BM varied from 67.3 kg in the first half of July to 59.1 kg in the second half of September. Mean BCI varied from 1.55 kg/ cm^3 in the first half of July to 1.46 kg/ cm^3 in

the second half of September (Fig. 2). The mean individual BM loss per 15 days was 0.53±0.33 kg, varying from -8.91 to 6.16, but 27.8 % of the females gained mass throughout the season.

Table 2. Body mass (BM) and curved carapace length (CCL) of loggerhead turtles from Cabo Verde in the four study years. N stands for sample size, SD for standard deviation.

	2013	**2014**	**2015**	**2016**
N	27	57	89	146
Average BM (kg)	69.31	63.30	66.47	60.78
SD	12.52	11.35	13.49	32.04
Minimum BM (kg)	43.50	48.25	46.95	42.00
Maximum BM (kg)	102.00	105.65	116.00	111.50
Mean CCL (cm)	84.36	76.89	77.82	76.24

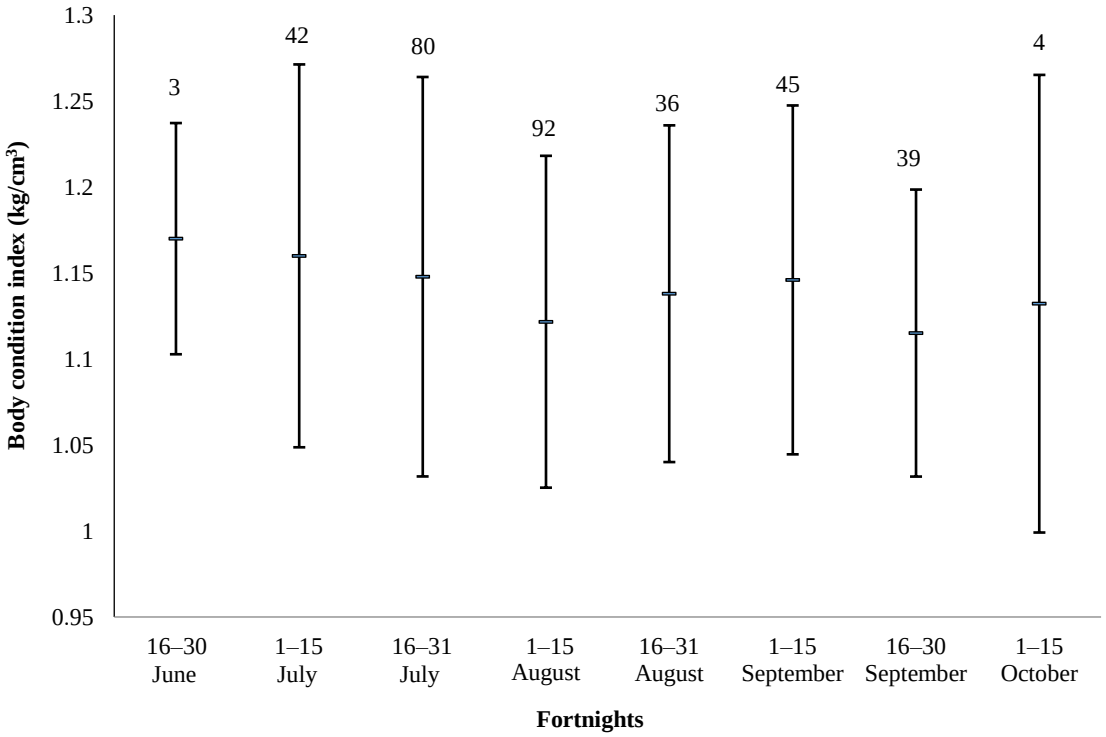

Fig. 2. Seasonal variation of the mean BCI index of loggerhead nesting in Cabo Verde. Each mean value of BCI correspond to data from the four study nesting seasons (2013–2016). The vertical bars indicate the standard deviation and the numbers over each bar correspond to the sample size.

The correlations between BCI and clutch size (r^2 = 0.01, p= 0.208, N= 206), egg mass (r^2= 0.00, p= 0.554, N= 83) and hatchling mass (r^2= 0.01, p= 0.512) were not significant (raw data available at https://figshare.com/articles/Pina_et_al_ZC_raw_data/12424343).

DISCUSSION

All females of the studied loggerhead turtle population of Boavista showed relatively high values for the BCI (e.g. Bjorndal *et al.* 2000, Seminoff *et al.* 2003, Barco *et al.* 2016, Stacy *et al.* 2018). These results suggest that nesting females have no nutritional problems and no difficulties to find food in their feeding grounds. Perhaps only adult females with large fat reserves migrate to Cabo Verde for nesting (Jessop *et al.* 2004). Females that do not get an optimal BCI would not begin the vitellogenesis process and would delay their reproduction remaining on their feeding grounds. On the other hand, adult females with poor BCI that try to nest could die during migration or immediately after the arrival to their nesting beaches. Several impacts threatening adult turtles in Cabo Verde, such as fishery bycatch (Coelho *et al.* 2015) or poaching on the beach (Marco *et al.* 2011, 2012a) may especially affect females with lower body condition. Moreover, we found no interannual variability in mean BCI of adult females. This result suggests that potential environmental differences among years in food availability to sea turtles could be affecting the mean BCI in the feeding ground and the percentage of females breeding in the next nesting season, but not the BCI of nesting females. Alternatively, the BCI could be a bad estimator of the physiological or health status of sea turtles (e.g. Flint *et al*. 2010). It would be very interesting to evaluate the variability of BCI of adults in feeding grounds to untangle this.

