## Analysis and visualization of phylogenetic xml trees

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Abstract - Biological organisms have evolved from single-celled bacteria to multicellular animals such as humans in a time-span of 4 billion years. During this evolutionary time, millions of different biological species have evolved from a single common ancestor. Such diversity in life has made the understanding and visualization of biological evolution a challenge. Phylogeny and relationship of organisms is in the form of a tree structure which can be represented in the form of an xml tree structure. Here we characterize and visualize a phylogenetic xml file by displaying its various branches using XSLT and converting part of the phylogenetic tree into SQL. Finally, we also visualize the entire phylogenetic tree using the software archaeoptervx.

## Introduction

Biological evolution of living organisms has occurred over a span of four billion years giving rise to wide variety of living species. The best data structure to store and analyze this massive amount of biological diversity is in the form of an xml tree.

However, there are several challenges in the construction and visualization of an xml database. First, in many cases, the confidence in delineating a particular lineage of biological species can be difficult. Secondly, in many cases many species are either unnamed or haven't been characterized completely. Such drawbacks make storing of phylogenetic data difficult in traditional SQL databases making NoSQL databases an obvious choice.

We have made use of XSLT to parse out those branches of the XML tree which have confidence above a certain threshold at various levels of the phylogenetic tree. We have also converted part of the XML tree into SQL using a custom python script to enable us firing query in traditional relational databases.

## Methods

a) Parsing of xml database with XSLT

An XSLT file was created which prints the branch length, confidence, and scientific name of a particular branch in the xml database. It then uses a series of nested for-loops to print out all the sub-branches in a tree using a threshold confidence of 80%. It prints the output in HTML tabular format, which can be easily viewed using a web browser.

b) Conversion of xml tree into SQL database

For this task, we chose Python language to write a script to perform the necessary task. We used two external Python libraries named BioPython and Psycopg2. Bio.Phylo contains a submodule 'PhyloXML' which was used to handle parsing and tokenizing the XML trees. Psycopg2 was used to connect to the PostgreSQL database. First, we tokenized the XML tree into tags using Phylo.read() function. Then we had to decide which tags are essential and omit the others, so we created a database to store those values. Finally, we connected to the PostgreSQL database and feed it the tokens we generated in the previous phase.

c) Visualization of phylogenetic tree using archaeopteryx

## **Results and Discussion**

- a) XSLT results
- b) SQL conversion and query

SQL conversion of XML proved to be a tough feat to achieve. Unlike SQL, XML is not well structured and the XML database we used **Commented [1]:** Briefly describe your custom python code here.

Also talk about the SQL queries.

**Commented [2]:** Discuss any details here regarding how you generated the diagram.

proved to be impossible to work with. Most of the species identified don't have a name ascribed to them. Some species don't have a confidence level mentioned in the XML. Some have scientific names while some don't. So, to avoid a lot of empty entries we decided to lose some information like 'scientific name' which have very rare occurrence. Converting this data manually is ineffective because it will require more time. Also, if we don't drop a few details, SQL transformation is possible but it will waste a lot of space since most of the columns will be empty. This is the list of the properties which we chose to include:

BRANCH\_NAME VARCHAR(20), BRANCH\_LENGTH FLOAT(20), TOTAL\_BRANCH\_LENGTH FLOAT(20), CONFIDENCE INTEGER, NODE\_PATH\_LENGTH INTEGER, TERMINALS\_NUMBER INT, PARENT\_NODE VARCHAR(20)

If a species doesn't have a name, we denote it as "Bx" where x stands for an integer value.

We were able to extract data of 134 species from the XML and convert it into SQL format with the above approach.

The output for query "select \* from phyloxml" can be seen in the snapshots given at the end of this report. Furthermore, we could fire up a query to find information with specific constraints like (confidence > 50 AND confidence < 75) or descendants of a species by firing simple SQL queries like

- "select \* from phyloxml where confidence > 50 AND confidence <75;"</li>
   "select \* from phyloxml where parent\_node = 'B40';"
- c) Visualization of xml file

**Commented [3]:** Mention the number of records converted into SQL.

Show some sample SQL queries. A screenshot would be great.

Mention that everything cannot be converted since the XML file does not have a definite schema.

