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Short communications

First record of freshwater fish on the Cape Verdean archipelago

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The Cape Verdean islands form a distinct aquatic freshwater ecoregion characterized mainly by temporal water bodies with an adapted invertebrate community. Freshwater fish were not previously recorded from the archipelago. During a non-exhaustive survey of freshwater bodies on five islands of the archipelago, the first presence of a freshwater fish was recorded. Using barcoding sequences, the species was identified as the guppy (*Poecilia reticulata*), a highly invasive species alien to the Cape Verdean Islands.

Key words: Cape Verde, guppy, *Poecilia reticulata*, Macaronesia.

The Cape Verdean archipelago lies in the middle of the Atlantic Ocean about 500 km off the west coast of Africa and consists of ten islands and several islets of volcanic origin (Brown 2004; Fig. 1). Being in the dry belt of the Sahel, the archipelago experiences a tropical climate with low rainfall. Consequently, water exists mainly as temporal streams and permanent streams only occur on the island of Santo Antão (Hazevoet 1995). However, extended periods of droughts occur regularly during which most water bodies on this island also dry out. This unstable environment led to the evolution of a specialized endemic freshwater fauna, consisting only of invertebrates, including dragonflies (Martens 2010) and freshwater snails (Rosa *et al.* 1999). Freshwater fish have never been recorded (Brown 2004).

The guppy (*Poecilia reticulata* Peters, 1859) is a small benthopelagic fish native to Central and South America (Lindholm *et al.* 2005). Because it is a popular aquarium fish, as well as its use as an agent for mosquito control, this species has been introduced widely and is now found on all continents except Antarctica (Froese & Pauly 2012). The wide environmental tolerance of *P. reticulata* such as its resistance to high salinity (Chervinski 1994), as well as its high fecundity, makes it a very successful invader (Lindholm *et al.* 2005). In part of its invasive range, the presence of guppies has resulted in a decline of native fish and invertebrate species abundance (Courtenay & Meffe 1989). *Poecilia reticulata* is therefore a possible threat when introduced into new habitats.

Between 7 and 27 October 2011, the authors surveyed five islands (Boa Vista, Sal, Santa Antão, São Nicolau and São Vincente) for the presence of freshwater bodies (Fig. 1). Surveys were performed by hiking transects either along the coast (Sal, Boa Vista) or along stream channels within valleys. All encountered freshwater bodies were visually inspected for the occurrence of molluscs and fish. Where present, samples were collected using a 20 × 25 cm hand net with a mesh size of 3 mm. Sampled habitats included pools in temporal rivers, streams and artificial reservoirs. Sampling was performed in a non-exhaustive way and therefore only a small fraction of the potential available habitats were sampled.

Freshwater bodies were only found on two islands (Boa Vista and Santa Antão). Here, only one artificial water reservoir on Santa Antão (17°08.169′N, 25°03.973′W) contained freshwater fish (Fig. 1). These were later identified as *P. reticulata.* This

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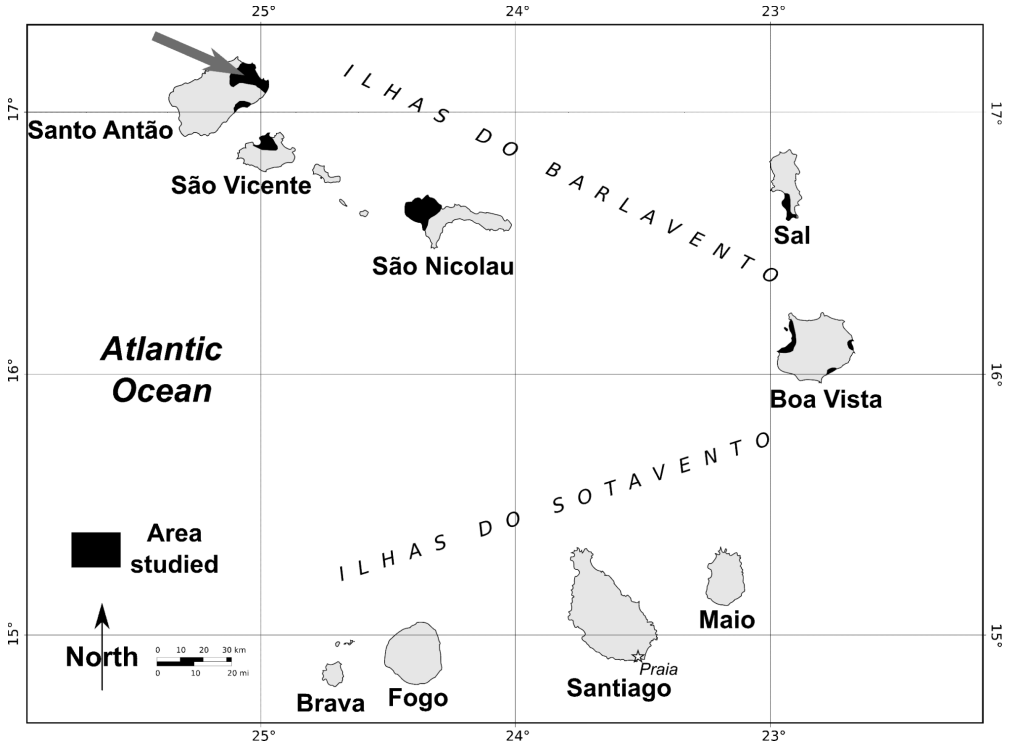

