EEB 723 Comparative Genomics: Assessment of Cnidarian Genome Qualities

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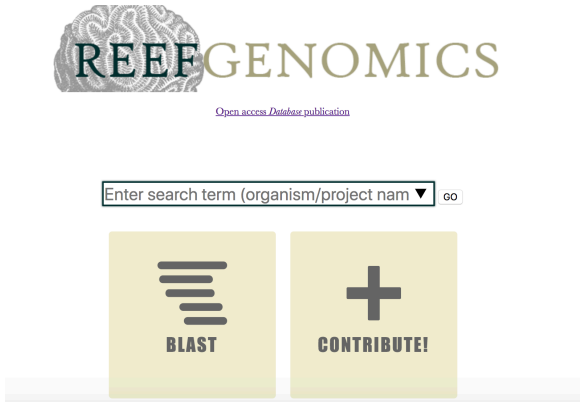
Relevance?

To better understand both the unique features and the relationships within this group it will be beneficial to understand the quality of these various genomes.

Physalia physalis: CO production and gene families with high differential gene expression

Outline

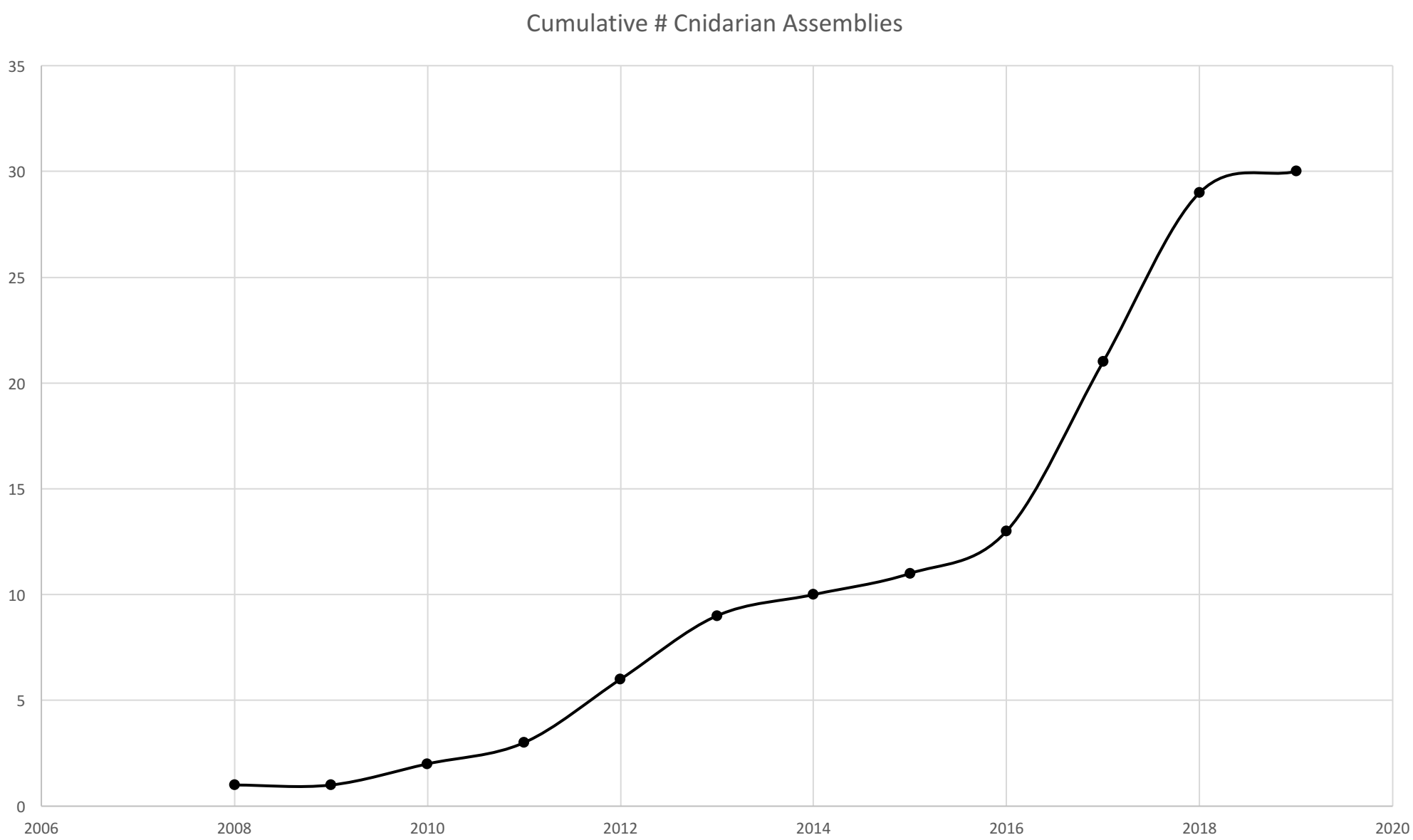
- Data collection (published papers, NCBI, reefgenomics.org)
  - Published data
  - assembly in fasta file format