 $\label{lem:commented [4]: Add the picture of the phylogenetic tree here. You may want to mention the total numb er of branches in the 1st, 2nd and third levels.}$ 

branch_name	branch_length	total_branch_length	confidence	node_path_length	terminals_number	parent_node		
	0.100405	0.100405	100	1	38	ROOT		
	0.41517	0.515575	100		18	B2		
	0.30159	0.817165	97			B3		
	0.15021	0.96737500000000001	69			B4		
	0.04885	1.01622500000000002	68			B5		
	0.04633	1.06255500000000001	59			B6		
	0.18918	1.251735	100			B7		
	0.07518	1.326915	97			B8		
θ	0.0073	1.33421500000000002	100			B9		
	0.0036	1.33781500000000002	91			B10		
001025424.1	0.00001	1.33782500000000003	0			B11		
	0.00327	1.34108500000000003	0	11		B11		
CLCN7	0.00962	1.34383500000000001	0			B10		
Clcn7	0.28745	1.614365	0			B9		
Clcn_g150497	0.12824	1.379975	0			B8		
Clc_146907	0.38499	1.447545	0	7		B7		
	0.37118	1.38740500000000002	100			B6		
Clc_CG8594	0.29315	1.68055500000000002	0			B13		
Clc_g16563	0.18816	1.575565	0			B13		
4	0.4337	1.401075	100			B5		
Clcn_CBG23365	0.02104	1.422115	0			B14		
Clcn_CE29336	0.00466	1.40573500000000002	0			B14		
	0.27675	1.093915	100			B4		
	0.16193	1.2558449999999999	100			B15		
	0.06936	1.325205	98			B16		
	0.03192	1.357125	100			B17		
	0.02482	1.381945	99			B18		
Clcn6	0.01157	1.393515	0			B19		
Clcn6	0.00537	1.387315	0			B19		
CLCN6	0.00234	1.359465	0			B18		
Clcn6	0.08378	1.408985	0			B17		
Clcn_g153343	0.23936	1.495205	0			B16		
Clc_139586	0.35537	1.449285	0			B15		
0	0.37011	0.88568500000000001	100			B3		
Clc_145284	0.32143	1.207115	0			B20		
Clcn_nov1	0.47263	1.35831500000000002	0			B20		
	0.42764	0.528045	100		20	B2		
	0.05585	0.5838949999999999				B21		
	0.06146	0.6453549999999999	92			B22		
	0.1309	0.7762549999999999	100			B23		
	0.05406	0.8303149999999999	67	l 6	10	B24		

	0.07178	0.9020949999999999			5	B25				
	0.0163	0.9183949999999999	86	8	4	B26				
	0.04239	0.9607849999999999	100		3	B27				
	0.0038	0.9645849999999999		10	2	B28				
.cn5	0.00001	0.9645949999999999	0		1	B29				
.cn5	0.00001	0.9645949999999999	0		1	B29				
_CN5	0.00803	0.9688149999999999	0	10	1	B28				
.cn5	0.06559	0.9839849999999999	0	9	1	B27				
.cn_g151908	0.21641	1.1185049999999999	0	8	1	B26				
	0.08833	0.91864499999999999	100		5	B25				
	0.01718	0.9358249999999999	100	8	4	B30				
	0.00177	0.937595			3	B31				
	0.00671	0.944305	70	10	2					
lcn4	0.00001	0.9443149999999999	0	11	1					
cn4	0.01342	0.9577249999999999	0		1					
CN4	0.00001	0.9376049999999999	0	10	1	B32				
lcn4	0.02178	0.9576049999999999	0	9	1					
lcn_g153787	0.05099	0.9696349999999999	0	8	1	B30				
	0.0705	0.8467549999999999	100	6	5	B24				
	0.01719	0.863945	100		4	B34				
	0.00481	0.8687549999999999	90	8	3	B35				
	0.00001	0.8687649999999999	45	9	2	B36				
	0.00336	0.8721249999999999	0	10	1					
.CN3	0.00001	0.8687749999999999	0	10	1	B37				
	0.00001	0.8687649999999999	0		1	B36				
	0.00361	0.867555	0	8	1	B35				
.cn_g127864	0.04395	0.890705	0		1	B34				
.c_140203	0.28639	0.9317449999999998	0		1	B23				
	0.1894	0.773295			2	B22				
.c_g16174	0.05022	0.823515	0		1	B38				
.c_CG5284	0.16939	0.942685	0		1	B38				
	0.30137	0.829415	100		2	B21				
.cn_CBG03262	0.00001	0.829425	0		1	B39				
.cn_CE27360	0.02216	0.851575	0	4	1	B39				
	0.565495	0.565495	100		30	ROOT				
	0.15381	0.719305	64		22	B40				
	0.03139	0.750695	59		14	B41				
	0.09003	0.840725			12	B42				
	0.10834	0.9490649999999999	100		11	B43				
	0.14142	1.090485	100		5	B44				
	0.07698	1.167465	99		4	B45				
	0.0994	1.266865	100	8	3	B46				
	0.02139	1.288255	100		2	B47				
re										