In oceanic females (< 85 cm CCL, Eder *et al.* 2012) there is a decrease of BCI with body length. Perhaps there is an ageing effect on the ability to maintain a good condition. However, neritic females (> 85 cm) have a better condition than large oceanic females. Heavier females have a larger reproductive output (Eder *et al.* 2012). However, body length only explained 4.8 % of variation in BCI. In this population, larger females have longer migration routes to rich neritic habitats, while smaller females feed in oceanic habitats between Cabo Verde and the continental African coast (Hawkes *et al.* 2006, Eder *et al.* 2012, Cameron *et al.* 2019). Migration has a significant energetic cost together with a higher risk and time cost (Bonte *et al.* 2012). Longer reproductive migrations for neritic females could consume higher amounts of energy counterbalancing the benefits of their better diet, explaining the hump-shaped curve in our results. Moreover, the remigration intervals could be also different as a function of body size. Larger females feeding in neritic habitats (Eder *et al.* 2012, Cardona *et al.* 2017, Cameron *et al.* 2019) could remigrate earlier having less time to store fat reserves, and thus, having similar body condition than smaller females with a poorer diet who could remain more years in the feeding grounds between consecutive breeding migrations.

The decline in BCI throughout the nesting season is likely caused by the successive egg depositions associated with a lack of feeding of females in the mating and nesting grounds (Hays *et al.* 2002, Santos *et al.* 2010, Vieira *et al.* 2014). Furthermore, their strong effort to come out to the beach, crawl on the sand, dig, and camouflage their nests involves a high energy and fat consumption. Vieira *et al.* (2014) showed that nesting females on Boavista in the beginning of the nesting season exhibited higher nucleic acid concentrations and better physiological condition than those sampled at the end of the season. This would explain why many females loose mass throughout the season. However, BM and BCI of some females are similar or even experiment an increase throughout the nesting season. These individual differences suggest the existence of different feeding strategies during the nesting season that should be explored. Moreover, the difference in mean BM across the nesting season corresponds to the mean mass of 2.4 nests of this population, but each female is laying an average of five nests per season in Cabo Verde (Varo-Cruz *et al.* 2007). A significant part of this difference in mass

could correspond to water added to the eggs by the females. However, the possibility of females feeding during the internesting periods may also explain this change.

CONCLUDING REMARKS

All adult females in the Endangered Northeast Atlantic loggerhead turtle subpopulation presented relatively high BCI despite the poor feeding habitat. The reduction on mean BM throughout the season was much lower than expected. Body condition was similar across years and with no influence in the reproductive output within a given season. It would very interesting evaluating the relation between BCI and the survival and remigration of adult females. We also emphasize in the need of better indexes to determine the health status of turtle populations, as these are often unrelated to the clinical status of individuals (e.g. Flint *et al.*, 2010).

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REFERENCES

Barco, S., Law, M., Drummond, B., Koopman, H., Trapani, C., Reinheimer, S., Rose, S., Swingle, W.M. & Williard, A. (2016) Loggerhead turtles killed by vessel and fishery interaction in Virginia, USA, are healthy prior to death. *Marine Ecology Progress Series*, 555, 221–234.

Bjorndal, K.A., Bolten, A.B. & Chaloupka, M.Y. (2000) Green turtle somatic growth model: evidence for density dependence. *Ecological Applications*, 10, 269–282.

Bjorndal, K.A., Bolten, A.B. & Chaloupka, M.Y. (2003) Survival probability estimates for immature green turtles, *Chelonia mydas*, in the Bahamas. *Marine Ecology Progress Series*, 252, 273–281.

Bolger, T. & Connolly, P.L. (1989) The selection of suitable indices for the measurement and analysis of fish condition. *Journal of Fish Biology*, 34, 171–82.

Bonte, D., Van Dyck, H., Bullock, J.M., Coulon, A., Delgado, M., Gibbs, M. & Schtickzelle, N. (2012) Costs of dispersal. *Biological Reviews*, 87, 290–312.

Cameron, S.J.K., Baltazar, M., Victor, S., Reischig, T., Correia, S. M., Harrod, C. & Eizaguirre, C. (2019). Diversity of feeding strategies in loggerhead sea turtles from the Cape Verde archipelago. *Marine Biology*, 166–130.

Cardona, L., Martins, S., Uterga, R. & Marco, A. (2017) Individual specialization and behavioral plasticity in a long-lived marine predator. *Journal of Experimental Marine Biology and Ecology*, 497, 127–133.

Casale, P. & Marco, A. (2015) *Caretta caretta* (North East Atlantic subpopulation). The IUCN Red List of Threatened Species 2015: e.T83776383A83776554.

Casale, P. & Tucker, A.D. (2017) *Caretta caretta* (amended version of 2015 assessment). The IUCN Red List of Threatened Species 2017: e.T3897A119333622.

Coelho, R., Santos, M.N., Fernandez-Carvalho, J. & Amorim, S. (2015) Effects of hook and bait in a tropical northeast Atlantic pelagic longline fishery: Part I — Incidental sea turtle bycatch. *Fisheries Research*, 164, 302–311.

Doughty, P. & Shine, R. (1997) Detecting life history trade-offs: measuring energy stores in "capital" breeders reveals costs of reproduction. *Oecologia*, 110, 508–513.

Eder, E., Ceballos, A., Martins, S., Pérez-García, H., Marín, I., Marco, A. & Cardona, L. (2012)

Foraging dichotomy in loggerhead sea turtles *Caretta caretta* off northwestern Africa. *Marine Ecology Progress Series*, 470, 113–122.