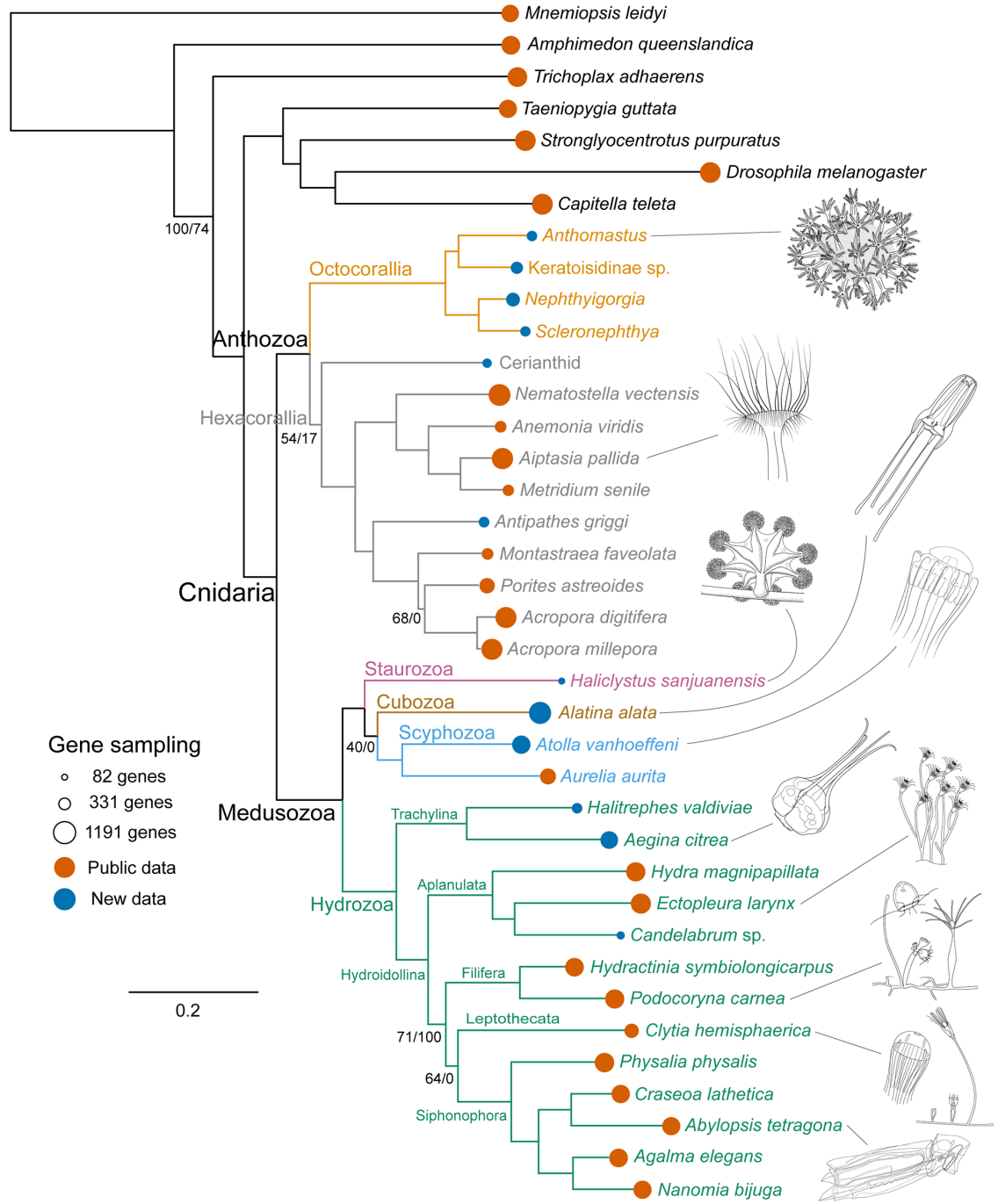
- Understanding and using the command line
- BUSCO on the Cluster
- Analysis