ICLCn1 	0.00347	1.291725	a .	10	1 B48	
Clcn_g146581	0.023	1.2898649999999998	0   0		1 B47	
	0.10289 0.23436	1.270355   1.3248449999999998	0   0	8   7	1   B46 1   B45	
	0.13663	1.08569499999999999	99		6   B44	
	0.02272	1.108415 1.179795	50   65	7   8	5   B49 4   B50	
	0.07977	1.2595649999999998	100		3   851	
	0.0061 0.00453	1.26566499999999998	64   0	10   11	2   B52 1   B53	
lcn2	0.00755	1.2732149999999999	0	11	1 B53	
LCN2 lcn2	0.01584 0.05756	1.275405   1.237355	0   0	10   9	1   B52 1   B51	
lcn g129629	0.02989	1.138305	0	8	1   B50	
lcn_g132311 lc_142005	0.08432   0.32253	1.1700149999999999   1.163255	0   0	7   5	1   B49 1   B43	
	0.28604	1.036735	100	4	2 B42	
.c_CG31116 .c_g16123	0.08284 0.08822	1.119575 1.124955	0   0	5   5	1   B54 1   B54	
	0.19888	0.918185	64		8 B41	
	0.32241   0.19492	1.240595 1.4355149999999999	100   100		4   B55 2   B56	
.cn_CE20461	0.01486	1.450375	0	6	1   B57	
.cn_CBG02916	0.00001	1.435525   1.661625	0   100	6   5	1   B57 2   B56	
.cn_CE27450	0.01893	1.6805549999999998	0	6 İ	1 B58	
.cn_CBG03117	0.00319 0.12841	1.664815 1.046595	0   44	6	1   B58 4   B55	
	0.25828	1.304875	100		2 B59	
.cn_CBG13104   .cn_CE27906	0.08006 0.0634	1.384935   1.368275	0 j	6	1   B60 1   B60	
	0.5062	1.552795	100		2 B59	
cn_CE28647 cn_CBG14338	0.0356	1.588395   1.580585	0   0	6   6	1   B61 1   B61	
CII_CD014330	0.35485	0.920345	100	2	8 B40	
	0.1213 0.25749	1.041645 1.299135	97   100	3   4	7   B62 6   B63	
	0.07581	1.3749449999999999	100		4 B64	
ckno	0.06387	1.438815   1.472095	100   0	6   7	2 B65	
ckna   ckna	0.01039	1.44920499999999999	e i		1 B66	
re	0.05298	1.42792499999999999	100		2 B65	
QL						- 0
.cn2	0.00453   0.00755	1.2701949999999997   1.273214999999998	0   0	11   11	1   853 1   853	- 0
cn2   cn2   CN2	0.01584	1.2732149999999998 1.275405	0	10	1   852	- 0
cn2   cn2   CN2   cn2	0.01584   0.05756   0.02989	1.2732149999999998	0   0   0   0	10   9   8	1   852 1   851 1   850	- 0
cn2   cn2   CN2   cn2	0.01584   0.05756   0.02989   0.08432	1.2732149999999998 1.275405 1.237355 1.138305 1.1700149999999998	0   0   0   0	10   9   8   7	1   B52 1   B51 1   B50 1   B49	- 0
cn2 cn2 CN2 cn2 cn_g129629 cn_g132311 c_142005	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604	1.2732149999999998 1.275405 1.237355 1.138305 1.170014999999999 1.163255 1.036735	0   0   0   0	10   9   8   7   5   4	1   B52 1   B51 1   B50 1   B49 1   B43 2   B42	- 0
cn2 cn2 cn2 cn2 cn2 cn2 cn_g129629 cn_g132311 c_142005 c_CG31116	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604   0.08284	1.273214999999998 1.275405 1.237355 1.138305 1.1700149999999998 1.163255 1.036735 1.119575	0   0   0   0   100	10   9   8   7   5   4	1   B52 1   B51 1   B56 1   B49 1   B43 2   B42 1   B54	- 0
cn2 cn2 cn2 cn2 cn2 cn2 cn_g129629 cn_g132311 c_142005 c_CG31116	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604   0.08284   0.08822	1.2732149999999998 1.275405 1.237355 1.138305 1.170014999999999 1.163255 1.036735	0   0   0   0   0   100	10   9   8   7   5   4   5   5	1   B52 1   B51 1   B50 1   B49 1   B43 2   B42	- o