Flint, M., Morton, J.M., Limpus, C.J., Patterson-Kane, J.C. & Mills, P.C. (2010) Reference intervals for plasma biochemical and hematologic measures in loggerhead sea turtles (*Caretta caretta*) from Moreton Bay, Australia. *Journal of Wildlife Diseases*, 46, 731–741.

Green, A.J. (2001) Mass/length residuals: measures of body condition or generators of spurious results. *Ecology*, 82, 1473–1483.

Hawkes, L.A., Broderick, A.C., Coyne, M.S., Godfrey, M.H., López-Jurado, L.F., López-Suarez, P., Merino, S.E., Varo-Cruz, N. & Godley, B.J. (2006) Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. *Current Biology*, 16, 990–995.

Hays, G.C., Broderick, A.C., Glen, F. & Godley, B.J. (2002) Change in body mass associated with long-term fasting in a marine reptile: the case of green turtles (*Chelonia mydas*) at Ascension Island. *Canadian Journal of Zoology*, 80, 1299–1302.

Jessop, T.S., Hamann, M. & Limpus, C.J. (2004) Body condition and physiological changes in male green turtles during breeding. *Marine Ecology Progress Series*, 276, 281–288.

Li, T.H., Chang, C.C., Cheng, I.J. & Lin, S.C. (2015) Development of a summarized health index (SHI) for use in predicting survival in sea turtles. *PloS One*, 10, e0120796.

Litzgus, J.D., Bolton, F. & Schulte-Hostedde, A.I. (2008) Reproductive output depends on body condition in spotted turtles (*Clemmys guttata*). *Copeia*, 2008, 86–92.

Lowe, W.H., Likens, G.E. & Cosentino, B.J. (2006) Self-organisation in streams: the relationship between movement behaviour and body condition in a headwater salamander. *Freshwater Biology*, 51, 2052–2062.

Marco, A., Abella-Pérez, E., Líria-Loza, A., Martins, S., López, O., Jiménez-Bordon, S., Medina, M., Oujo, C., Gaona, P., Godley, B.J. & López-Jurado L.F. (2012a) Abundance and exploitation of loggerhead turtles nesting in Boavista Island, Cape Verde: the only substantial rookery in the Eastern Atlantic. *Animal Conservation*, 15, 351–360.

Marco, A., Abella-Pérez, E., Líria-Loza, A., Martins, S., Loureiro N.S. & López-Jurado, L.F. (2012b) Manual para monitorização de tartarugas marinhas nas Ilhas de Cabo Verde. *Zoologia Caboverdiana*, 3, 24–47.

Marco, A., Abella-Pérez, E., Monzón-Arguello, C., Martins, S., Araújo, S. & López-Jurado, L.F. (2011) The international importance of the Archipelago of Cape Verde for marine turtles, in particular the loggerhead turtle *Caretta caretta*. *Zoologia Caboverdiana*, 2, 1–11.

O'Dwyer, T.W., Buttemer, W.A., Priddel, D.M. & Downing, J.A. (2006) Prolactin, body condition and the cost of good parenting: an interyear study in a long-lived seabird, Gould's Petrel (*Pterodroma leucoptera*). *Functional Ecology*, 20, 806–811.

Santos, A.J., Freire, E.M., Bellini, C. & Corso, G. (2010) Body mass and the energy budget of gravid hawksbill turtles (*Eretmochelys imbricata*) during the nesting season. *Journal of Herpetology*, 44, 352–360.

Schulte-Hostedde, A.I., Millar, J.S. & Hickling, G.J. (2001) Evaluating body condition in small mammals. *Canadian Journal of Zoology*, 79, 1021–1029.

Schulte-Hostedde, A.I., Zinner, B., Millar, J.S. & Hickling, G.J. (2005) Restitution of mass–size residuals: validating body condition indices. *Ecology*, 86, 155–163.

Seminoff, J. A., Jones, T. T., Resendiz, A., Nichols, W.J. & Chaloupka, M.Y. (2003) Monitoring green turtles (*Chelonia mydas*) at a coastal foraging area in Baja California, Mexico: multiple indices to describe population status. *Journal of the Marine Biological Association of the United Kingdom*, 83, 1355–1362.

Sinervo, B. & Svensson, E. (1998) Mechanistic and selective causes of life history trade-offs and plasticity. *Okos*, 83, 432–442.

Stacy, N. I., Lynch, J. M., Arendt, M. D., Avens, L., McNeill, J. B., Cray, C., Day, R.D., Lee, A.M., Peden-Adams, M.M., Thorvalson, K., Segars, L. & Norton, T.M. (2018) Chronic debilitation in stranded loggerhead sea turtles (*Caretta caretta*) in the southeastern United States: Morphometrics and clinicopathological findings. *PloS One*, 13, e0200355.

Stevenson, R.D. & Woods Jr, W.A. (2006) Condition indices for conservation: new uses for evolving tools. *Integrative and Comparative Biology*, 46, 1169–1190.

Varo-Cruz, N., Cejudo, D. & López-Jurado, L.F. (2007) Reproductive biology of the loggerhead turtle (*Caretta caretta* L. 1758) on the island of Boavista (Cape Verde, West Africa). *In*: López-

Jurado, L.F. & Liria-Loza, A. (Eds), *Marine Turtles. Recovery of Extinct Populations.* Monografías del Instituto Canario de Ciencias Marinas, Las Palmas, Spain, pp. 127–144.

Vieira, S., Martins, S., Hawkes, L. A., Marco, A. & Teodósio, M.A. (2014) Biochemical indices and life traits of loggerhead turtles (*Caretta caretta*) from Cape Verde Islands. *PLoS One*, 9,e112181.

