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Interactive comment on "Differential gene expression in the mussel *Bathymodiolus azoricus* from the Menez Gwen and Lucky Strike deep-sea hydrothermal vent sites" *by* R. Bettencourt et al.

R. Bettencourt et al.

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Rebuttal Anonymous Referee #2 We thank Referee #2 for taking the time to review our discussion paper. We understand the paper in its present form, reveals some inconsistencies and confusing interpretations partially due to an apparent lack of "story-line" and incoherent flow between different sections and experiments reported. This was reconsidered and carefully amended in the revised version of the manuscript but readers and public audience should be aware that the work presented is of descriptive nature and not aiming at the characterization of physiological reactions and molecular mechanisms in light of differences found in gene expression between Menez Gwen and Lucky

Strike B. azoricus mussels. In the contrary, our manuscript was aiming at the finding of "signatures" or "markers" of descriptive nature, supported by differences found at gene expression levels, in-situ hybridization results and 16S amplicon sequencing results. All three have the potential to show differences of such markers or signatures pointing at the geographical origin of both Menez Gwen and Lucky Strike populations and interpret our results in light of our long-standing knowledge of immune genes in B. azoricus and more recently our microbial community studies from gill tissues.

We believe the paper was harshly misevaluated due to an error on our part in writing the probe sequences used in in-situ hybridization experiments. We have in most of the cases and several years, used oligonucleotide probes aimed at nuclear genes instead of ribosomal genes. While the so called "correct general "standard FISH probes have been extensively popularized, and Duperron's probes are well known for targeting 16S rRNA, nothing really impedes someone of using other probes of different sequences and test them in FISH experiments as they might work just as well. Not only we wanted to use probes targeting nuclear genes (this somewhat novel but it has now become more and more in use, especially in Nicole Dubilier's lab) we wanted also to base our probes on bacterial sequences that we have revealed from our own transcriptome studies in B. azoricus not someone else's sequences. Ribo probes work as well as cDNA probes as long as they follow the rules of base complementarity, RNA integrity (whether or not the target RNA is intact) and are targeting coding sequences since this is what we wanted to target, after all, expressed mRNA. In the present study we wanted to target the MMO and sulfur oxidation genes and used probes that were designed to target the respective nuclear genes: MMO- CACTAACTATGCTAACCGCGATGTCA SOX- CGACTAGGAGCACATCTATTAGGTTT

The sequences for our MMO probe design came from our sequence >mussel_c5320 length: 933 methane monooxygenase protein A [Methylococcaceae bacterium SF-BR] ensued from our transcriptomics studies already published and referred in the discussion paper as Bettencourt et al. 2010 BMC Genomics BMC Genomics, 11, 559,

doi:10.1186/1471-2164-11-559, 2010 and Egas et al. 2012 Mar. Drugs, 10, 1765–1783, 2012.

The sequence for our SOX probe design came from our sequence >mussel_c3834 length: 922 sulfur oxidation protein SoxY [Sulfurovum sp. NBC37-1] Ensued form the same published studies as above

A BLAST search in NCBI confirmed that our complementary sequence resulted in hits within Bathymodiolus MMO gene

Bathymodiolus brooksi gill symbiont clone GoM_Chap_pmoA_2.1 particulate methane monooxygenase A (pmoA) gene, partial cds Sequence ID: gb|JN021262.1|Length: 467Number of Matches: 1 Related Information Range 1: 58 to 83GenBankGraphicsNext MatchPrevious MatchFirst Match Alignment statistics for match #1 Score Expect Identities Gaps Strand Frame 52.0 bits(26) 7e-05() 26/26(100%) 0/26(0%) Plus/Minus Features: Query 1 GTGATTGATACGATTGGCGCTACAGT 26 |||||||||||||||||||||||||| Sbjct 83 GTGATTGATACGATTGGCGCTACAGT 58