cn2 cn2 cn2 cn2 cn_g129629 cn_g132311 c_142005	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604   0.08284   0.08822   0.19888   0.32241	1.273214999999998 1.275405 1.237355 1.38305 1.170014999999998 1.036735 1.119575 1.124555 0.918185 1.246595	0   0   0   0   100   0   64   100	10   9   8   7   5   4   5   5   3   4	1   852 1   858 1   859 1   849 1   843 2   842 1   854 1   854 8   841 4   855	- 0
cn2 cn2 cn2 cn2 cn_g129629 cn_g132311 c_142605 c_C631116 c_g16123	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604   0.08284   0.08822   0.19888   0.32241   0.19492   0.01486   0.01486   0.01486   0.01486   0.01575   0.01486   0.01575   0.01486   0.01575   0.01486   0.01575   0.0157	1.273214999900008 1.27349 1.27549 1.27355 1.13839 1.1636733 1.1636733 1.119575 1.124955 0.918185 1.248555 1.249555 1.249555 1.4585749999999999999999999999999999999999	0   0   0   0   100   0   64   100   100	10 9 8 7 5 4 5 3 4 5	1 852 1 851 1 856 1 849 1 843 2 842 1 854 1 854 8 841 4 855 2 856 1 857	- 0
cn2 cn2 cn2 cn2 cn_g129629 cn_g132311 c_142605 c_C631116 c_g16123	0.01584   0.05756   0.02989   0.08432   0.32253   0.26604   0.08284   0.08284   0.19888   0.32241   0.19492   0.01486   0.00001	1.2732149999909098 1.27349 1.27549 1.27349 1.33839 1.176014999999999 1.46925 1.036735 1.114957 1.124955 0.91818 1.246595 1.4355149999999999 1.435514999999999	0   0   0   0   0   100   100   100   0	10 9 8 7 5 4 5 3 4 5	1 852 1 851 1 859 1 849 1 849 2 843 2 844 1 854 8 841 4 855 2 856 1 857 1 857	- a
cn2 cn2 Cn2 Cn2 Cn2 cn_g129629 cn_g132311 cn_g132311 c_142005 c_CG31116 c_g16123 cn_CE20461 cn_CE20461	0.01584   0.05756   0.02989   0.08432   0.32253   0.28604   0.08284   0.08822   0.19888   0.32241   0.19492   0.01486   0.00001   0.42103   0.01893   0.01575	1.2732149999909098 1.27348 1.27348 1.27348 1.27355 1.23838 1.176014999999999 1.46925 1.119575 1.124955 0.918185 1.24695 1.4355149999999999 1.458375 1.686554999999999	0   0   0   0   0   0   0   0   0   0	19 9 8 7 5 5 3 4 4 5 6 6	1 852 1 851 1 859 1 849 1 843 2 842 1 854 1 855 2 855 2 855 2 855 1 857 2 856 1 856	- o
cn2 cn2 Cn2 Cn2 Cn2 cn_g129629 cn_g132311 cn_g132311 c_142005 c_CG31116 c_g16123 cn_CE20461 cn_CE20461	0.01584   0.05756   0.02989   0.08432   0.3253   0.26604   0.08284   0.08284   0.1988   0.32241   0.19492   0.01486   0.00001   0.42103   0.01893   0.00319	1.2732140999990998 1.2273755 1.23836 1.138385 1.170014999999999 1.036735 1.114975 0.918183 1.435514999999999 1.435525 1.438575 1.688554999999999	0   0   0   0   0   0   0   0   0   0	10 9 8 8 7 7 5 5 5 5 6 6 6 6 6 6	1 852 1 851 1 859 1 849 1 843 2 842 1 854 1 854 1 855 2 856 1 857 2 856 1 857 2 856 1 858 1 858	- 0
cn2 cn2 cn2 cn2 cn2 cn g1329629 cn g132311 c 142005 c C631116 c g16123 cn CE20461 cn_CE20461 cn_CE6082916 cn_CE27450 cn_CE27450 cn_CE6608117	0.01584 0.025756 0.02989 0.08432 0.32253 0.28604 0.08284 0.08822 0.19888 0.32241 0.19492 0.01486 0.00001 0.42103 0.08319 0.08319 0.12841 0.25828	1.2732140999999999 1.273485 1.27355 1.27355 1.138305 1.170014999999999 1.163275 1.119575 1.124955 0.181883 1.435514999999999 1.435525 1.680554999999999 1.68152 1.68152 1.68455499999999999998	0 0 0 0 100 0 0 64 100 0 0 100 0 44 100	10 9 8 9 7 7 5 9 4 5 5 5 6 6 6 4 5 5 5 5 6 6 6 6 5 5 6 6 6 6	1 852 1 851 1 859 1 849 1 843 2 842 1 854 1 854 1 855 2 856 1 857 1 857 2 856 1 856 1 858 1 858 2 855 2 855 2 855	- 0