Table of Data

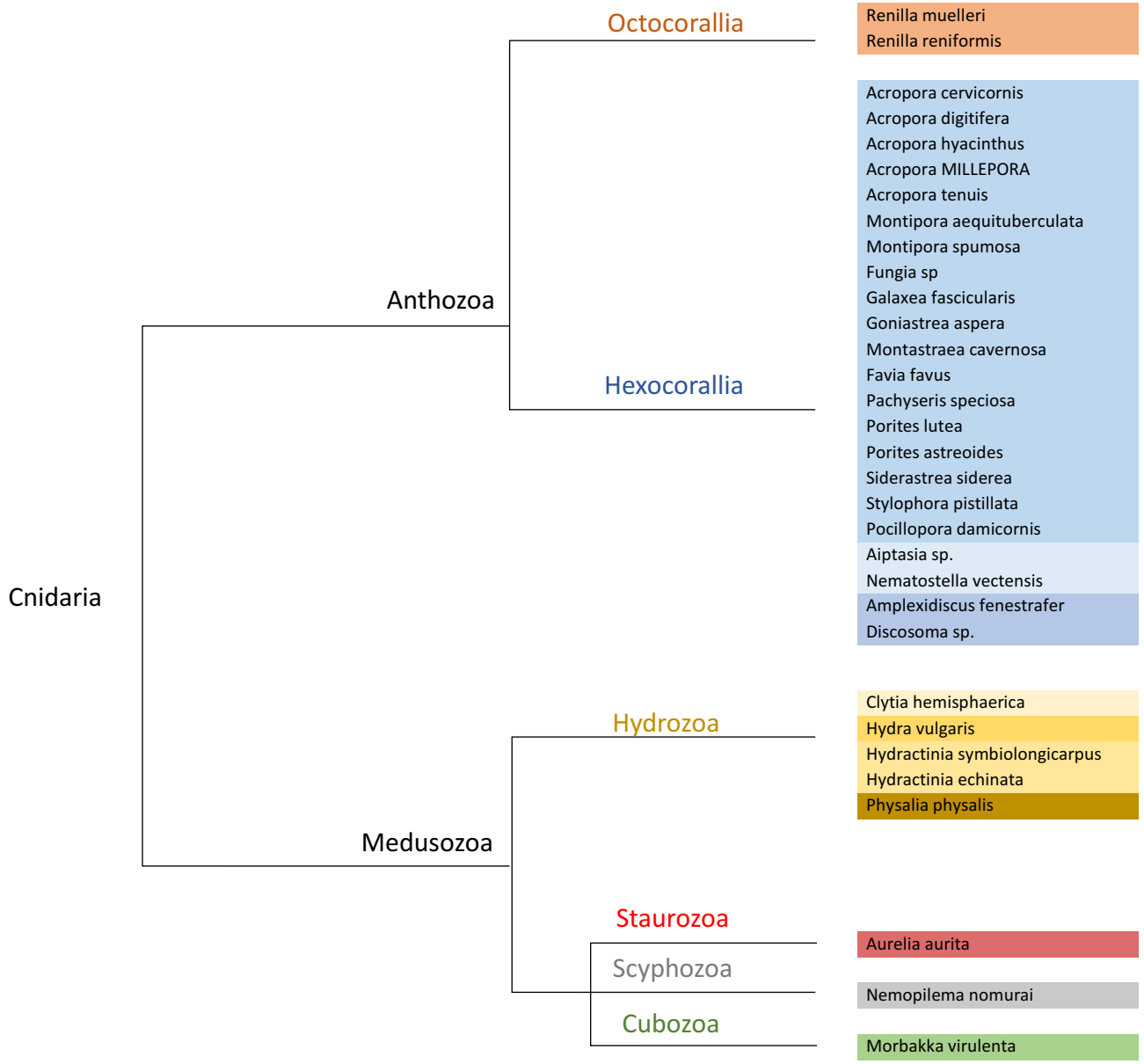
Species	Year Published	NCBI taxon ID	Class	Order	Family	BUSCO	Length (bp)	GC content %	N50 sequence length (bp)	L50 sequence count	Repeats
ACROPORA CERVICORNIS	2013	6130	Anthozoa	scleractinia	acroporidae	C:90.2%[S:86.7%,D:3.5%],F:8.2%,M:1.6%,n:978	61198767	46.54	977	16180	
Acropora digitifera	2011	70779	Anthozoa	Scleractinia	Acroporidae	C:74.4%[S:69.5%,D:4.9%],F:8.4%,M:17.2%,n:978	447497157	39.04	483559	272	
ACROPORA HYACINTHUS	2012	55974	anthozoa	scleractinia	acroporidae	C:35.0%[S:33.1%,D:1.9%],F:44.4%,M:20.6%,n:978	25069110	40	422	19234	
Acropora MILLEPORA	2012	45264	anthozoa	scleractinia	acroporidae	C:92.6%[S:70.0%,D:22.6%],F:3.4%,M:4.0%,n:978	71228058	41.71	1969	10663	
ACROPORA TENUIS	2012	70783	anthozoa	scleractinia	acroporidae	C:45.2%[S:42.3%,D:2.9%],F:40.1%,M:14.7%,n:978	40340041	40.26	507	22074	
Aiptasia sp.	2015	1720303	Anthozoa	Actiniaria	Aiptasiidae	C:87.1%[S:84.2%,D:2.9%],F:4.9%,M:8.0%,n:978	256132296	36.33	442145	171	
Amplexidiscus fenestrafer	2017	51823	Anthozoa	Corallimorpharia	Discosomidae	C:83.4%[S:82.6%,D:0.8%],F:5.8%,M:10.8%,n:978	370076467	39.3	510298	191	
Discosoma sp.	2017	86600	Anthozoa	Corallimorpharia	Discosomidae	C:85.8%[S:82.7%,D:3.1%],F:4.9%,M:9.3%,n:978	444311543	39.97	771896	142	
Favia favus	2013	1869259	Anthozoa	Scleractinia	Faviidae	C:49.9%[S:38.3%,D:11.6%],F:25.6%,M:24.5%,n:978	1633128770	39.22	3458	113886	
Fungia sp	2018	465046	anthozoa	Scleractinia	Fungiidae	C:86.5%[S:84.7%,D:1.8%],F:4.3%,M:9.2%,n:978	606319501	38.41	323149	550	
Galaxea fascicularis (Complexa),	2018	46745	anthozoa	scleractinia	Euphylliidae	C:87.0%[S:86.0%,D:1.0%],F:4.9%,M:8.1%,n:978	334165880	39.43	87933	1007	
Goniastrea aspera (Robusta).	2018	1540031	Anthozoa	Scleractinia	Merulinidae	C:88.6%[S:87.0%,D:1.6%],F:2.6%,M:8.8%,n:978	764857003	39.29	518949	440	
Montastraea cavernosa	2018	63558	Anthozoa	Scleractinia	Montastraeidae	C:68.3%[S:65.3%,D:3.0%],F:4.2%,M:27.5%,n:978	448367954	39.41	342344	352	
MONTIPORA AEQUITUBERCULATA	2014	105609	Anthozoa	Scleractinia	Acroporidae	C:42.8%[S:27.7%,D:15.1%],F:11.2%,M:46.0%,n:978	40571320	41.25	1105	10743	
Nematostella vectensis	2008	45351	Anthozoa	Actiniaria	Edwardsiidae	C:91.4%[S:88.7%,D:2.7%],F:2.6%,M:6.0%,n:978	356613585	40.64	472588	181	
