

SHORT COMMUNICATION

D. JOÃO DE CASTRO BANK, A SHALLOW WATER HYDROTHERMAL-VENT IN THE AZORES: CHECKLIST OF THE MARINE MOLLUSCS

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D. João de Castro Bank (DJC) is a shallow seamount with hydrothermal activity located between the islands of Terceira and São Miguel, Azores (Portugal). Due to its remote location, few investigators have worked in the area. Thirty-three species of marine molluscs are recorded as new for DJC which brings the total number of species to 42 for this specific area. Common micro-mollusc species known for the Azores (*e.g.*: the sublittoral species *Alvania poucheti* and *Setia subvaricosa*) are not present, and possible reasons for this are discussed.

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INTRODUCTION

D. João de Castro Bank (DJC) (Latitude: 38°13.3'N; Longitude: 26°36.2'W) is an isolated seamount located between Terceira and São Miguel Island, Azores (Fig. 1a), 36 nautical miles from Terceira island and 40 miles away from São Miguel. The shallower part of the bank is probably the result of several submarine eruptions occurred during two weeks in December 1720. These eruptions took place at 100 m depth and projected ashes and steam visible from São Miguel and Terceira Islands. The ashes accumulated, forming a small island which the winter storms completely destroyed two years later (Agostinho, 1934, 1960; Weston, 1964; Machado, 1967).

DJC is the upper part of a volcanic cone, like those present in most of the Azorean Islands. The cone has a base at 50 m depth, the shallowest part being at 13 m. Inside the cone, the depth is 45 m. In the North-South direction the cone is 300 m long and 600 m in the East-West direction (Fig. 1B).

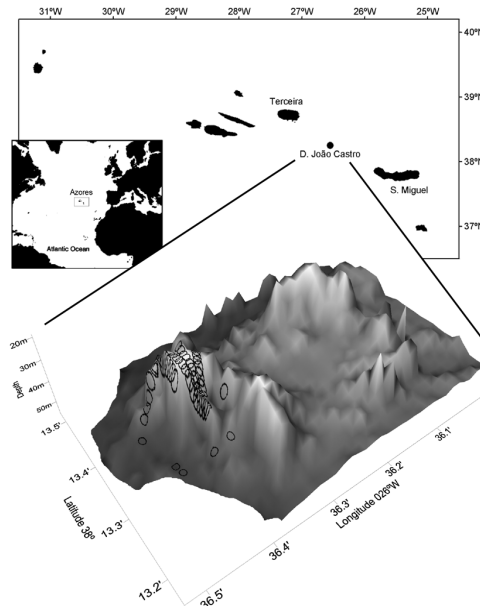


Fig. 1. a) Geographic location of D. João de Castro Bank; b) Topography of D. João de Castro Bank (©ImagDOP and ISR/IST).

DJC is rare in the Atlantic Ocean, due to the presence of hydrothermal activity at shallow depths (SANTOS et al. 1996; photos in CARDIGOS et al. 2000). A small area of the bottom (100x50 m), between 16 and 45 m depth, in the western part, exhibit release of gases, mainly CO₂ (Victor Hugo Forjaz, pers. comm.). This gas has its source in a magmatic chamber located between 1 and 5 km under the seafloor (MACHADO & LEMOS 1998). Recently, a second area with hydrothermal activity was discovered, at around 200 m depth, southeast of the shallowest part of the bank (PASCOAL et al. 2000).

ÁVILA (2000a) compiled a complete checklist of known shallow water marine molluscs from the archipelago of the Azores. Additional species were added by ÁVILA et al. (2000a & b), ÁVILA & ALBERGARIA (2002); SEGERS (2002). ÁVILA (1997) based only in macro-species observation reported 9 species from DJC. The present work is the first analysis of directed sampling for molluscs in DJC. A new list of molluscs was compiled based in previous publication (ÁVILA 1997; WIRTZ & D'UDEKEN D'ACÓZ 1999) and this study.