Cn2	0.01584 0.05756 0.02989 0.08432 0.3253 0.28604 0.08284 0.08284 0.08882 0.19888 0.32241 0.19492 0.01486 0.00001 0.42103 0.01893 0.00319 0.12841 0.25828 0.08006	1.2732149999909098 1.273495 1.273495 1.273495 1.138395 1.1061499999999999 1.40573 1.124955 6.918185 1.246595 1.4355149999999999 1.458375 1.661625 1.668554999999999 1.688554999999999 1.688554999999999	0 0 0 0 0 0 0 0 64 100 100 0 100 0 44 100	10   9   8   7   7   5   4   5   6   6   6   6   6   6   6   6   6	1 852 1 851 1 859 1 849 1 843 2 842 1 854 1 854 4 855 2 855 2 856 1 857 1 857 1 857 1 857 2 856 1 856 1 858 4 855 2 856	- a
Cn2 Cn2 Cn2 Cn2 Cn2 Cn3 Cn3 Cn3 Cn3 Cn3 Cn4 Cn4 Cn3 Cn3 Cn4 Cn4 Cn4 Cn5 Cn5 Cn6 Cn6 Cn6 Cn6 Cn7	0.01584 0.05756 0.02989 0.08432 0.32253 0.28604 0.08284 0.08224 0.19888 0.32241 0.19492 0.01486 0.00001 0.42103 0.01893	1.2732149999909098 1.27349 1.27549 1.27345 1.27345 1.38895 1.18895 1.189575 1.124955 6.918185 1.246595 1.4355149999999999 1.458375 1.661625 1.664815 1.646595 1.946895 1.948895 1.948895 1.948895 1.948895 1.948895 1.948895	0 0 0 0 0 0 0 0 64 100 100 0 100 0 44 100 0	10   9   8   7   7   5   4   5   5   6   6   6   6   6   6   6   6	1 852 1 851 1 859 1 849 1 843 2 842 1 854 1 854 4 855 2 857 1 857 2 856 1 856 1 856 2 856 1 856 1 856 1 856 1 856 2 856	- 0
cn2 cn2 cn2 cn2 cn2 cn 2129629 cn g132311 c_142005 c_C631116 c_g16123 cn_CE20461 cn_CE20461 cn_CE609317 cn_CE609317 cn_CB673104 cn_CE673066 cn_CE78647	e. e1584 i e. e1584 i e. e1584 i e. e2989 i e. e8432 e. e. e8432 e. e. e8644 e. e822 e. e. e8224 e.	1.2732149999999999 1.27349 1.27349 1.27359 1.27369 1.38389 1.176014999999999 1.46253 1.119575 1.124955 0.918185 0.918185 1.248959 1.43551499999999999 1.458375 1.145522 1.6865549999999999 1.66895 1.9685549999999999999999999999999999999999	0 0 0 0 0 0 0 0 64 100 0 0 0 100 0 4 4 100 0 0 0	10 9 8 9 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	1 852 1 851 1 851 1 859 1 849 1 843 2 842 1 854 1 854 1 855 2 855 1 857 1 857 2 856 1 856 1 858 1 858	- 0
Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn3129629 Cn_g132311 C_142005 C_G31116 C_g16123  Cn_CE20461 Cn_CE20461 Cn_CE27450 Cn_CE603117 Cn_CB60317 Cn_CB60317 Cn_CB60316 Cn_CE27966 Cn_CE27906 Cn_CE27906 Cn_CE27906 Cn_CE28647	e. d1584 i. e. d1582 ii e. d15	1.2732149999999999 1.27349 1.27349 1.27359 1.27369 1.38389 1.176014999999999 1.603735 1.114955 0.918185 0.918185 1.246595 1.435514999999999 1.435723 1.66125 1.680554999999999 1.680554999999999 1.488935 1.98835 1.98835 1.38835 1.38835 1.588359 1.588835 0.928385	0 0 0 0 0 0 0 0 64 100 0 0 0 0 44 100 0 0 0 0 0 0 0 0 0 0	10 9 8 9 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	1 852 1 851 1 851 1 859 1 849 1 843 2 842 1 854 1 854 1 855 2 856 1 857 1 857 2 856 1 856 1 858 1 858 1 858 1 858 1 858 1 858 1 869 2 859 1 869 2 859 1 869 1 869	- a
Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn3129629 Cn_g132311 C_142005 C_G31116 C_g16123  Cn_CE20461 Cn_CE20461 Cn_CE27450 Cn_CE603117 Cn_CB60317 Cn_CB60317 Cn_CB60316 Cn_CE27966 Cn_CE27906 Cn_CE27906 Cn_CE27906 Cn_CE28647	e. e1584 j. e. e1584 j. e. e1584 j. e. e1584 j. e. e5756 e. e. e2989 j. e. e2694 j. e. e2799 j. e. e2694 j. e. e2799 j. e. e2799 j. e. e2799 j. e. e2794 j. e. e2799 j. e. e27	1.2732149999909098 1.27349 1.27549 1.27349 1.37355 1.33839 1.1760149999999999 1.169255 1.124955 1.124955 1.24695 1.44355149999999999 1.458375 1.661625 1.668554999999999 1.648815 1.646595 1.348475 1.348475 1.384935 1.368275 1.58275 1.58285	0 0 0 0 100 0 64 100 100 0 0 0 44 100 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   7   5   5   5   6   6   6   6   6   6   6	1 852 1 851 1 856 1 849 1 843 2 842 1 854 1 854 1 855 2 855 1 857 1 857 1 857 1 856 1 857 1 856 1 857 1 856 1 857 1 856 1 857 1 858 2 856 1 857 1 858 1 859 1 869 1 860 1 861 1 861 1 861 1 864 7 862 7 862 7 862 7 862 7 862 7 864 7 864 8 864 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	- o
Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn3129629 Cn_g132311 C_142005 C_G31116 C_g16123  Cn_CE20461 Cn_CE20461 Cn_CE27450 Cn_CE603117 Cn_CB60317 Cn_CB60317 Cn_CB60316 Cn_CE27966 Cn_CE27906 Cn_CE27906 Cn_CE27906 Cn_CE28647	e. e1584 j. e. e1584 j. e. e1584 j. e. e5756 e. e. e2989 e. e. e5756 j. e. e2989 j. e. e5756 j. e. e2989 j. e. e5756 j. e. e57576	1.2732140999909098 1.273495 1.273495 1.273495 1.1383895 1.1708149999999998 1.1636735 1.1149575 1.124955 1.244955 1.246	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   7   5   5   5   6   6   6   6   6   6   6	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   855 2   855 1   857 1   857 2   856 1   857 2   856 1   857 2   856 1   857 2   856 1   857 2   856 1   857 2   856 1   858 1   858 1   858 1   858 1   858 4   855 2   856 3   868 4   864 6   866 6   86	- 0
Cn2 Cn2 Cn2 Cn2 Cn2 Cn3	0. 01584   0. 05756   0. 02989   0. 05756   0. 02989   0. 08422   0. 32253   0. 32625   0. 32684   0. 08822   0. 08822   0. 08882   0. 08882   0. 08882   0. 08882   0. 08882   0. 08882   0. 08882   0. 08882   0. 08883   0. 081485   0. 044218   0. 044218   0. 044218   0. 044218   0. 04582   0. 08960   0. 05779   0. 0582   0. 0582   0. 02779   0. 0582   0. 1213   0. 0588   0. 1213   0. 0588   0. 05887   0.	1.273214999990999 1.27349 1.27549 1.27359 1.27359 1.38389 1.176014999999999 1.636735 1.124955 0.918185 0.918185 1.246595 1.435514999999999 1.435514999999999 1.435523 1.6601523 1.6601523 1.6601523 1.6601523 1.6601523 1.6601523 1.6601523 1.6601523 1.660152 1.860152	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   7   5   5   5   6   6   6   6   6   6   6	1 852 1 851 1 859 1 859 1 849 1 843 2 842 1 854 1 854 1 855 2 856 1 857 2 856 1 857 2 856 1 857 2 856 1 857 2 856 1 858 1 858 1 858 1 858 1 858 1 860 1 860 2 859 1 860 1 861 8 844 7 862 6 863 4 864 2 865	- a