Wallace, B.P., DiMatteo, A. D., Hurley, B.J., Finkbeiner, E. M., Bolten, A.B., Chaloupka, M.Y., Hutchinson, B.J., Abreu-Grobois, F.A., Amorocho, D., Bjorndal, K.A., Bourjea, J., Bowen, B.W., Briseño-Dueñas, R., Casale, P., Choudhury, B.C., Costa, A., Dutton, P.H., Fallabrino, A., Girard, A., Girondot, M., Godfrey, M.H., Hamann, M., López-Mendilaharsu, M., Marcovaldi, M.A., Mortimer, J.A,. Musick, J.A., Nel, R., Pilcher, N.J., Seminoff, J.A., Troëng, S., Witherington, B. & Mast, R.B. (2011) Global conservation priorities for marine turtles. *PLoS One*, 6, e24510.

Willemsen, R.E. & Hailey, A. (2002) Body mass condition in Greek tortoises: regional and interspecific variation. *Herpetological Journal*, 12, 105–114.

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Ethics and Biodiversity: theoretical framework of its disciplinary relevance for the PALOP countries

Carlos Almeida Pereira [1, *]

[1] *CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, 4485-661 Vairão, Portugal*

**Corresponding author e-mail: carlos.pereira@cibio.up.pt*

RESUMO

Não obstante a sua opulência em termos de diversidade biológica, o continente africano enfrenta sérios riscos no contexto de uma crise global ambiental. Cenários de mitigação dos impactos por via de estratégias de investigação científica têm vindo a ser procuradas numa base sólida, e serão certamente a solução mais eficaz. Contudo, para uma sustentabilidade a longo prazo desta estratégia, será crucial conjugá-la com metodologias de estruturação mental consolidadas, nas quais a proeminência do valor intrínseco dos ecossistemas naturais seja vigorosamente enfatizado, ainda que em correlação com a importância da biodiversidade para a prosperidade económica e social das comunidades. Na circunstância, as potenciais vantagens da integração de uma unidade curricular sobre "Ética e Biodiversidade" em cursos pós-graduados em Angola e outros Países Africanos de Língua Portuguesa (PALOPs), incluindo Cabo Verde, foram problematizadas, no contexto de um curso de mestrado em "Biodiversidade, Genética e Conservação" em desenvolvimento em associação com instituições de ensino superior de países africanos. A importância dessa abordagem decorre do facto de se constatar uma quase total ausência de formação na área de ética ambiental nestes países, conquanto que esta dimensão possa ser considerada crucial para a consecução dos Objectivos de Desenvolvimento Sustentável da Agenda 2030 das Nações Unidas.

Palavras-chave: crise global ambiental, estratégias científicas de mitigação, objectivos de desenvolvimento sustentável

ABSTRACT

Aside its richness in terms of biological diversity, African continent faces serious risks in the context of the global environmental crisis. Scenarios of mitigation of the impacts via scientific research strategies are being sought on a solid basis, and they will certainly be the most sensible solution. For a long-term sustainability of this approach, although, it would be crucial to conjugate them with consolidated mental structuration methodologies, in which the prominence of the intrinsic value of the natural ecosystems should be strongly emphasized, even if in correlation with the importance of biodiversity for communities' economic and social prosperity. In the circumstance, the potential advantages of the integration of a curricular unit on 'Ethics and Biodiversity' for post-graduate courses in Angola and other Portuguese-speaking African countries (PALOPs), including Cabo Verde, were problematized, in the context of a master's degree in 'Biodiversity, Genetics and Conservation' under development in association with higher education institutions from African countries. The importance of this approach stems from the fact that, in these countries, almost no training in the area of the environmental ethics is provided, though this dimension may be considered crucial for the achievement of the Sustainable Development Goals (SDGs) of the Agenda 2030 of the United Nations.

Keywords: global environmental crisis, scientific mitigation strategies, sustainable development goals

INTRODUCTION

Africa has an incalculable wealth in biodiversity. Its living organisms constitute about a quarter of the overall global picture and African biomes range from mangroves to deserts, from Mediterranean to tropical forests, from temperate to subtropical and mountain savannah, and even to ice-covered peaks (Huntley *et al*. 2019). PALOP countries do not diverge from this scenario. All reveal a remarkable profusion and variety with regard to plant and animal life, and a striking beauty of its plains and plateaus, its forests and woods. Angola, large nation on the southwest coast of Africa, is a place of a remarkably physiographic, climatic and biological variety (Huntley *et al.* 2019). Although it encompasses only 4% of the terrestrial area of Africa, Angola has a rich diversity of landscapes and seascapes, possesses the highest diversity of biomes, and is second only to mega-diverse South Africa in terms of number of ecoregions found within its borders (Huntley *et al*. 2019). Regarding the other PALOPs, a very significant part of Guinea-Bissau and Mozambique, as well as the whole area of Cabo Verde and São Tomé & Príncipe, are included in the worldwide biodiversity hotspots (Myers 2003), and in all of them is positively recognizable a pronounced wealth of wildlife and vegetation, and the uniqueness and scientific value of their natural heritage.