Pachyseris speciosa	2017	497657	Anthozoa	Scleractinia	Scleractinia incertae sedis	C:90.5%[S:87.1%,D:3.4%],F:1.4%,M:8.1%,n:978	5652089	39.74	788453	372	
Porites lutea	2017	51062	Anthozoa	Scleractinia	Poritidae	C:91.7%[S:89.7%,D:2.0%],F:1.7%,M:6.6%,n:978	552020673	39.05	660708	242	
Renilla muelleri	2018	37510	Anthozoa	Pennatulacea	Renillidae	C:87.7%[S:84.5%,D:3.2%],F:3.7%,M:8.6%,n:978	172160214	36.17	70522	633	
Pocillopora damicornis	2017	46731	Anthozoa	Scleractinia	Pocilloporidae	C:88.1%[S:87.6%,D:0.5%],F:3.0%,M:8.9%,n:978	234350878	37.82	326133	198	
PORITES ASTREOIDES	2013	104758	Anthozoa	Scleractinia	Poritidae	C:30.8%[S:29.8%,D:1.0%],F:38.4%,M:30.8%,n:978	16907062	42.45	661	8021	
Renilla reniformis	2017	6136	Anthozoa	Pennatulacea	Renillidae	C:36.4%[S:35.0%,D:1.4%],F:23.4%,M:40.2%,n:978	131554742	36.65	1843	18068	
Siderastrea siderea	2016	130672	Anthozoa	Scleractinia	Siderastreidae	C:51.3%[S:41.0%,D:10.3%],F:12.8%,M:35.9%,n=978	104309788	42.99	2747	12946	
Stylophora pistillata	2017	50429	Anthozoa	Scleractinia	Pocilloporidae	C:88.0%[S:86.8%,D:1.2%],F:2.9%,M:9.1%,n:978	400108361	38.54	457453	246	
Morbakka virulenta	2019	686327	Cubozoa	Carybdeida	Carukiidae	C:80.4%[S:79.6%,D:0.8%],F:5.2%,M:14.4%,n:978	951575644	35.59	2173999	128	
Montipora spumosa	2017	2052915	Hexacorallia (	Scleractinia	Acroporidae	C:56.0%[S:43.1%,D:12.9%],F:20.8%,M:23.2%,n:978	1290483357	39.51	4995	60108	
Hydra vulgaris	2010	6087	Hydrozoa	Hydroida	Hydridae	C:76.8%[S:75.3%,D:1.5%],F:8.3%,M:14.9%,n:978	852170992	27.57	96317	2524	
Hydractinia echinata	2016	35630	Hydrozoa	Anthoathecata	Hydractiniidae	C:88.0%[S:86.3%,D:1.7%],F:2.8%,M:9.2%,n:978	420895846	35.19	63821	1403	
Hydractinia symbiolongicarpus		13093	Hydrozoa	Hydroida	Hydridae	C:84.5%[S:52.8%,D:31.7%],F:5.4%,M:10.1%,n:978	398006619	34.26	18302	6199	
Physalia physalis	2018	168775	Hydrozoa	Siphonophorae	Physaliidae	C:					
Aurelia aurita	2018	6145	Scyphozoa	Semaeostomeae	Ulmariidae	C:79.1%[S:77.4%,D:1.7%],F:6.1%,M:14.8%,n:978	376932402	37.1	1042981	112	
Nemopilema nomurai	2018	321803	Scyphozoa	Rhizostomeae	Rhizostomatidae	C:86.9%[S:79.6%,D:7.3%],F:2.7%,M:10.4%,n:978	213621014	38.22	2711397	28	


