



Evolution of Chinese Virus Mutants

Silicon Valley Forth Interest Group

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Chinese Virus (CV)

- **Wuhan Coronavirus was named SARS-CoV-2, then COVID-19, now Chinese Virus (CV) according to President Trump.**
- **The pandemic now exceeds the size and seriousness of SARS in 2003. It caused 6,786 deaths in US as of 4/3/2020.**



To Cure Chinese Virus

- **Infected people can be cured with intravenous infusion of vitamin C.**
- **Intravenous infusion protocol:**
 - **First day: 6 grams of sodium ascorbate at the rate 1 g/h.**
 - **Next 3 day: 1 grams of sodium ascorbate at the rate 1 g/h.**



To Cure Chinese Virus

- **Infected people can also be cured by oral ingestion of vitamin C:**
 - **Take 10 grams of vitamin C every 4 hours, until diarrhea.**
- **Taking 10 grams of vitamin C daily protects you from the infection by Chinese Virus.**



Chinese Virus

- **Rumors had that it was manufactured in Wuhan P4 Lab.**
- **It is sequenced in many laboratories in many countries.**
- **It is suspected to mutate continually.**



Compare Virus Genomes

- **I have the best tools to compare genomes.**
- **My Exhaustive Pattern Search algorithm can be used to identify similarities and differences between genomes.**



Genbank Downloads

- **I have followed the COVID-19 Genbank.**
- **I downloaded and analyzed these sequences:**
 - **3/9/2020 51 genomes**
 - **3/25/2020 120 genomes**
 - **3/30/2020 320 genomes**



Differences in Genomes

- **I scan 20 nucleotide patterns in a source genome.**
- **If a pattern appears in a target genome, it is marked as a match, else a mismatch.**
- **Matches and mismatches are collected in separated files and analyzed.**



Mismatches in Genomes

- **I compare all CV genomes against CV0, a Reference Sequence with genome ID MN908947 or NC045512.**
- **Mismatches are tabulated for all 320 CV genomes.**



Point Mutations (PM)

- **CV0 has 29,903 nucleotides.**
- **Mismatches from CV0 are mostly differences in isolated single nucleotides.**
- **They are called Point Mutations.**



Point Mutations

- **Most mismatches from CV0 look like random errors.**
- **However, there are many consistent point mutations.**
- **Two mutants CV1 and CV2 can be identified. I can follow their evolution.**



Mutant CV1

- **Last month I reported mutant CV1 with two PMs at 8782 and 28144.**
- **However, Koyama, Platt & Parida published the same mutant before me.**



Mutant CV1

- **Variant analysis of COVID-19 genomes.** Koyama, Takahiko & Platt, Daniel & Parida, Laxmi. (2020). 10.2471/BLT.20.253591.
- **Co-occurrence of 8782C>T and 28144T>C variants are frequently found among travelers but not from Wuhan samples.**



Mutants CV1 and CV2

- **Earlier works on CV1 identified only two PM at locations 8782 and 28144.**
- **With more published genomes, I identify 5 PMs in CV1 and 6 PMs in a new mutant CV2.**
- **I can also observe the evolution and the spread of CV0, CV1 and CV2.**



Mutant CV1

Location	Frequency	Mutation
8782	151	C>T
17747	123	C>T
17858	123	A>G
18060	128	C>T
28144	152	T>C



Mutant CV2

Location	Frequency	Mutation
241	71	C>T
1059	63	C>T
3037	76	C>T
14408	72	C>T
23403	72	A>G
25563	70	G>T



Tracing CV Mutants

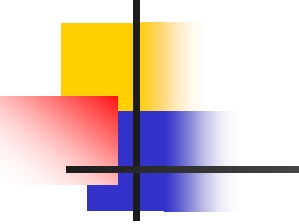
- **From the published genome data, I can trace the spread of CV0, and its two mutants CV1 and CV2.**
- **I can also observe the evolution of CV1 and CV2.**



Spread of CV0

- **CV0 originated in Wuhan, and first spread to Southeast Asia, South Korea, Taiwan, and Australia.**
- **It jumped to CA and then to MA.**
- **It also jumped to Italy, and then the whole Europe, and to Brazil.**