GenBankGraphicsNextPreviousDescriptions Endosymbiont of Bathymodiolus puteoserpentis partial pmoA gene for particulate methane monooxygenase subunit A, sequence ID #7986 Sequence ID: emb|FR865039.1|Length: 471Number of Matches: 1 Related Information Range 1: 31 to 56GenBankGraphicsNext MatchPrevious MatchFirst Match Alignment statistics for match #1 Score Expect Identities Gaps Strand Frame 52.0 bits(26) 7e-05() 26/26(100%) 0/26(0%) Plus/Minus Features: Query 1 GTGATTGATACGATTGGCGCTACAGT 26 |||||||||||||||||||||||||| Sbjct 56 GTGATTGATACGATTGGCGCTACAGT 31

A BLAST search in NCBI confirmed that our sequence >mussel_c3834 length: 922 sulfur oxidation protein SoxY [Sulfurovum sp. NBC37-1] from which our SOX in-situ probe was designed is indeed matching proteins hits containing the SOX Y domain from SOX Y superfamily GenPeptGraphicsNextPreviousDescriptions sulfur oxidation protein SoxY [Sulfurovum sp. AR] Sequence ID: ref|ZP_10062574.1|Length: 155Num-

ber of Matches: 1 Related Information Range 1: 6 to 155GenPeptGraphicsNext MatchPrevious MatchFirst Match Alignment statistics for match #1 Score Expect Method Identities Positives Gaps Frame 205 bits(522) 2e-62() Compositional matrix adjust. 119/150(79%) 135/150(90%) 0/150(0%) +1 Features: Query 301 FLKSICaasavvatvspsllvaKDAPKGGNALSYDAAvvtitggkvvtgSDKIKLTVPEI 480 F+KSICAASAV ATV+PS L AK+APKGGN LSYDAAV ITGGK V SDK+ LTVPEI Sbjct 6 FIKSICAASAVAATVTPSALFAKEAPKGGNVLSYDAAVAAITGGKAVADSDKVNLTVPEI 65

Query 481 AENGAVVPVKVNVESPMTDADYVKAIHVLTTKNSNARCADVMLTPLNGKGYFATRVKLGG 660 AENGAVVPVKV+V+ PM + +YVKAIHVL+TKN NARCADVMLTPLNGKGYFATR+KLGG Sbjct 66 AENGAVVPVKVDVDHPMEENNYVKAIHVLSTKNGNARCADVMLTPLNGKGYFATRIKLGG 125

Query 661 TQDVVALVEMSDGSFLRAAKPVKVTIGGCG 750 TQDVVALVE+S+G+F+++AK VKVTIGGCG Sbjct 126 TQDVVALVELSNGTFIKSAKSVKVTIGGCG 155

GenPeptGraphicsNextPreviousDescriptions sulfur oxidation protein SoxY [Sulfurovum sp. NBC37-1] Sequence ID: ref|YP_001357815.1|Length: 159Number of Matches: 1 Related Information Gene-associated gene details Range 1: 32 to 159GenPeptGraphicsNext MatchPrevious MatchFirst Match Alignment statistics for match #1 Score Expect Method Identities Positives Gaps Frame 178 bits(452) 7e-52() Compositional matrix adjust. 90/128(70%) 105/128(82%) 0/128(0%) +1 Features: Query 367 KDAPKGGNALSYDAAvvtitggkvvtgSDKIKLTVPEIAENGAVVPVKVNVESPMTDADY 546 K PKG NALS +AA+ ITGGK SDK+KLTVPEIAENGAVVPVKVNV+ PM + +Y Sbjct 32 KAVPKGPNALSVEAAIDAITGGKGAKESDKVKLTVPEIAENGAVVPVKVNVDHPMEEGNY 91

Query 547 VKAIHVLTTKNSNARCADVMLTPLNGKGYFATRVKLGGTQDVVALVEMSDGSFLRAAKPV 726 VKAIHVL KN N+RC DVMLTP NGK YFATR+KLG TQ+V+ + E+SDG+F++AAK V Sbjct 92 VKAIHVLAAKNGNSRCVDVMLTPANGKAYFATRIKLGSTQEVIGVAELSDGTFIKAAKSV 151

Query 727 KVTIGGCG 750 KVTIGGCG Sbjct 152 KVTIGGCG 159

So in conclusion, our probes are theoretically good for FISH experiments and results obtained do show signal specificity. The mistake describing our FISH probes was detrimental to referee's evaluation of the manuscript, since we wanted to target functional genes but led the referee to believe that the 16S rRNA was targeted.