Fig. 1. Map of the Cape Verdean archipelago (modified from ©Wikimedia 2011). Black areas indicate the regions investigated in this study. The arrow indicates the only site where *Poecilia reticulata* has been observed.

artificial water reservoir was constructed of concrete (8 m long × 4 m wide × 1.5 m deep) with muddy substrate on the bottom and is part of an irrigation system receiving inflowing water from irrigation channels and is further connected to a freshwater stream. No fish were however observed in the streams below the reservoir.

Two juveniles were captured with a hand net, sacrificed with an overdose of anaesthetic clove oil and preserved in absolute ethanol for further analysis. To determine species identity of the juvenile fish, standard barcoding primers (LCO 1490, HCO2198, see Folmer *et al.* 1994), amplifying a part of the mitochondrial cytochrome c oxidase subunit I (COI) gene were used. DNA was extracted using a 10% Chelex solution, following the manufacturers protocol (Biorad, Switzerland). PCR setup was as follows: initial denaturation at 94°C for 3 min followed by 35 cycles with 30 s at 94°C, 30 s at 48°C and 1 min at 72°C with a final elongation step of 5 min at 72°C. Sequencing was performed on a Beckman Coulter CEQ 8000 capillary system (Beckman Coulter, Switzerland) following the manufacturers instructions.

Obtained sequences were aligned using BioEdit 7.1.3 (Hall 1999). A phylogenetic tree was constructed with publicly available barcode sequences of the *Poecilia* genus on BOLD (Ratnasingham & Hebert 2007) in MEGA 4 (Tamura *et al.* 2007). Here, using 654 overlapping base pairs (bp), an unrooted neighbour joining tree was constructed with the implemented pairwise deletion option. Further statistical support was estimated using 1000 bootstrap replicates.

Both sequenced individuals showed the same mitochondrial COI haplotype. The obtained sequence was deposited on GenBank (Accession number JQ734533). In the reconstructed phylogenetic tree, these two individuals formed a significant clade with two other specimens of *Poecilia reticulata* (GenBank accession number JN028265 and JN028266, Fig. 2), which originate from an introduced lineage in Canada. The clade significantly differentiated *P. reticulata* from other species of the *Poecilia* genus.

Although we were only able to catch juveniles, the barcoding approach reliably identified the species identity of both individuals as *P. reticulata*. Because malaria is absent from Santa Antão and most other islands (Alves *et al.* 2006), it seems to be

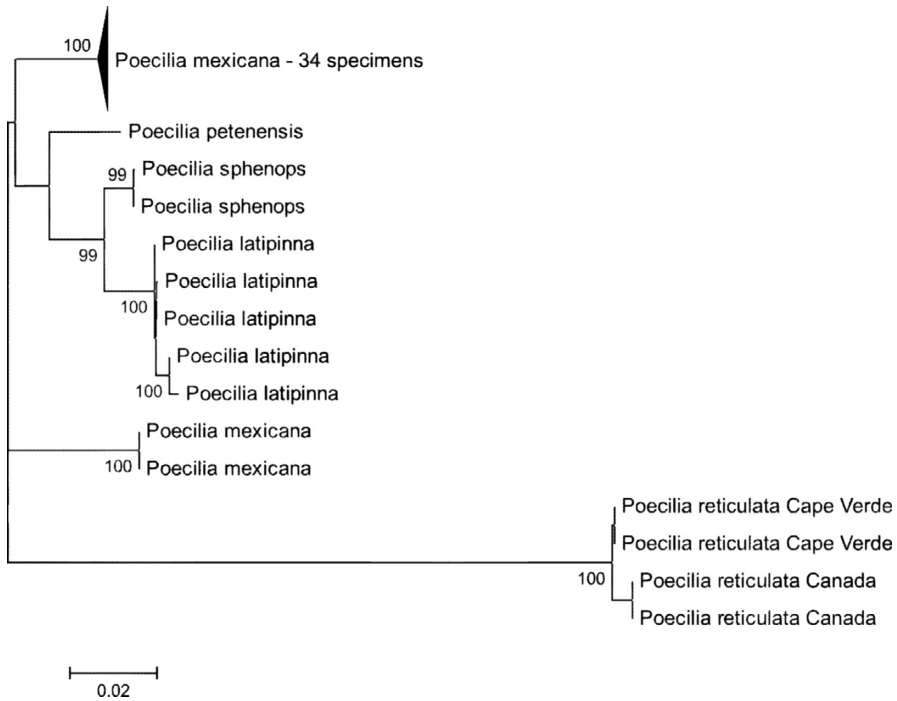

Fig. 2. Unrooted phylogenetic tree using 654 base pairs of the mitochondrial control region. Statistical support was estimated using 1000 bootstrap replicates. Only values with >90% bootstrap support are indicated next to the branches.