Notwithstanding its richness in terms of biological diversity, African continent faces serious risks in the circumstance of the global environmental crisis (Ellis 2019). Similarly to what generically occurs in the African continent, those referred countries faces unprecedented challenges on attempting to reconcile human well-being and economic prosperity with the protection of the surrounding environment (UNEP-WCMC 2016). Concomitantly, they are threatened with severe environmental risks, mainly through a rampant population growth. This results in extensive demographic pressure scenarios, accompanied by processes of unregulated urbanization (with the subsequent binomial pollution-diseases), and intensive agricultural exploitation (UNEP-WCMC 2016). This situation has a harmful impact on the natural

environment, which is, in some situations, critically damaged, and of difficult immediate restoration (UNEP-WCMC 2016). Consequently, the development of mitigation research strategies is pointed as a priority, namely in the sense of promoting collaborative actions among European and African countries to address the Aichi goals (United Nations 2011, UNEP-WCMC 2016), and the Objectives of the UN Agenda 2030 regarding biodiversity (UNESCO 2015). Prospects of mitigation of the impacts, via scientific research strategies, will be certainly the most sensible solution, but for a long-term sustainability of this approach, it would be crucial to conjugate them with consolidated mental structuration methodologies, otherwise it will fall short of the intended results in the absence of a paradigm shift (Loreau 2014). In these methodologies, the prominence of the intrinsic value of natural ecosystems, in view of its inherent ontological and ethical relevance, should be emphasized, in correlation with the conventional strategy of addressing the importance of biodiversity for communities' economic and social prosperity.

The underlying rationale is quite simple: on failing the dissemination of a mind-set and attitudinal change, which determinedly extol the inherent significance of the axiological dimension of the environment – besides its 'instrumental' importance for humankind – the current detrimental anthropocentric pattern will be perpetuated, as well as the harmful consequences arising from it (Loreau 2014).

In practical terms, even in an optimistic scenario, in which from the application of the research strategies and actions previously stated, an environmental recovery may occur, triggering in people the awareness about the tangible importance of biodiversity to their lives, the risk of re-incurring in the previous inaccuracies, in the medium term, will be always hanging over, threateningly. Once momentarily mitigated the menaces for populations themselves, relapsing in harmful behaviours may always be a possibility, in the absence of an endemic reverence by the surrounding environment (Hébert 2014). Concomitantly, the motivation for the properly actions in this respect should also be intrinsic, and not only derived from external conventions or normative systems, i.e. national/ regional regulatory frameworks with penalizing schemes for the infractions, as in the hypothetical absence of the concerning law enforcement, the trigger for the ethical accomplishments will fade away (Loreau 2014). The challenge, therefore, is still beyond the recognition of the high importance of natural surrounding for current and future human generations, as exceeding the short-term gains that are the cause of most biological diversity loss. The challenge is to raise awareness to the fact that environment has a per se value that surpasses human referrals, and its obliteration is intrinsically immoral – and not only by reference to our human condition and our basic civilizational and social needs (Hébert 2014).

If a direct correlation between education and behavioural change seems unquestionable, a similar correspondence between biodiversity training and an optimized management of environmental resources also appears substantially highlighted in prominent scientific literature (Gayford 2000, Kassas 2002, Weely & Wals 2010). Therefore, the same should be expected in what refers to the paradigm shift proposed regarding the recognition of the *per se* value of environment.

Thus, in the context of this conceptualization, the pertinence of establishing a masters course in 'Biodiversity, Genetics and Conservation' with a curricular unit of 'Ethics and Biodiversity' for graduates in Biological Sciences was studied. The potential advantages of extending this approach to other PALOP countries, namely Cabo Verde, was stressed.

MATERIAL AND METHODS

For studying the relevance of the establishment of a curricular unit on 'Ethics and Biodiversity', an online research, on the potential incidence of disciplines correlated to ethics in MSc in biodiversity-related areas (the research question that guided this study) was conducted for Angola and other concerned PALOP countries (Cabo Verde, Guinea Bissau, Mozambique, São Tomé & Príncipe). Sources for seeking the official information were the following: Angola Informativa – Cátalogo Angolano de Cursos Superiores (https://www.angolaformativa.com/pt/top-cursos/); Universidade de Cabo Verde, Uni-CV (http://www.unicv.edu.cv/ensino/pos-graduacao); MZ Formativa – Catálogo Moçambicano de Cursos Superiores (https://www.mzformativa.com/pt/oferta-formativa/mestrado/); University of São Tomé (https://ustp.st/cursos.php); UniPiaget Guinea Bissau (http://guine-bissau.unipiaget.org/#Curso); University Amílcar Cabral (https://www.uan.ao/dt_logos/universidade-amilcar-cabral/.

RESULTS

This research in official governmental/ institutional websites, combined with ratified information from the concerned Universities on the incidence of disciplines associated to Ethics in MSc in biodiversity-related areas for the specified countries, has proved that almost no training is provided in this area (Fig. 1 and Table 1).

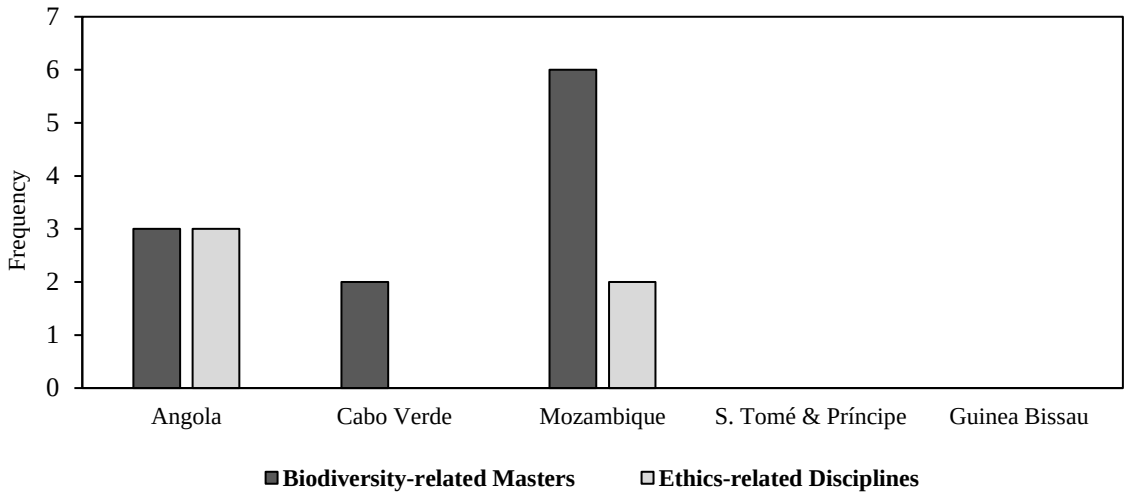

Fig. 1. Frequency of Biodiversity-related masters and Ethics-related disciplines. Check Material & Methods for further details.