Cumulative # Cnidarian Assemblies
35
30
25
20
15
10
5
0
2006
2008
2010
2012
2014
2016
2018
2020

Cnidarian Consensus Phylogeny



Zapata et al.
https://doi.org/10.1371/journal.pone.0139068


Cnidaria
Anthozoa
Octocorallia
Hexocorallia
Medusozoa
Hydrozoa
Staurozoa
Scyphozoa
Cubozoa
Renilla muelleri
Renilla reniformis
Acropora cervicornis
Acropora digitifera
Acropora hyacinthus
Acropora MILLEPORA
Acropora tenuis
Montipora aequituberculata
Montipora spumosa
Fungia sp
Galaxea fascicularis
Goniastrea aspera
Montastraea cavernosa
Favia favus
Pachyseris speciosa
Porites lutea
Porites astreoides
Siderastrea siderea
Stylophora pistillata
Pocillopora damicornis
Aiptasia sp.
Nematostella vectensis
Amplexidiscus fenestrafer
Discosoma sp.
Clytia hemisphaerica
Hydra vulgaris
Hydractinia symbiolongicarpus
Hydractinia echinata
Physalia physalis
Aurelia aurita
Nemopilema nomurai
Morbakka virulenta

BUSCO Scores and assembly length


BUSCO scores and N50
100
1000
10000
100000
1000000
10000000
Stylophora pistillata
Siderastrea siderea
Renilla reniformis
Renilla muelleri
Porites lutea
Porites astreoides
Pocillopora damicornis
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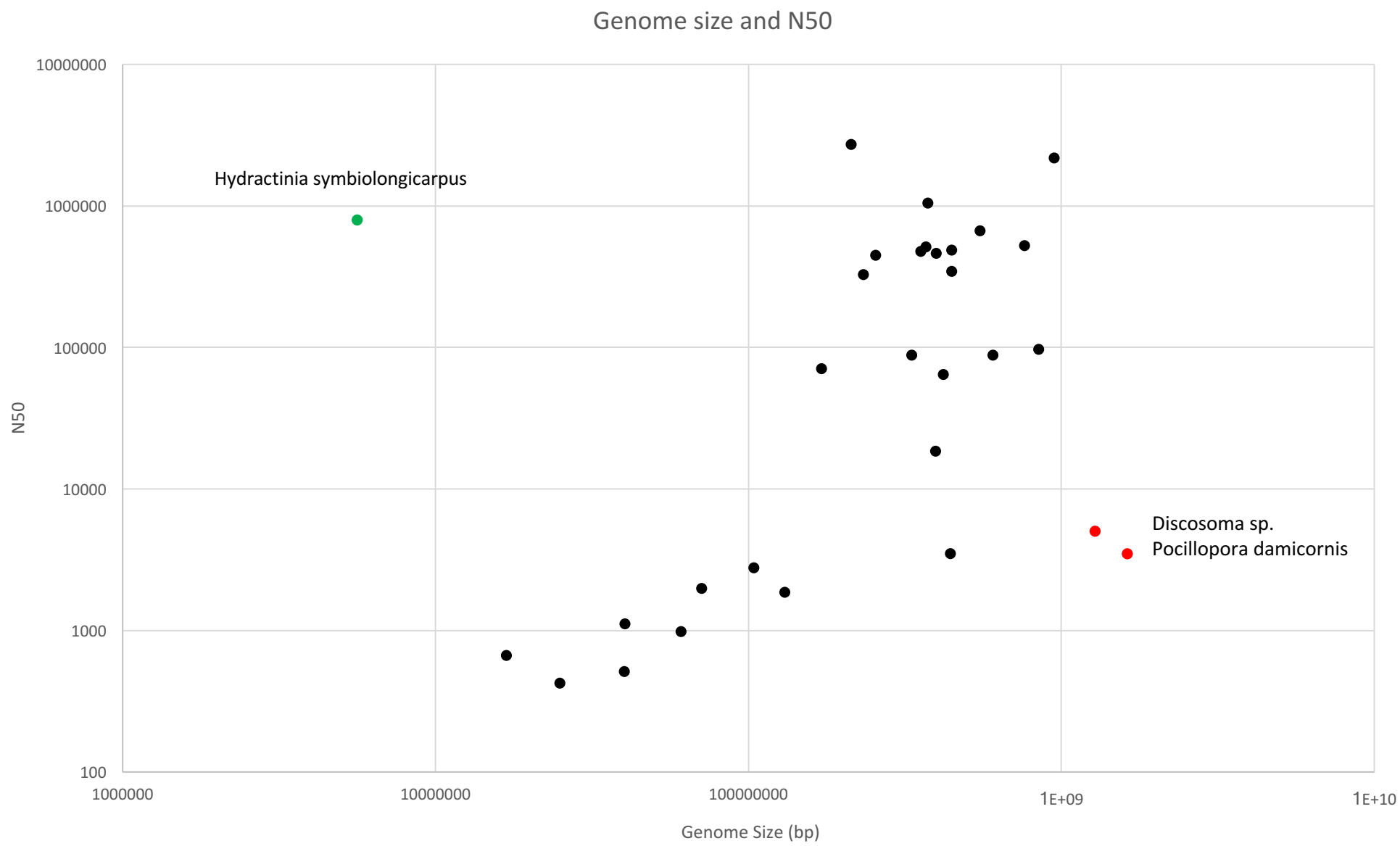
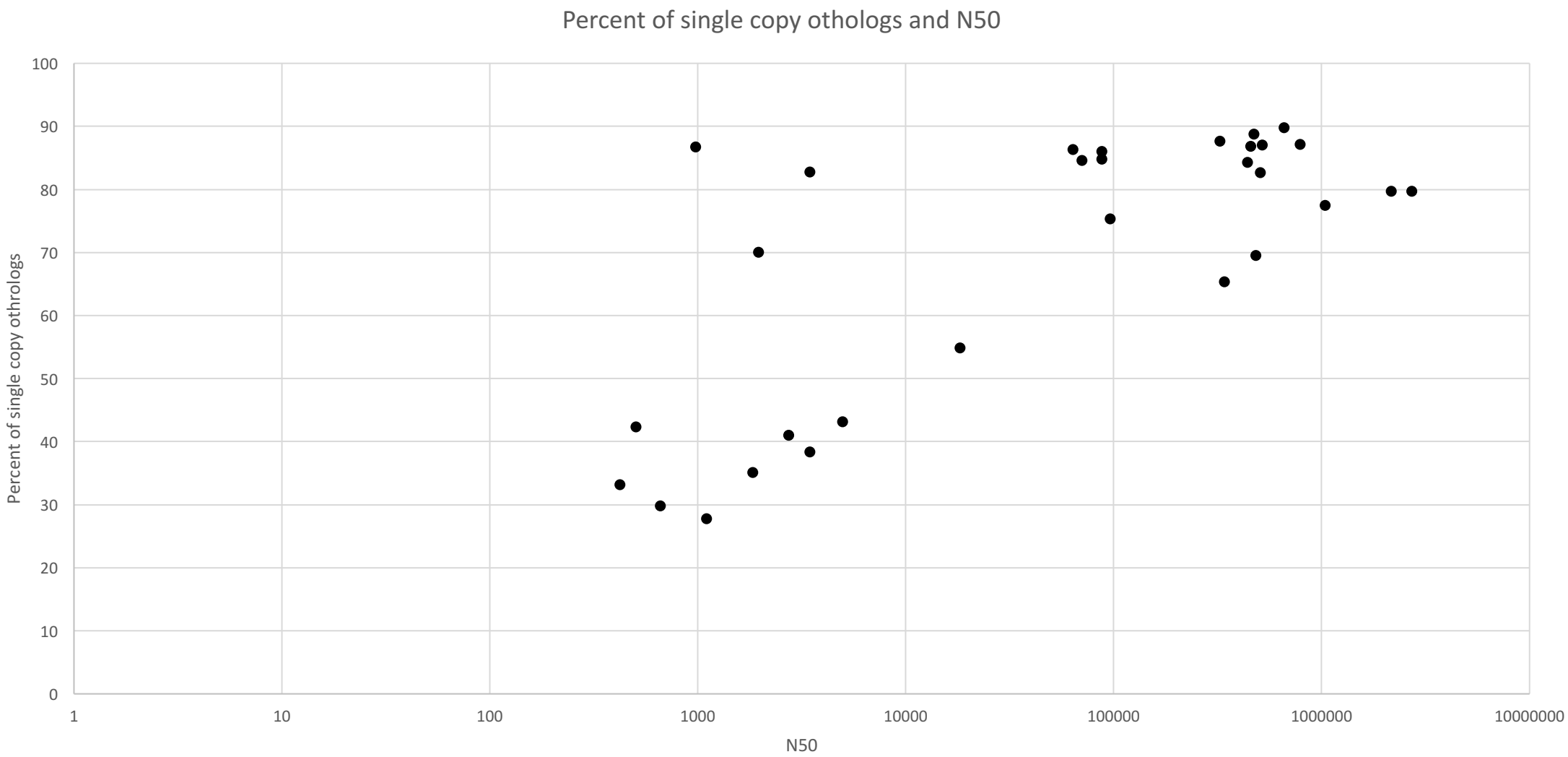
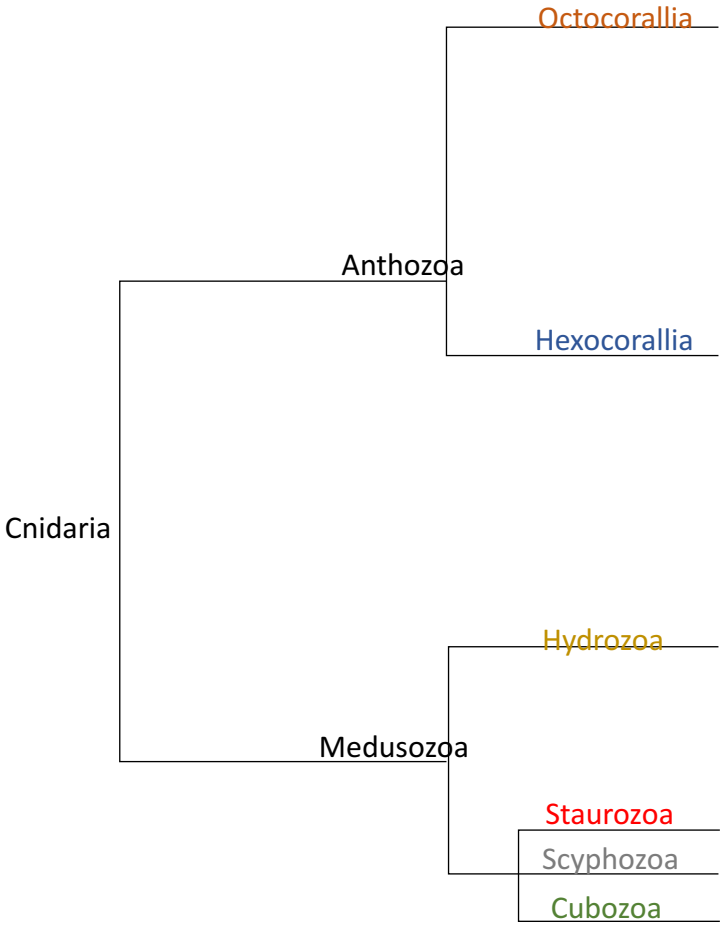
Aiptasia sp.
Acropora tenuis
Acropora MILLEPORA
Acropora hyacinthus
Acropora digitifera
Acropora cervicornis
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Single
Duplicated
Fragmented
Missing