MATERIALS AND METHODS

Visual macro species identification were made by SCUBA diving during Expeditions made by the DOP/UAç in 1996 (27th July) and ASIMOV Project Expeditions in 2000 (11 days between 22 August and 19 September).

Samples were collected at DJC bank, between the 22 and 25 of July 2000 at Stations labeled DBUA 811 to 817 (See Table 1). Four quadrates 25x25 cm were scrapped off with a chisel (Table 1) during SCUBA dives. The samples (including the attached algae and associated organisms) were sieved by pouring water through a 1mm mesh size sieve. The molluscs were then removed from the algae, sorted by species, labeled and preserved in 70% ethanol. All the samples were numbered and deposited in the reference collection of the Department of Biology of the University of the Azores (DBUA). Species determination, synonymy and the ordination of families follow the CLEMAM database (LE RENARD 2003).

Table 1

Number, date, and depth of the samples in the Reference Collection of the Department of Biology of the University of the Azores (DBUA) and physical characterization of the sampling stations at D. João de Castro Bank used in this study.

DBUA stations	Date	Depth (m)	Hydrothermal activity	Distance to Vents (m)	Type of bottom	Short description of the sampling area	Most common algae
811	22/07/2000	20.5	very low	0.5	rocky	NW top of a seamount. Bottom covered by algae. The most intense vents were located along a fault. Subjected to strong currents.	<i>Acrosorium venulosum</i> , <i>Cladophora prolifera</i> , <i>Corallina elongata</i>
812	25/07/2000	16.9	very high	0.3	rocky	Idem	<i>Corallina elongata</i>
813	25/07/2000	17.0	high	1.0	rocky	Idem	<i>Sargassum</i> sp., <i>Corallina elongata</i>
814	25/07/2000	16.0	high	1.3	rocky	Idem	<i>Sargassum</i> sp.
815	25/07/2000	16.0-20.0			rocky		<i>Sargassum</i> sp., <i>Corallina elongata</i>
816	25/07/2000	41.9			gravel		No algae collected
817	25/07/2000	19.0			rocky		<i>Sargassum</i> sp.

ABBREVIATIONS USED IN TEXT

DJC – Dom João Castro Bank
ASIMOV - Advance system integration for

managing the coordinated operation of robotic ocean vehicles

DBUA - Department of Biology of the University of the Azores, Ponta Delgada.

DOP/UAç - Department of Oceanography and Fisheries, University of the Azores, Horta
ImagDOP - Image bank and multimedia nucleus of the Department of Oceanography and Fisheries, University of the Azores, Horta.
CLEMAM - Check List of European Marine Mollusca
IMAR - Instituto do Mar

RESULTS

Thirty three species of marine molluscs were recorded as new for DJC, (25 gastropods, 7 bivalves and 1 cephalopoda), which brings the total number of species to 42 known for this specific area.

TAXONOMIC LIST OF MOLLUSCS FROM D. JOÃO DE CASTRO BANK

GASTROPODA

Family Patellidae

Patella aspera Gmelin, 1791
Patella sp. DOP Expedition 1996.
Patella aspera Gmelin, 1791.
ASIMOV Expedition 2000.

Family Scissurellidae

Sinezona cingulata (Costa O. G., 1861)
DBUA 812, 813, 816.

Family Haliotidae

Haliotis tuberculata coccinea Reeve, 1846
DOP Expedition 1996. ÁVILA, (1997), WIRTZ & D'UDENKEN D'ACÓZ (1999).

Family Trochidae

***Calliostoma* sp.**

Calliostoma cf. *zizyphinum* (Linnaeus, 1758). Banco D. João de Castro (Ávila, 1997: 405) (misidentification). WIRTZ & D'UDENKEN D'ACÓZ (1999), ASIMOV Expedition 2000 (misidentification).
Calliostoma sp. DBUA 813, 814.