Spread of CVO



Date	Place	Virus ID
2019/12/30	China, Wuhan	MN908947
2020/1/13	Nepal	MT072688
2020/1/20	South Korea	MT039890
2020/1/22	USA, CA	MN994468
2020/1/22	Viet Nam	MT192772
2020/1/25	Australia	MT007544
2020/1/25	Taiwan	MT192759
2020/1/27	India	MT012098
2020/1/29	USA, MA	MT039888
2020/1/30	Italy	MT066156
2020/2/7	Sweden	MT093571
2020/2/27	USA, WA	MT163716
2020/2/28	Brazil	MT126808
2020/3/7	USA, MN	MT188340
2020/3/13	Pakistan	MT240479



Spread of CV1

- **CV1 originated in Shenzhen, China, and jumped to WA, and then to IL, AZ, CA, TX, and MN.**
- **It also spread to Taiwan, India, Pakistan, and then to Spain.**



Spread of CV1

Date	Place	Virus ID
2020/1/10	China, Shenzhen	MN938384
2020/1/19	USA, WA	MN985325
2020/1/21	USA, IL	MN988713
2020/1/22	USA, AZ	MN997409
2020/1/23	USA, CA	MN994467
2020/1/31	India, Kerala State	MT050493
2020/1/31	Taiwan	MT066175
2020/2/11	USA, TX	MT106054
2020/2/27	Spain, Valencia	MT233519
2020/3/4	Pakistan, Gilgit	MT233526
2020/3/5	USA, MN	MT188341



Spread of CV2

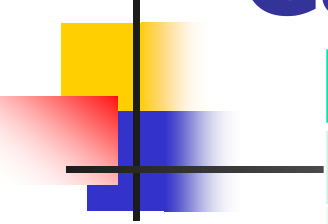
- **CV2 originated in Valencia, Spain.**
- **It jumped to Peru, and then to CA.**
- **It then move back to WA, and co-exits with CA0 and CA1.**



Spread of CV2

Date	Place	Virus ID
2020/3/2	Spain, Valencia	MT233522
2020/3/10	Peru	MT263074
2020/3/11	USA, CA	MT192765
2020/3/12	USA, WA	MT246453

Cases from U Washington



Mutant	Cases	Percentage
CV0	7	3%
CV1	129	63%
CV2	69	34%
Total	205	

- **University of Washington is the most diligent in sequencing Chinese Viruses. It reported 205 sequences.**
- **Currently 2/3 cases are CV1, and 1/3 cases are CV2. Very few CV0.**



Evolution of CV1

- **On 1/10/2020 PMs at 8782 and 28144 first appeared in Shenzhen, China.**
- **On 1/19/2020, PM at 18060 was added in WA.**
- **On 2/24 2020 PMs at 17747 and 17858 were added in WA.**



Evolution of CV2

- **On 3/2/2020 PMs at 241, 3037, 14408, and 23403 first appeared in Valencia, Spain.**
- **On 3/12/2020, PMs at 1059 and 25563 were added in WA.**



Point Mutation Table

- **PMs are collected in all 320 CV genomes, shown in 10 slides.**
- **Columns are Dates, Location, ID and the lists of PMs.**
- **CV1s are in red, and CV2s are in green.**
- **I will scroll the slides to show you how CV mutates.**



Point Mutation Table

- **If you need a copy of this point mutation table, send me a email or call me at:**

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Home	Insert	Page Layout	Formulas	Data	Review	View												
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2020/3/14	MT246480	USA WA		3037	14408	18877	23403	25563						
2020/3/14	MT246481	USA WA		241	1059	3037	14408	23403	25563					