The auto-fluorescence referred by the referee is simply not accurate. First of all it does not come from lipid droplets! But rather sugar granules that we have already figured out in 2008 and reported in a paper from that year Bettencourt et al. 2008 Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology May 2008, Volume 150, Issue 1, Pages 1-7. The ALEXA fluorochromes are the finest available in the market and their spectrum of absorbance and emission are well defined and would only being visualized with appropriate filters from the fluorescent microscope such as ours, a Leica DM6000. Auto-fluorescence is only visualized in the present case at UV emission well below the spectrum used by our ALEXA Fluorochrome, hence the specificity.

Regarding the bacterial community criticism: We have devoted 1 full-length article to this question apart from our work published in 2010 Bettencourt et al. BMC Genomics in which we described in detail how the cDNA library was built and how we ended up with 3000 bacterial genes sequences which made through the poly-A selection during the course of library preparation and prior to 454 sequencing. Bacterial mRNA do not have poly-A tails, right, but it is not true that bacterial mRNA will be removed after poly-A selection, actually some bacterial RNAs are poly-adenylated too. The point here is not to debate whether or not our initial cDNA was "contaminated" with bacterial mRNA but to deal with the fact that in our initial work on the transcriptome sequencing of B. azoricus gill tissues (vide Bettencourt et al. 2010 BMC Genomics) some 3000 cDNA sequences were revealed pointing at functional bacterial genes that were subjected to the MG RAST, the Metagenomics RAST server, an automated analysis platform for metagenomes providing quantitative insights into microbial populations

based on sequence data. This is a fact that cannot go unnoticed and that prompted us to dedicate another work published in Marine Drugs by Egas et al. 2012 with the title "The Transcriptome of Bathymodiolus azoricus Gill Reveals Expression of Genes from Endosymbionts and Free-Living Deep-Sea Bacteria". I do agree with the anonymous reviewer in that the V6 sequencing experiment also has little value, given the possibility that cDNA libraries were poorly represented by bacterial mRNA, however it was not clearly written or stated in our paper that both LS and MG cDNA libraries were obtained by using random primers and not oligo-dT during the process of reverse-transcription and that would significantly change the outcome of our analyses. The same total RNA was used but reverse-transcribed differently, using random primers instead of oligo-dT. Moreover, the 16S amplicon sequencing was strictly meant for gill's microbiome structure analyses, not for quantifying bacterial gene expression. Furthermore, the cDNA library used for qPCR of bacterial genes might have been inappropriate to the reviewer's view, as this was subjected to poly-A selection but it was primarily generated for host gene expression studies, nonetheless given our previous results on the transcriptome sequencing of B. azoricus gill tissues and the bacterial genes that were revealed then, we felt compelled to pursue these qPCR experiments even with the same cDNA libraries. It is not uncommon that mispriming events do occur with RNA species and often cases, even ribosomal RNA will be misprimed with oligo-dT and reverse-transcribed into cDNA. rRNA is expressed at a very high level, so even a little leaky priming by nonspecific priming would work rather well, but not as well as the random priming. Such abundant RNA species (rRNA) almost invite mispriming merely by being highly present and thus a small amount will always be reverse transcribed into cDNA, including bacterial mRNA, because of normal, expected low-level RT mis-priming events... One has to assume in the present case that bacterial mRNA was highly present in our gill total RNA extractions. In view of this, the manuscript has been re-written taking into account the referee's criticisms in what regards the result being a mixture between bacterial densities and activities. In deed we have addressed in a more intelligible way the hypothesis being tested in the present study that is whether

or not there are site-related differences in gene expression and bacterial densities in the mussel Bathymodiolus azoricus from the Menez Gwen and Lucky Strike deep-sea hydrothermal vent sites that could serve as markers for distinguishing different B-azoricus mussels from either vent sites. Moreover, the argument that the presence of bacterial density and how it might influence marker genes of immune response, has been addressed in the Discussion section.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/10/C5327/2013/bgd-10-C5327-2013-supplement.pdf

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