Jujubinus pseudogravinae Nordsieck, 1973
DBUA 814.

Family Tricoliidae

Tricolia pullus azorica Dautzenberg, 1889
DBUA 816 (only fragments of shell and one operculum).

ORDER APOGASTROPODA

Family Cerithiidae

Bittium latreillii (Payraudeau, 1826)
DBUA 811, 812, 813, 815, 816.

Family Triphoridae

Marshallora adversa (Montagu, 1803)
DBUA 811(?), 812.

Family Rissoidae

Alvania angioyi van Aartsen, 1982
DBUA 811, 813.

Alvania cancellata (da Costa, 1778)
DBUA 816.

Alvania sleursi (Amati, 1987)
DBUA 811.

Family Caecidae

***Caecum* sp.**
DBUA 816.

Family Vermetidae

Thylaeodus* cf. *rugulosus Monterosato, 1878
DBUA 815.

Vermetus* cf. *triquetrus Bivona-Bernardi, 1832
DBUA 812, 814.

Family Lamellariidae

Lamellaria latens (Müller O. F., 1776)
DBUA 816.

Family Cassidae

Phalium granulatum (Born, 1778)
DOP Expedition 1996.
Phalium undulatum (Gmelin, 1791). ÁVILA (1997).

Family *Ranellidae*

Charonia lampas lampas (Linnaeus, 1758)

Charonia lampas lampas (Linnaeus, 1758).
DOP Expedition 1996. ÁVILA (1997). WIRTZ
& D'UDENKEN D'ACUZ (1999).

Cymatium parthenopeum parthenopeum (von
Salis, 1793)

ÁVILA (1997)

Family *Bursidae*

Bursa scrobilator (Linnaeus, 1758)

ÁVILA (1997)

Family *Muricidae*

Ocinebrina aciculata (Lamarck, 1822)

DBUA 813.

Stramonita haemastoma haemastoma (Linnaeus,
1766)

DBUA 813, 815.

Thais haemastoma (Linnaeus, 1767). Ávila
(1997).

Stramonita haemastoma (Linnaeus, 1766).
WIRTZ & D'UDENKEN D'ACUZ (1999).
ASIMOV Expedition 2000.

Family *Coralliophilidae*

Coralliophila meyendorffi (Calcara, 1845)

DBUA 815.

Family *Nassariidae*

Nassarius incrassatus (Strøm, 1768)

DBUA 815.

Family *Columbellidae*

Columbella adansoni Menke, 1853

ASIMOV Expedition 2000. DBUA 811, 813,
815, 816.

Family *Mitridae*

Mitra cornea Lamarck, 1811

DBUA 815.

Family *Conidae*

Anachis avaroides Nordsieck, 1975

DBUA 811, 813, 814, 815.

Mitromorpha crenipicta (Dautzenberg, 1889)

DBUA 816.

Raphitoma linearis (Montagu, 1803)

DBUA 816.

Family *Omalogyridae*

Omalogyra atomus (Philippi, 1841)

DBUA 811, 813.

Family *Cavoliniidae*

Cavolinia inflexa (Lesueur, 1813)

DBUA 815.

Family *Limacinidae*

Limacina inflata (d'Orbigny, 1836)

DBUA 816.

Family *Discodorididae*

Discodoris atromaculata (Bergh, 1880)

DOP Expedition 1996.

BIVALVIA

Family *Arcidae*

Arca tetragona Poli, 1795

DBUA 811, 812, 815.

Family *Mytilidae*

Trichomusculus semigranatus (Reeve, 1858)

DBUA 811, 812, 813, 814, 815, 816.

Family *Pinnidae*

Pinna rudis Linnaeus, 1758

Expedition DOP 1996. ÁVILA (1997).
ASIMOV Expedition 2000.

Family *Pectinidae*

Palliolium incomparabile (Risso, 1826)

DBUA 812.

Crassadoma pusio (Linnaeus, 1758)

DBUA 811, 812, 813, 814, 815.