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2020/3/14	MT246486	USA WA		6310	8782	17747	17858	18060	27327	28144	29870			
2020/3/14	MT246488	USA WA		8782	17747	17858	18060	21575	22988	28144				
2020/3/14	MT246489	USA WA		8782	17747	17858	18060	22984	27384	28144	29870			
2020/3/14	MT251972	USA WA		8782	17747	17858	18060	28144	28229					
2020/3/14	MT251973	USA WA		1059	3037	14408	23403	25563	26807	29553				
2020/3/14	MT251975	USA WA		3992	8782	17747	17858	18060	22984	27384	27806	28144	29869	
2020/3/14	MT251976	USA WA		241	1059	3037	14408	16912	23403	25563	29553			
2020/3/14	MT251977	USA WA		832	1545	8782	17747	17858	18060	28144	29870			
2020/3/14	MT251978	USA WA		8782	14229	17747	17858	18060	28144					
2020/3/14	MT251979	USA WA		241	1059	3037	14408	23403	25563	29553				
2020/3/14	MT259248	USA WA		241	694	1059	3037	14408	23403	25563	26433			
2020/3/14	MT259250	USA WA		242	313	3037	14408	23403	28883	29870				
2020/3/14	MT259251	USA WA		241	1059	3037	14408	23403	25563	29870				
2020/3/14	MT259252	USA WA		490	3177	8782	18736	19684	24034	26729	27635	27999	28077	
2020/3/14	MT259267	USA WA		6691	7843	11083	13768	14805	15869	17247	17639	19542	26144	
2020/3/14	MT259269	USA WA		6424	8782	11042	17747	17858	18060	22207	24694	28144	28283	
2020/3/14	MT259274	USA WA		8782	17747	17858	18060	28144	28376	29870				
2020/3/14	MT259275	USA WA		8782	17747	17858	18060	28144						
2020/3/14	MT263447	USA WA		8782	15927	17747	17858	18060	26936	27722	28144			
2020/3/15	MT246487	USA WA		210	241	1059	3037	14408	23403	25563	29553			
2020/3/15	MT246490	USA WA		241	1059	3037	14408	23403	25563	29553				
2020/3/15	MT259245	USA WA		8782	17747	17858	18060	28144	29870					
2020/3/15	MT259271	USA WA		8782	15888	17747	17858	18060	28144					
2020/3/15	MT259273	USA WA		241	1059	3037	14408	23403	25563	27207	29553			
2020/3/15	MT259277	USA WA		241	833	1059	3037	14408	21764	23403	25563	27964		
2020/3/15	MT259278	USA WA		241	1059	3037	14408	23403	25563	29553				
2020/3/15	MT259280	USA WA		258	8782	10818	14937	17747	17858	18060	28144	29869		
2020/3/15	MT259281	USA WA		241	1059	3037	14408	23403	24368	25563				
2020/3/15	MT259282	USA WA		8782	17747	17858	18060	22988	28144					
2020/3/15	MT259284	USA WA		400	6947	8782	17747	17858	18060	22165	27326	28144		
2020/3/15	MT259285	USA WA		4236	11083	14805	19137	25655	26144	29870				
2020/3/15	MT259286	USA WA		241	1059	3037	12111	14408	23403	25563	29553			

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2020/3/15	MT259287	USA WA		8782	10572	11538	17326	17747	17858	17884	18060	19645	23242
2020/3/16	MT259236	USA WA		8782	17747	17858	18060	23010	28144				
2020/3/16	MT259237	USA WA		8782	17747	17858	18060	28144	28280	29515			
2020/3/16	MT259239	USA WA		261	1059	3037	14408	23403	25563	29553			
2020/3/16	MT259241	USA WA		222	8782	17747	17858	18060	28144				
2020/3/16	MT259244	USA WA		241	833	1059	3037	14408	23403	25563	27964		
2020/3/16	MT259247	USA WA		258	8782	17747	17858	18060	19632	23989	28144	29869	
2020/3/16	MT259253	USA WA		3955	8681	8782	17747	17858	18060	22604	28144		
2020/3/16	MT259254	USA WA		8782	17747	17858	18060	28144					
2020/3/16	MT259257	USA WA		8782	14604	17747	17858	18060	21911	28144	29870		
2020/3/16	MT259260	USA WA		241	1059	3037	14408	23403	25563	29553			
2020/3/16	MT259261	USA WA		241	1059	3037	12111	14408	23403	25563	29553		
2020/3/18	MT258377	USA WA		8090	8173	11083	14805	17247	26144	29868			
2020/3/18	MT258378	USA WA		241	833	1059	3037	14408	23403	25563	27964		
2020/3/18	MT258379	USA WA		241	3037	6680	10129	14408	23403	28883	29747		
2020/3/18	MT258380	USA WA		241	1059	3037	14408	15771	23403	25563			
2020/3/18	MT258381	USA WA		241	1059	3037	10129	11916	14408	23403	25563	29870	
2020/3/18	MT258382	USA WA		241	375	617	1059	2145	3037	4263	6861	9135	10129
2020/3/18	MT258383	USA WA		241	1059	1529	3037	14408	15771	18433	23403	25563	29868
2020/3/20	MT263403	USA WA		8782	16329	17747	17858	18060	23010	28144			
2020/3/20	MT263419	USA WA		8602	8782	17747	17858	18060	28144	29870			
2020/3/20	MT263420	USA WA		8782	17747	17858	18060	25064	26803	28144			
2020/3/20	MT263444	USA WA		8782	17747	17858	18060	28144					
2020/3/21	MT263405	USA WA		8078	8782	17747	17858	18060	28144				
2020/3/21	MT263406	USA WA		241	1059	3037	10319	14408	15720	23403	25563	27964	29869
2020/3/21	MT263416	USA WA		8782	11083	17747	17858	18060	21850	28144			
2020/3/22	MT263386	USA WA		148	222	2676	8782	22606	28144	28878	29742		
2020/3/22	MT263394	USA WA		241	1059	3037	14408	23403	25563	29553			
2020/3/22	MT263396	USA WA		8782	17747	17858	18060	28144					
2020/3/22	MT263412	USA WA		2232	8782	17747	17858	18060	23010	28144	29870		
2020/3/23	MT263381	USA WA		8782	17747	17858	18060	28144					
2020/3/23	MT263382	USA WA		194	8782	17747	17858	18060	28144	29869			