Cn2 Cn2 Cn2 Cn2 Cn2 Cn3 Cn3 Cn3 Cn3 Cn3 Cn4 Cn3 Cn3 Cn4 Cn3 Cn3 Cn4 Cn4 Cn5 Cn4 Cn6 Cn6 Cn6 Cn6 Cn6 Cn6 Cn7	e. e1584 j. e. e1584 j. e. e1584 j. e. e5756 e. e. e2989 e. e. e5756 j. e. e2989 j. e. e5756 j. e. e2989 j. e. e5756 j. e. e57576	1.2732140999909098 1.27348 1.27548 1.27355 1.27489 1.138385 1.149099999999 1.686735 1.114955 0.918185 1.248595 1.4455149999999999 1.459375 1.459575 1.661625 1.66658 1.666815 1.666815 1.666815 1.666815 1.666815 1.566815	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   6   6   6   6   6   6   6   6   6	1   852 1   852 1   859 1   849 1   843 2   843 2   843 4   855 2   856 1   857 1   857 1   856 1   856 1   858 4   855 2   856 1   856 1   858 4   858 4   858 4   858 4   858 5   859 1   860 2   859 1   860 3   860 4   864 5   865 1   866 1   866	- a
Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn2 Cn3129629 Cn_g132311 C_142005 C_G31116 C_g16123  Cn_CE20461 Cn_CE20461 Cn_CE6063117 Cn_CE6063117 Cn_CE7906 C	0. 01584	1.2732140999909999 1.273755 1.273469 1.273755 1.23836 1.170014999999999 1.436735 1.114975 0.1018183 1.435514999909999 1.438525 1.680554999909999 1.438525 1.664815 1.664815 1.664815 1.664815 1.68485549999999999 1.438525 1.588295 1.588295 1.588295 1.588391 1.3749449999999999 1.438815 1.3749449999999999	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   6   6   6   6   6   6   6   6   6	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 4   855 2   856 1   857 2   856 1   857 2   856 1   858 4   855 2   856 1   858 4   855 2   856 1   887 2   856 1   887 2   856 1   887 2   856 1   887 2   856 1   888 4   855 2   856 1   886 1   866 1   866	- 0
CO2 CO2 CO2 CO2 CO3	0. 01584 1. 0. 01584 1. 0. 05756 0. 0. 03756 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	1.2732149999999999 1.273755 1.273755 1.27369 1.318389 1.176014999999999 1.1636735 1.114975 1.119575 1.124955 0.918183 1.435514999999999 1.435525 1.6865549999999999 1.586895 1.586895 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.384875 1.3848935 1.36275 1.3848935 1.36275 1.3848939	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   5   5   5   6   6   6   5   5   6   6	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 4   855 2   856 1   857 1   857 2   856 1   858 1   858 1   858 1   858 1   858 2   856 1   858 1   857 2   856 1   858 1   858 2   856 1   866 1   866 2   867 1   867 1   867 1   867 1   867 1   867	- a
CO2 CO2 CO2 CO2 CO3	6. d1584 i. 6. d5756 c. 0.2989 c. 0.3756 c. 0.2989 c. 0.3726 c. 0.2989 c. 0.3225 c. 0.2864 c. 0.8842 c. 0.8842 c. 0.8842 c. 0.9888 c. 0.	1.273214099909099 1.27345 1.27346 1.27345 1.13836 1.176814999999999 1.16827 1.124955 0.918185 1.248595 1.4485514999999999 1.458375 1.661625 1.66855499999999 1.468815 1.66855499999999 1.86875 1.86875 1.86875 1.86875 1.86875 1.86875 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384933 1.366273 1.384939	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   5   6   6   6   7   7   7   7   7   5   5   5   6   6   7   7   7   7   5   5   5   5   6   6   7   7   7   7   7   5   5   5   5   5	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 4   855 2   855 2   856 1   857 1   857 2   856 1   857 1   860 2   859 1   861 1   866 1   867 2   867 2   867 2   867 2   867 2   867 2   867	- a