Family *Anomiidae*

Anomia ephippium Linnaeus, 1758

ÁVILA (1997). ASIMOV Expedition 2000.

Family Limidae

Limaria hians (Gmelin, 1791)
DBUA 814.

Family Chamidae

Pseudochama gryphina (Lamarck, 1819)
DBUA 813, 815.

Family Semelidae

Ervilia castanea (Montagu, 1803)
DOP Expedition 1996. DBUA 816.

CEPHALOPODA

Family Octopodidae

Octopus vulgaris Cuvier, 1797
DOP Expedition 1996. ASIMOV Expedition
2000.

DISCUSSION

A revision of the Patellidae was recently undertaken by TITSELAAR (1998), who classified two species occurring in the Azores as *Patella gomesi* Drouët, 1858 and *P. ulyssiponensis* Gmelin, 1791. ÁVILA et al. (2000a) followed LE RENARD 2003 using the names *Patella candei* d'Orbigny, 1840 (= *P. gomesi* sensu Titselaar) and *Patella ulyssiponensis* Gmelin, 1791. However, KOUAPANOU et al. (1999), based on partial sequences of the 12S and 16S mitochondrial genes, and HAWKINS et al. (2000), suggested that the Atlantic island and European mainland forms of *P. aspera* s. l. (= *P. ulyssiponensis*) may be separate species. According to these authors, *P. ulyssiponensis* should be applied to the European species, whereas this species of *Patella ulyssiponensis* s.l. in the Azores belong to a single species, *P. aspera* s. s. An integration of the morphological and genetic data is needed prior to a taxonomical decision is made.

None of the recorded species are considered rare or endangered. However, limpets are commercially endangered at a regional level and the harvests are regulated by regional laws (Decreto Regulamentar Regional no. 14/93/A). National law regulates *Octopus vulgaris*, for

stock management reasons (Portaria no. 281-C/97).

At depths comparable to those found at D. João de Castro Bank, the most abundant gastropods found in the rocky shores of the Azorean islands, are *Bittium latreillii*, *Tricolia pullus azorica*, *Alvania sleursi*, *Anachis avaroides* and *Jujubinus pseudogravinae* (ÁVILA 2003). These also occur at DJC although *T. pullus azorica* was found only as dead fragments. However, common Azorean infralittoral species as *Alvania poucheti* and *Setia subvaricosa*, are not present at DJC bank. The lack of these mollusc species in DJC, might be a result of the young geological age of this area (only 280 years), the reduced size of shallow water area (above 50 m depth only 600 m x 300 m), its high exposition to strong currents and wave action, the relative isolation of the seamount (36 miles apart from the nearest island), the presence of hydrothermal vents or a combinations of these factors.

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REFERENCES

- AGOSTINHO, J. 1934. The volcanoes of the Azores. *Bulletin Volcanologic* 8: 123-138.
AGOSTINHO, J. 1960. Actividade vulcânica nos Açores. *Açoreana* 5: 362-478.