It turns out that Guinea Bissau, and São Tomé & Príncipe have no postgraduate training in biodiversity-related areas (Table 1). On the other three countries that are conducting masters in this area (Angola, Cabo Verde and Mozambique) the scenario differed. The master's in 'Environmental Management and Governance' from the Angolan University Agostinho Neto (UAN) incorporates three collateral Ethics-related disciplines ('Environmental Law', 'International Policies and Conventions' and 'Introduction to Environmental Policy and Governance'), and no Ethics-related disciplines occur in the other master's ('Agronomy and Natural Resources' from University José Eduardo dos Santos

(UJES) and 'Environmental Engineering' from UAN; Table 1). Two master's courses are conducted in Cabo Verde, at Uni-CV ('Management and Environmental Policies' and 'Agricultural Information Management and Precision Agriculture'), but without any ethical reflection. In Mozambique, six master's courses in the area of biodiversity are conducted at University Eduardo Mondlane (UEM) ('Aquatic Biology and Coastal System'; 'Coastal and Environmental Geology'; Sustainable Aquaculture; Marine Biology and Fisheries Management; Biotechnology; Forest Sciences). However, incidence information regarding Ethics-related disciplines was obtained only for the master's in Sustainable Aquaculture, and Marine Biology and Fisheries Management (Table 1).

Table 1. Details on Biodiversity-related masters and Ethics-related disciplines provided in the different universities from each PALOP country. Note that Biodiversity-related masters do not exist on São Tomé & Príncipe nor Guinea-Bissau. Check results for details on the university names (Uni).

Country	Masters designation	Uni	Ethics-related disciplines
Angola	Agronomy and Natural Resources	UJES	Not available
	Environmental Management and Governance	UAN	Environmental Law International Policies and Conventions Introduction to Environmental Policy and Governance
	Environmental Engineering	UAN	Not available
Cabo Verde	Management and Environmental Policies	Uni-CV	Not available
	Agricultural Information Management and Precision Agriculture	Uni-CV	Not available
Mozambique	Aquatic Biology and Coastal Systems	UEM	Not available
	Coastal and Environmental Geology	UEM	Not available
	Sustainable Aquaculture	UEM	Biosafety
	Marine Biology and Fisheries Management	UEM	Fisheries Legislation
	Biotechnology	UEM	Not available
	Forest Sciences	UEM	Not available

DISCUSSION

Most of the analysed countries lack training in the area of Environmental Ethics. Hence, a biodiversity-related post-graduate training, namely for recently graduated life sciences students, with a curricular unit of 'Ethics and Biodiversity' proposed among the syllabus of a future master's course in 'Biodiversity, Genetics and Conservation', is pertinent. This would allow an axiological reflection on the prominence of the intrinsic value of the natural ecosystems, in view of its inherent ontological and ethical relevance. The pilot course would be set in an association between the University of Porto (Portugal) and the University Mandume ya Ndemufayo (Angola) and could be replicated in the other PALOP countries. This course is completely aligned with the Sustainable Development Goals (SDGs) of the Agenda 2030, namely regarding ensuring inclusive and equitable quality education and protecting life on land (UNESCO, 2015). It will also go along with the aspirations of the Agenda 2063 'The Africa We Want', specifically respecting the improvement of a strong cultural identity, a common heritage, shared values and ethics (African Union Commission, 2015). This could then be replicated in other PALOP countries, namely those in which CIBIO has established TwinLabs (http://www.unescolifeonland.com/%20en/twinlabs), including Cabo Verde. In this country, CIBIO's collaborative

institutional network is solid and structured, and a consolidated scientific capacity building scheme has been established several years ago, namely with Uni-CV, contemplating bilateral cooperation in several academic areas, explicitly with regard to postgraduate training. Other Portuguese institutions, with international programmes currently running on the ground – e.g.: University of Coimbra, with a whole series of academic cooperation agreements with higher education institutions in Cabo Verde and, through the UNESCO Chair in Biodiversity and Conservation for Sustainable Development, with solid collaboration schemes in Angola (University Mandume Ya Ndemufayo) and in Mozambique (Lúrio University); University of Lisbon, with scientific, academic and cultural cooperation agreements with higher education institutions in Angola (ISCED-Huíla; Technical University of Angola) and Mozambique (Technical University of Mozambique; Catholic University of Mozambique; Pedagogical University of Mozambique); University of Aveiro, with cooperation protocols with Uni-CV (Cabo Verde) and with the Gorongosa National Park Research Center (Mozambique); University of Minho, through its international protocols with ISCED-Huíla (Angola) and with the Superior Institute of Health Sciences of Maputo (Mozambique); or Jean Piaget Institute of Cabo Verde, among others – may also contribute to the achievement of this objective.