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2020/3/23	MT263384	USA WA		252	490	3177	8782	9113	18736	21648	24034	26729	27635
2020/3/23	MT263387	USA WA		162	259	382	553	8782	17747	17858	18060	25337	28144
2020/3/23	MT263388	USA WA		258	8782	10323	15927	17747	17858	18060	26936	28144	
2020/3/23	MT263400	USA WA		8602	8782	17747	17858	18060	26152	28144	29868		
2020/3/23	MT263402	USA WA		241	3037	14408	23403	28883					
2020/3/23	MT263423	USA WA		8782	17747	17858	18060	28144	29870				
2020/3/23	MT263458	USA WA		6693	8782	14877	17747	17858	18060	28144	29188		
2020/3/23	MT263462	USA WA		8782	8937	17747	17858	18060	28144				
2020/3/23	MT263463	USA WA		8782	11704	17747	17858	18060	20256	28144	29870		
2020/3/23	MT263464	USA WA		8602	8782	17747	17858	18060	28144				
2020/3/23	MT263465	USA WA		241	1059	3037	14408	23403	25563	29553	29870		
2020/3/23	MT263467	USA WA		241	1059	3037	14408	16912	23403	25563	29553	29867	
2020/3/23	MT263468	USA WA		241	1059	3037	14408	23403	25523	25563	27869		
2020/3/23	MT263469	USA WA		8782	17747	17858	18060	22984	27384	28144	29870		
2020/3/24	MT263383	USA WA		219	8782	17747	17858	18060	28144	29868			
2020/3/24	MT263390	USA WA		241	1059	3037	14408	23403	25563	29553	29870		
2020/3/24	MT263391	USA WA		138	241	1059	3037	14408	23403	25563	29553		
2020/3/24	MT263392	USA WA		91	241	1059	3037	14408	16912	23403	25563	29553	
2020/3/24	MT263395	USA WA		8782	11083	17747	17858	18060	28144	29410	29557		
2020/3/24	MT263398	USA WA		255	6310	8782	17747	17858	18060	27327	28144	28378	29869
2020/3/24	MT263399	USA WA		1401	8782	17747	17858	18060	28144				
2020/3/24	MT263404	USA WA		4236	11083	14805	25655	26144					
2020/3/24	MT263408	USA WA		241	619	1059	3037	14408	14912	23403	25563		
2020/3/24	MT263410	USA WA		490	3177	6040	8782	12478	18736	21910	24034	26729	28077
2020/3/24	MT263411	USA WA		241	3037	9534	14408	18877	23403	25563	28969		
2020/3/24	MT263413	USA WA		241	1059	3037	14408	23403	25563	26799	29553	29870	
2020/3/24	MT263414	USA WA		2110	8782	17747	17858	18060	21575	28144			
2020/3/24	MT263415	USA WA		241	673	1059	3037	4683	14408	23403	25563	27964	
2020/3/24	MT263417	USA WA		241	1059	3037	14408	23403	25563	27804	29553		
2020/3/24	MT263418	USA WA		8782	17747	17858	18060	23010	26799	28144			
2020/3/24	MT263421	USA WA		1238	3593	4683	8782	17747	17858	18060	26799	27200	28144
2020/3/24	MT263422	USA WA		5000	8782	15927	17747	17858	18060	26936	28144	29085	29867