- ÁVILA, S.P. 1997. Moluscos marinhos recolhidos no Banco "D. João de Castro". *Açoreana* 8(3): 331-332.
- ÁVILA, S.P. 2000a. Shallow-water marine molluscs of the Azores: biogeographical relationships. *Arquipélago. Life and Marine Sciences, Supplement 2 (Part A)*: 99-131.
- ÁVILA, S.P. 2000b. The shallow-water Rissoidae (Mollusca, Gastropoda) of the Azores and some aspects of their ecology. *Iberus* 18(2): 51-76.
- ÁVILA, S.P. 2003. The littoral molluscs (Gastropoda, Bivalvia and Polyplacophora) of São Vicente, Capelas (São Miguel Island, Azores): ecology and biological associations to algae. *Iberus* 21(1): 11-33.
- ÁVILA, S.P., J.M.N. AZEVEDO, J.M. GONÇALVES, J. FONTES & F. CARDIGOS 2000a. Checklist of the shallow-water marine molluscs of the Azores: 2 - São Miguel island. *Açoreana* 9(2): 139-173.
- ÁVILA, S.P., J. FONTES, F. TEMPERA & F. CARDIGOS 2000b. Additions to the marine molluscs of the Formigas islets, Azores. *Açoreana* 9(2): 175-178.
- ÁVILA, S.P. & A. ALBERGARIA 2002. The shallow-water Polyplacophora of the Azores and some comments on the biogeographical relationships of the Azorean malacofauna. *Bollettino Malacologico* 38(1-4): 41-44.
- CARDIGOS, F., A. COLAÇO & R.S. SANTOS 2000. Projectos de Investigação Científica: o caso ASIMOV. *Revista Mundo Submerso* (IV)48: 54-59.
- HAWKINS, S.J., H.B.S.M. CORTE-REAL, F.G. PANNACCIULLI, L.C. WEBER & J.D.D. BISHOP 2000. Thoughts on the ecology and evolution of the intertidal biota of the Azores and other Atlantic islands. *Hydrobiologia* 440: 3-17.
- KOUFOPANOU, V., D.G. REID, S.A. RIDGWAY & R.H. THOMAS 1999. A molecular phylogeny of the patellid limpets (Gastropoda: Patellidae) and its implications for the origins of their antitropical distribution. *Molecular Phylogenetics and Evolution* 11(1): 138-156.
- LE RENARD, J. 2003. Check List of European Marine Mollusca. *Unitas Malacologia, Internet Resources for Malacologists*. Available from: www.mnhn.fr/base/malaco.html. Last accessed: 22 November, 2003.
- MACHADO, F. 1967. Active volcanoes in the Azores. Pp. 7-52 in: VAN PADANG, N., A.F. RICHARDS, F. MACHADO, T. BRAVO, E. BAKER & W. LE MAITRE (Eds). Part XXI, Atlantic Ocean. *Catalogue of the Active Volcanoes of the World*, Roma: *International Association of Volcanology* 128 pp.
- MACHADO, F. & R. LEMOS 1998. Sobre uma possível erupção submarina no Banco D. João de Castro em 1997. *Açoreana* 8(4): 559-564.
- PASCOAL, A., P. OLIVEIRA, C. SILVESTRE, L. SEBASTIÃO, M. RUFINO, V. BARROSO, J. GOMES, G. AYELA, P. COINCE, M. CARDEW, A. RYAN, H. BRAITHWAITE, N. CARDEW, J. TREPTE, N. SEUBE, J. CHAMPEAU, P. DHAUSSY, V. SAUCE, R. MOITIÉ, R.S. SANTOS, F. CARDIGOS, M. BRUSSIEUX & P. DANDO 2000. *Advance system integration for managing the coordinated operation of robotic ocean vehicles (ASIMOV)*. EuroOCEANS 2000. 7 pp.
- SANTOS, R.S., J. GONÇALVES & F. CARDIGOS, 1996. D. João de Castro Bank. *Report to the European Community under contract INTAS project 94-0592*: 1- 5.
- SEGERS, W. 2002. On some shallow-water marine molluscs of the Azores. *Gloria Maris* 41(4-5): 84-104.
- TITSELAAR, F.F.L.M. 1998. A revision of the recent European Patellidae (Mollusca: Gastropoda) Part 1. The Patellidae of the Azores, Madeira, the Selvagens and the Canary Islands. *Vita Marina Magazine* 45(1-2): 21-62
- WESTON, F.S. 1964. List of recorded volcanic eruptions in the Azores with brief reports. *Boletim do Museu e Laboratório Mineralógico e Geológico da Universidade de Lisboa* 10: 3-18.
- WIRTZ, P. & D'UDEKEN D'ACÓZ, C. 1999. List of animal species seen during four dives at the Banco João de Castro. Report for ASIMOV Project. 2p.

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