In addition to seeking to request for a reflection on the intrinsic value of biodiversity, and on the need for a *per se* respect that is due to the surrounding environment, the objective of the discipline should be the discussion about the complex environmental dilemmas related to global biodiversity crisis. It should also promote comprehensive deliberation exercises and the structuring of ethical frameworks, values and principles, which may provide personal guidance and a theoretical background for policy options in this area. Concurrently, it will seek to operationalize excellent training in ethical issues related to biological diversity. It is expected to endow students with a general understanding of the concept of biodiversity, the fundamentals and principles of ethics, the operationalized values in sustainable management, of the laws and governance strategies involved in biological diversity preservation, and on the ethical issues that need to be considered for the genesis of policies and strategies for biodiversity conservation. Its study plan should encompass several curricular modules as, for instance: ‘Ethics and Biodiversity’; ‘Value of Biodiversity’; ‘Law, Governance and Biodiversity’; and ‘Ethics in Policies and Strategies in Preserving Biodiversity’. With this scheme, it is aimed to achieve the abovementioned SDGs, regarding biodiversity (UNESCO 2017a), as well as for the enrichment of the curricular (international) offer of the involved institutions.

CONCLUDING REMARKS

If PALOP's natural levels of biological diversity are expected to be preserved and improved, political and educational strategies should be structurally pursued. National authorities and academics from those nations are completely aware of the problem, and have already signalized several conservation actions and national networks of protected areas (e.g. MAOH 2014). At the same time, a change of mentalities, in the terms previously suggested, equally proves to be mandatory, as well as the inclusion of advanced training programmes in which an ethical reflection related to biodiversity issues shall be integrated. Therefore, the incorporation of a theoretical field on ‘Ethics and Biodiversity’ could be of an outstanding significance. This could be achieved either by means of the implementation of new master’s courses in Biodiversity, or by the reformulation of already

existing ones (namely through the inclusion of that disciplinary area in the corpus of masters in Biology already established). Bearing in mind the existence of many collaborations and strong research connections of European Universities with some of these nations, a significant part of the path seems already traced.

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REFERENCES

African Union Commission (2015) *Agenda 2063 The Africa We Want*. Africa Union Commission, Addis Ababa, Ethiopia, 24 pp.

Araújo, S., Lima, L., Monteiro, R. Medina, A. & Gomes, I. (2015) *Fifth National Report on the Status of Biodiversity in Cabo Verde.* Direcção Nacional do Ambiente, Praia, Cabo Verde, 95 pp.

Ellis, E. (2019) Evolution: Biodiversity in the Anthropocene. *Current Biology*, 29, 829–833.

Gayford, C. (2000) Biodiversity Education: a teacher's perspective. Environmental *Education Research*, 6, 347–361.

Hébert, I.-M. (2014) Reverence for the Conscious of Nature. *In*: Vacoch, D. & Castrillón F. (Eds.), *Ecopsychology, Phenomenology and the Environment. The Experience of Nature*. Springer, USA, pp. 27–46.

Huntley, B. J., Russo, V., Lages, F. & Ferrand, N. (Eds) (2019*) Biodiversity of Angola*. *Science & Conservation: A Modern Synthesis*. Springer, Cham, Switzerland, 549 pp.

Kassas, M. (2002) Environmental education: biodiversity. *The Environmentalist*, 22, 345–351.

Loreau, M. (2014) Reconciling utilitarian and non-utilitarian approaches to biodiversity conservation. Ethics in Science and *Environmental Politics*, 14, 27–32.

MAHOT – Ministério do Ambiente, Habitação e Ordenamento do Território (2014) Estratégia Nacional e Plano de Acção para a Conservação da Biodiversidade 2015–2030. Direcção Nacional do Ambiente, Praia, Cabo Verde, 128 pp.

Meyers, N. (2003) Biodiversity hotspots revisited. *BioScience*, 53, 916–917.

UNEP-WCMC (2016) *The State of Biodiversity in Africa: A mid-term review of progress towards the Aichi Biodiversity Targets*. UNEP-WCMC, Cambridge, UK, 96 pp.

UNESCO (2015) *Transforming our world: the 2030 Agenda for Sustainable Development*. United Nations General Assembly, New York, USA, 41 pp.

UNESCO (2017a) *Education for Sustainable Development Goals: Learning Objectives*. UNESCO, Paris, France, 63 pp.

UNESCO (2017b) *Rethinking Education Towards a Global Common Good?* UNESCO, Paris, France, 85 pp.

United Nations (2011) *Strategic Plan for Biodiversity (2011-2020) and the Aichi Biodiversity Targets*. United Nations, New York, USA, 2 pp.

Weely, D. & Wals, A. (2010) Making biodiversity meaningful through environmental education. *International Journal of Science Education*, 24, 1143–1156.

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Nota breve | Short note

First confirmed sighting of pygmy killer whales *Feresa attenuata* off Cabo Verde

Simon Berrow [1, *], Eduard Degollada [2], Beatrice Jann [3], Edita Magileviciute [4], Kateline Pereira [4], Manuel S. D. Rodrigues [5], Pedro López-Suárez [5], Tony Whelan [1] & Caroline R. Weir [6]

[1] Irish Whale and Dolphin Group, Kilrush, Co Clare, Ireland
[2] EDMAKTUB Associació, Barcelona, Spain
[3] Swiss Whale Society, Swiss Whale Society, Ar Inèra 9, CH-6999 Astano, Switzerland
[4] Associação Cabo-verdiana de Ecoturismo (ECOCV), Praia, Santiago, Cabo Verde
[5] Bios.CV, Sal Rei, Boavista, Cabo Verde
[6] Ketos Ecology, Kingsbridge, Devon, UK

**Corresponding author e-mail: simon.berrow@iwdg.ie*

Keywords: Atlantic Ocean, melon-headed whale, *Peponocephala electra*, identification, calves

Pygmy killer whales (PKW) *Feresa attenuata* Gray, 1874 inhabit tropical and sub-tropical oceanic waters worldwide, including around volcanic islands (Baird 2018). They are naturally rare, and their ecology and distribution are poorly understood (McSweeney *et al*. 2009, Baird 2018). A live mass stranding of PKW occurred at Boavista during February 2012 (López-Suárez *et al*. 2012), but no other validated records exist for Cabo Verde. Here we describe the first confirmed sighting.