CO2 CO2 CO2 CO2 CO3	0. 01584 1. 0. 01584 1. 0. 05756 0. 0. 03756 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 03750 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	1.2732149999999999 1.273755 1.273469 1.273755 1.27369 1.138385 1.106149999999999 1.1063735 1.124955 6.918183 1.4355149999999999 1.435525 1.686554999999999 1.686554999999999 1.98699999999 1.98699999999999999999999999999999999999	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   6   6   7   7   7   5   6   6   7   7   7   6   6   6   7   7	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 4   855 2   856 1   857 2   856 1   857 2   856 1   858 4   855 2   856 1   858 1   858 1   858 4   855 2   856 1   858 4   855 2   856 1   888 4   855 2   856 1   888 4   855 2   856 1   888 4   855 2   856 1   888 4   855 2   856 1   866 1   866	- 0
CO2 CO2 CO2 CO2 CO3	0. 01584 1. 0. 01584 1. 0. 01584 1. 0. 05756 0. 0. 02989 1. 0. 02253 1. 0. 02264 1. 0. 02862 1. 0. 028	1.2732149999999999 1.273755 1.273755 1.273755 1.138385 1.1760149999999999 1.036735 1.1149575 1.124955 6.918188 1.4365149999999999 1.435512 1.686152 1.6865549999999999 1.186825 1.586895 1.586895 1.586895 1.586895 1.586895 1.586895 1.586895 1.4474849999999999 1.4727449999999999 1.472944999999999 1.4729449999999999 1.4729449999999999 1.4729449999999999 1.4729449999999999 1.472944999999999999999999999999999999999	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   6   6   7   7   7   5   6   6   7   7   7   6   6   6   7   7	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 4   855 2   856 1   857 2   856 1   857 2   856 1   858 4   855 2   856 1   858 1   858 1   858 4   855 2   856 1   858 4   855 2   856 1   858 4   855 2   856 1   858 1   869 2   865 1   866 1   866 2   865 1   866 1   866 2   865 1   866 1   866 2   865 1   866 1   866 1   866 1   867 2   868 1   868	- 0
CD2 CD2 CD2 CD2 CD3	6. d1584 i.e. d5756 i.e. d2989 c. d5756 i.e. d2989 c. d5756 i.e. d2989 c. d5825 i.e. d2989 c. d6822 d. d6824 d.	1.273214099909099 1.273755 1.273465 1.273755 1.27365 1.38385 1.38895 1.368735 1.149575 0.918185 0.918185 1.448595 1.4555149999999999 1.455514999999999 1.455514999999999 1.568055499999999 1.568055499999999 1.568075 1.588075 1.588075 1.588075 1.588075 1.588075 1.588075 1.588075 1.588075 1.384933 1.366275 1.384933 1.366275 1.384933 1.366275 1.384933 1.366275 1.384933 1.366275 1.384933 1.366275 1.474899999999999999999999999999999999999	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10   9   8   7   7   5   6   7   7   5   6   7   7   5   6   7   7   5   6   6   7   7   5   6   6   6   7   7   5   6   6   7   7   5   6   6   6   7   7   5   6   6   6   7   7   5   6   7   7   5   6   6   6   7   7   5   6   6   7   7   5   6   6   7   7   5   6   6   7   7   7   5   6   6   7   7   7   7   5   6   6   7   7   7   7   7   7   7   7	1   852 1   851 1   859 1   849 1   843 2   842 1   854 1   854 1   855 2   855 2   856 1   857 1   857 1   858 1   888 1   888 1   888 4   855 2   856 1   857 1   856 1   858 4   857 1   866 1   866 2   859 1   866 2   859 1   866 1   866 2   859 1   861 1   861 1   861 1   865 1   865 1   865 1   865 1   865 1   865 1   865 1   866 1   868 1   868 1   868	- 0