Genome size and N50
10000000
1000000
100000
10000
1000
100
N50
Hydractinia symbiolongicarpus
Discosoma sp.
Pocillopora damicornis
1000000
10000000
100000000
1E+09
1E+10
Genome Size (bp)


Percent of single copy othologs and N50
Percent of single copy othrologs
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
10000
100000
1000000
10000000
N50

GC % and Phylogeny



Renilla muelleri
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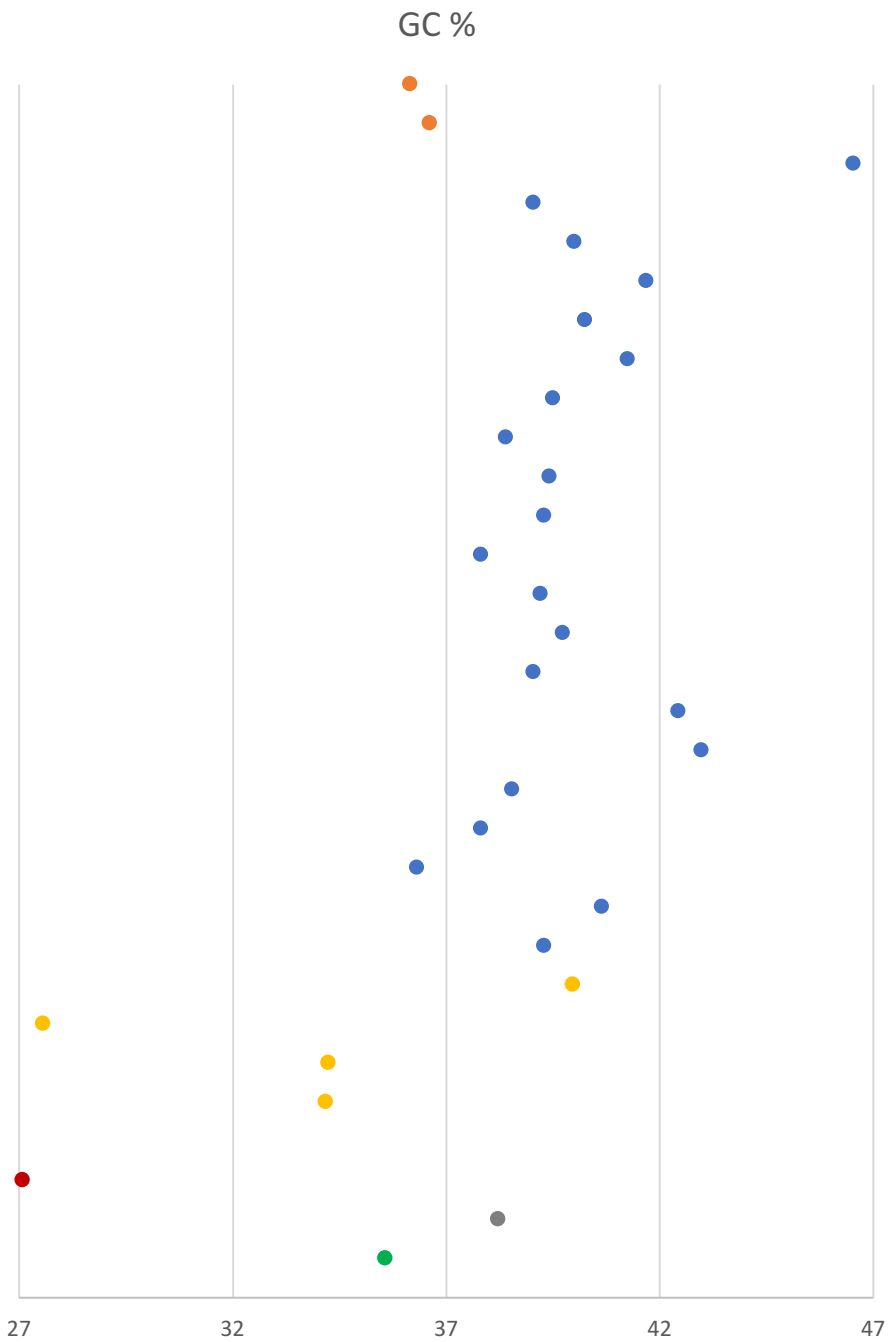
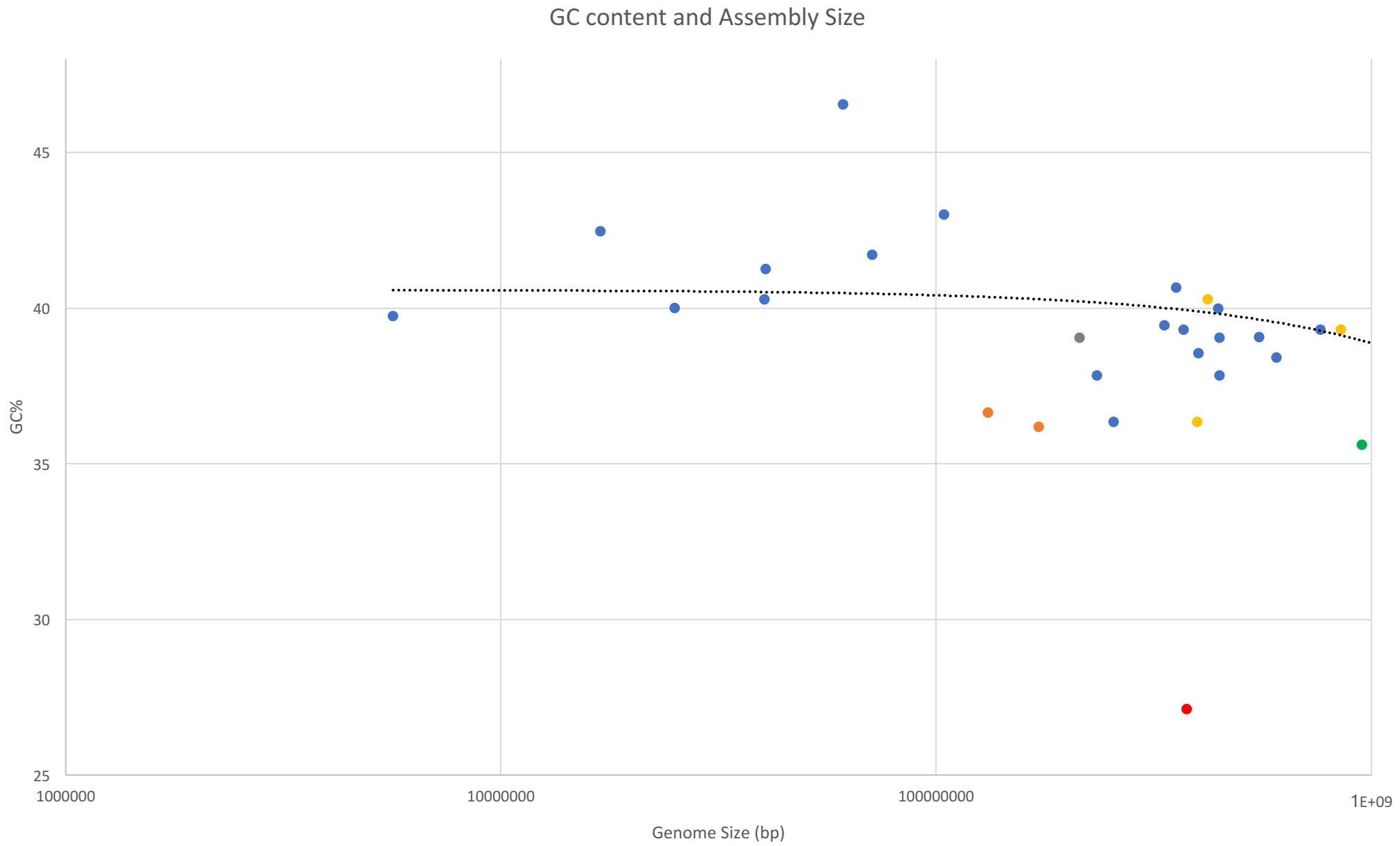