Distinguishing between PKW and melon-headed whales (MHW) *Peponocephala electra* at sea is challenging (Baird 2018). Both are relatively small, reaching 2.6 and 2.8 m respectively, and have similarly dark body colouration, no beak, and white lips (Jefferson *et al*. 2015). However, subtle differences exist in colouration, the shape of the head, flippers and dorsal fin, and the dorsal cape pattern.

During a visual cetacean survey from a 14.3 m catamaran on 10 September 2019, a group of approximately 30 small odontocetes, including two calves, was photographed. The sighting occurred in 150 m water depth off São Filipe, Fogo Island (14.80ºN, 24.38ºW), approximately 1 km from shore and 1 km from the 1000 m depth contour. The animals were initially identified as MHW, but were re-

identified as PKW following subsequent examination of the photographs.

The primary feature used to identify the São Filipe animals was the cape. Compared with MHW, the dark cape was more strongly demarcated from the lighter flank, and dipped below the fin at a shallower angle with the apex of the dip located slightly further back on the body (Fig. 1). It widened forward of the blowhole into a dark crown that slanted downwards towards the mouth (Fig. 1), and contrasted with the paler crown (and resulting masked appearance) usually apparent in MHW (Jefferson *et al*. 2008). In side profile the animals had rounded head shape (Fig. 1A), while that of MHW is typically more pointed. Additionally, the white lip colouration extended onto the face (Fig. 1A), which is more indicative of PKW. The flipper tips were rounded (Fig. 1B), rather than pointed as in MHW. In combination, these features confirmed the São Filipe animals as PKW.

Fig. 1. Pygmy killer whales photographed off Fogo Island, Cabo Verde, on 10 September 2019, showing diagnostic identification features. **A**) Rounded head with white lips extending onto the face, dark cape broadening into a crown in front of the blowhole, and prominent dorsal (photo by M. Rodrigues). **B**) and **C**) Well-demarcated dorsal cape with prominent shallow dip below dorsal fin, and flippers with rounded tips (photos from drone by E. Degollada). **D**) One of the two calves recorded in the group, exhibiting relatively smaller size and characteristic pale neonatal folds (photo by S. Berrow).

Few verified records of PKW have been documented from the Atlantic African coast. One animal was captured off Senegal during 1958 (Fraser 1960), and another landed as bycatch in Ghana during 2007 (Van Waerebeek *et al*. 2009). A photograph from Côte d'Ivoire in 2011 (Weir *et al*. 2013), is now considered by those authors to be of insufficient quality to distinguish between PKW and MHW. Consequently, our sighting and the stranding in 2012 (López-Suárez *et al*. 2012), represent noteworthy records for the eastern Atlantic.

Given the challenges of distinguishing between PKW and MHW, even at close range and in good light, future records should be carefully assessed. Supporting material should be independently verified, and records otherwise considered unconfirmed (López-Suárez *et al*. 2012).

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REFERENCES

Baird, R.W. (2018) Pygmy Killer Whale *Feresa attenuata*. *In:* B. Würsig, J.G.M. Thewissen and K.M. Kovacs (Eds), *Encyclopedia of Marine Mammals Third Edition*, Academic Press, London, UK. pp. 788–790.

Fraser, F.C. (1960) A specimen of the genus *Feresa* from Senegal. *Bulletin de l'Institut Français d'Afrique Noire*, 22, 699–707.

Jefferson, T., Webber, M. & Pitman, R.L. (2008) *Marine Mammals of the World: A Comprehensive Guide to Their Identification*. Academic Press, San Diego, California, pp. 592.

López-Suárez, P., Oujo, C., Acre, M. & Hazevoet, C.J. (2012) A stranding of pygmy killer whale *Feresa attenuata* Grey, 1974 on Boavista during February 2012: first record for the Cape Verde Islands. *Zoologia Caboverdiana*, 3, 52–55.

McSweeney, D.J., Baird, R.W., Mahaffy, S.D., Webster, D.L. & Schorr, G.S. (2009) Site fidelity and association patterns of a rare species: pygmy killer whales (*Feresa attenuata*) in the main Hawaiian Islands. *Marine Mammal Science*, 25, 557–572.

Van Waerebeek, K., Ofori-Danson, P.K. & Debrah, J. (2009) The cetaceans of Ghana, a validated faunal checklist. *West African Journal of Applied Ecology*, 15, 61–90.

Weir, C.R., Goncalves, L. & May, D. (2013). New Gulf of Guinea (Africa) range state records for pygmy killer whale (*Feresa attenuata*) and Fraser's dolphin (*Lagenodelphis hosei*). *Marine Biodiversity Records*, 6, e 35.

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Caixa Postal 163, São Vicente, Cabo Verde
E-mail: zoologiacaboverdiana@gmail.com
Website: www.scvz.org

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Orca anã *Feresa attenuata* ao largo da ilha do Fogo, Setembro 2019 | Pygmy killer whale *Feresa attenuata* off Fogo Island, September 2019 (fotografia de | photo by 'Strava', Manuel Rodrigues)

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