unlikely that this species was introduced for mosquito control. Therefore, it is very likely that the population represents an unintentional introduction originating from ornamental fish trade. The ancestral source population could not be identified because only few sequences were available.

Introduced species are considered to be a major threat to the local ecosystem of the Cape Verdean islands, with over 300 known invasive species being present (CBD 2007). The introduction of guppies may have negative impacts on the freshwater ecosystem as its biota evolved in the absence of vertebrate predators. However, further studies are needed to assess the actual impact of guppies on the local ecosystem. Given the known invasiveness of guppies, even when genetically depauperated (Lindholm *et. al.* 2005), as well as its ability to compete with other species (Courtenay & Meffe 1989) it seems to be likely that the observed population could colonize a larger range. Here the artificial water reservoirs might play a crucial role as they provide save refugia even during droughts, which could allow the species to persist. Because the species seemed locally restricted, measures could still be implemented to avoid its further spread.

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REFERENCES

ALVES, J., ROQUE, A.L., CRAVO, P., CRAVO, P., VALDEZ, T., JELINEK, T., DO ROSARIO, V.E. & AREZ, A.P. 2006. Epidemilogical characterization of *Plasmodium falciparum* in the republic of Cabo Verde: implications for potential large-scale re-emergence of malaria. *Malaria Journal* **5**: 1–8.

BROWN, A. 2004. Cape Verde. In: *Freshwater Ecoregions of Africa and Madagascar*, (eds) M.L. Thieme, R. Abell, M.L.J. Stiassny & P. Skelton, 1st edn, pp. 264–265. Island Press, Washington, U.S.A.

CBD – CONVENTION OF BIOLOGICAL DIVERSITY, 2007. Third report – Cape Verde. 172 pp. Online at: http://www.cbd.int/doc/world/cv/cv-nr-03-en.pdf (accessed 10 March 2012).

CHERVINSKI, J. 1984. Salinity tolerance of the guppy, *Poecilia reticulata* Peters. *Journal of Fish Biology* **24**: 449–452.

COURTENAY, W.R. & MEFFE, G.K. 1989. Small fishes in strange places: a review of introduced poeciliids. In: *Ecology and Evolution of Livebearing Fishes (Poeciliidae)*, (eds) G.K. Meffe & F.F. Snelson, 1st edn, pp. 319–331. Prentice Hall, New Jersey, U.S.A.

FOLMER, O., BLACK, M., HOEH, W., LUTZ, R. & VRIJENHOEK, R. 1994. DNA primers for amplifica-

tion of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* **3**: 294–299.

FROESE, R. & PAULY, D. 2012 (eds). FishBase, version (02/2012). Online at: www.fishbase.org.

HAZEVOET, C.J. 1995. *The Birds of the Cape Verde Islands*. Dorset Press, Dorchester, U.K.

HALL, T.A. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleaic Acids Symposium Series* **41**: 95–98.

LINDHOLM, A.K., BREDEN, F., ALEXANDER, H.J., CHAN, W., THAKURTA, S. G. & BROOKS, R. 2005. Invasion success and genetic diversity of introduced populations of guppies *Poecilia reticulata* in Australia. *Molecular Ecology* **14**: 3671–3682.

MARTENS, A. 2010. Ecology of the dragonflies at the westernmost spot of Africa, the island of Santo Antão, Cape Verde (Odonata). *International Journal of Odonatology* **13**: 241–254.

RATNASINGHAM, S. & HEBERT, P.D.N. 2007. BOLD: The barcoding of life data system (www.bardoinglife.org). *Molecular Ecology Notes* **7**: 355–364.

ROSA, F., SIMONES, M. & LAGOS COSTA, F. 1999. Geographic distribution of the freshwater snails on the island of Santiago (Cape Verde-Cabo Verde): preliminary data. *Garcia de Orta Serie de Zoologica* **23**: 193–201.

TAMURA, K., DUDLEY, J., NEI, M. & KUMAR, S. 2007. MEGA4 Molecular evolutionary genetics analysis (MEGA) software version 4.0. *Molecular Biology and Evolution* **24**: 1596–1599.

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