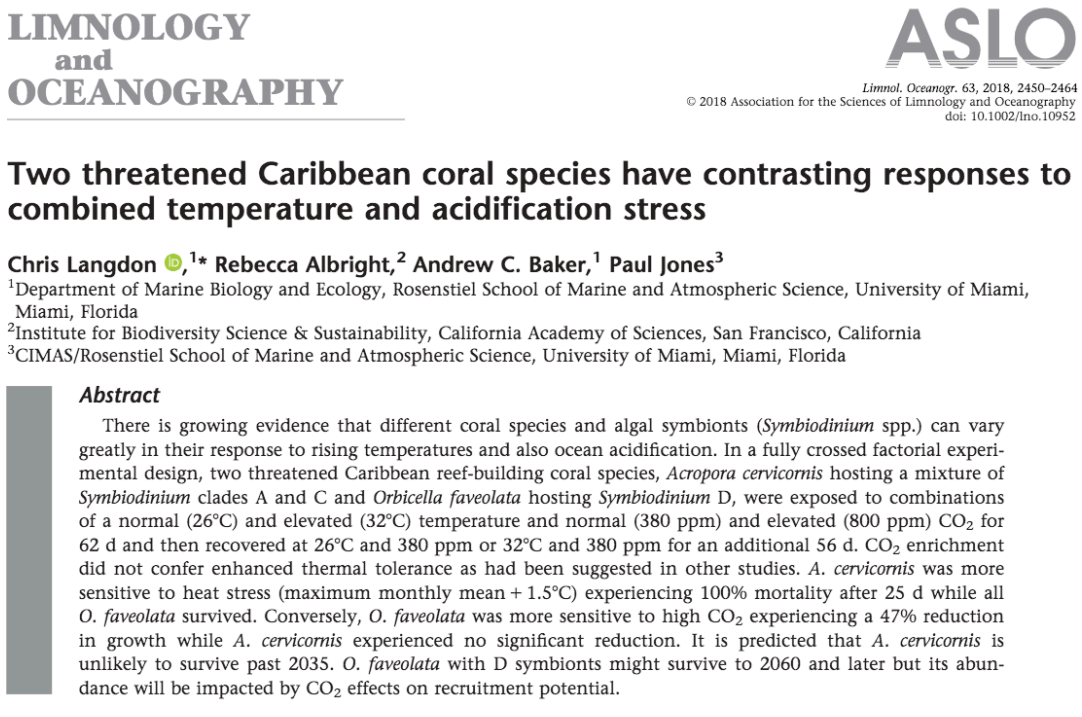

GC content and Assembly Size
45
40
35
30
25
GC%
1000000
10000000
100000000
1E+09
Genome Size (bp)

What can be done next with this data set?

- Now I have this collection of assemblies?
  - Repeat data
  - AED to look at how well gene structure is inferred
  - Synteny
  - More ways to infer genome quality?
  - More genomes !?

Personal “take homes” from this project

- No previous experience with computing in any way
  - – more confidence and (some) ability now!!
- Improved understanding of genomics, gene data and genomic statistics
- Another tool: Using comparative genomics help us to understand questions such as….?
  - E.g. physiology, biogeography, and adaptation and evolution in response to climatic change



LIMNOLOGY and OCEANOGRAPHY

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Two threatened Caribbean coral species have contrasting responses to combined temperature and acidification stress

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Abstract

There is growing evidence that different coral species and algal symbionts (*Symbiodinium* spp.) can vary greatly in their response to rising temperatures and also ocean acidification. In a fully crossed factorial experimental design, two threatened Caribbean reef-building coral species, *Acropora cervicornis* hosting a mixture of *Symbiodinium* clades A and C and *Orbicella faveolata* hosting *Symbiodinium* D, were exposed to combinations of a normal (26°C) and elevated (32°C) temperature and normal (380 ppm) and elevated (800 ppm) CO_2 for 62 d and then recovered at 26°C and 380 ppm or 32°C and 380 ppm for an additional 56 d. CO_2 enrichment did not confer enhanced thermal tolerance as had been suggested in other studies. *A. cervicornis* was more sensitive to heat stress (maximum monthly mean + 1.5°C) experiencing 100% mortality after 25 d while all *O. faveolata* survived. Conversely, *O. faveolata* was more sensitive to high CO_2 experiencing a 47% reduction in growth while *A. cervicornis* experienced no significant reduction. It is predicted that *A. cervicornis* is unlikely to survive past 2035. *O. faveolata* with D symbionts might survive to 2060 and later but its abundance will be impacted by CO_2 effects on recruitment potential.