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2020/3/24	MT263425	USA WA		8782	17747	17858	18060	28144	29870				
2020/3/24	MT263426	USA WA		241	398	1059	3037	6996	14408	23403	25563	29553	29870
2020/3/24	MT263428	USA WA		241	1059	3037	5183	14408	23403	25563	25691	29868	
2020/3/24	MT263429	USA WA		1440	2891	28854							
2020/3/24	MT263430	USA WA		8782	17747	17858	18060	28144	28708	29869			
2020/3/24	MT263431	USA WA		241	1059	3037	11916	14408	21764	23403	25563		
2020/3/24	MT263432	USA WA		241	1059	3037	14408	23403	25563				
2020/3/24	MT263433	USA WA		241	2416	3037	14408	23403	25563	26233			
2020/3/24	MT263434	USA WA		1912	8782	17747	17858	18060	28144				
2020/3/24	MT263435	USA WA		6693	8782	14877	17747	17858	18060	28144	29188		
2020/3/24	MT263436	USA WA		241	1059	3037	14408	21763	23403	25563	29553		
2020/3/24	MT263437	USA WA		241	1059	3037	14408	23403	25563	29553			
2020/3/24	MT263438	USA WA		241	3037	14408	23403	25452					
2020/3/24	MT263439	USA WA		241	1059	3037	12809	14408	23403	25563	29870		
2020/3/24	MT263440	USA WA		2041	8782	17747	17858	18060	28144				
2020/3/24	MT263441	USA WA		2094	6943	8782	17747	17858	18060	19203	22984	27384	28144
2020/3/24	MT263442	USA WA		241	1059	3037	14408	23403	25563	29553	29870		
2020/3/24	MT263443	USA WA		8782	15927	17747	17858	18060	18401	24795	26805	26936	28144
2020/3/24	MT263445	USA WA		241	1059	3037	14408	16912	23403	25563	26803	29553	
2020/3/24	MT263446	USA WA		241	1059	3037	14408	23403	25563	29553			
2020/3/24	MT263448	USA WA		8782	16887	17747	17858	18060	25850	27525	28144	29870	
2020/3/24	MT263449	USA WA		8782	17747	17858	18060	28144	29870				
2020/3/24	MT263450	USA WA		8782	17747	17858	18060	21893	27276	27384	28144		
2020/3/24	MT263451	USA WA		248	276	1238	8782	17747	17858	18060	25494	28144	28924
2020/3/24	MT263452	USA WA		8782	16299	17747	17858	18060	28144				
2020/3/24	MT263453	USA WA		6333	6950	8782	17747	17858	18060	22057	23906	24432	26028
2020/3/24	MT263454	USA WA		8782	17326	17747	17858	17884	18060	19645	26801	28144	
2020/3/24	MT263455	USA WA		317	8782	17747	17858	18060	28144				
2020/3/24	MT263456	USA WA		8782	17747	17858	18060	28144	29867				
2020/3/24	MT263457	USA WA		7518	8782	17747	17858	18060	23119	27525	28144		
2020/3/24	MT263459	USA WA		1059	3037	14408	23403	25563	27255	27344	27964		



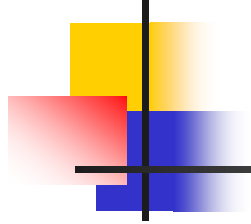
Point Mutations

- **CV0, CV1 and CV2 are stable mutants.**
- **There are huge number of PMs come and go. However, they are valid PMs, not random errors.**



Evolution of CV

- **CV produces lots of random PMs. Most mutants are caused by imperfect RNA replications.**
- **Only the most viral mutants survive and keep on spreading.**
- **Do not hope that CV will stop on its own in losing its virality.**



Thank You!