

Title : A multi-disciplinary comparison of great ape gut microbiota in a central African forest and European zoo

Victor Narat^{1,2*}, Katherine R Amato^{3,4*}, Noémie Ranger⁵, Maud Salmona^{5,6}, Séverine Mercier Delarue⁵, Stephanie Rupp⁷, Philippe Ambata⁸, Richard Njouom⁹, François Simon⁵, Tamara Giles-Vernick^{2,4**}, Jérôme LeGoff^{5,6**}

Corresponding authors: Jérôme LeGoff and Tamara Giles-Vernick, tamara.giles-vernick@pasteur.fr

¹ Eco-anthropologie, UMR7206 CNRS/MNHN/Paris Diderot, Site du Musée de l'Homme, Paris, France.

² Institut Pasteur, Anthropology and Ecology of Disease Emergence Unit, Paris, France

³ Department of Anthropology, Northwestern University

⁴ Humans and the Microbiome, CIFAR, Toronto, Canada

⁵ Université de Paris, Equipe INSIGHT, Inserm U976, F-75010 Paris, France

⁶ Département des Agents Infectieux, Virologie et Greffes, AP-HP, Hôpital Saint-Louis, F-75010 Paris, France

⁷ Department of Anthropology, City University of New York – Lehman College, New York, NY

⁸ Ministry of Agriculture and Rural Development, Yaounde, Cameroon

⁹ Centre Pasteur du Cameroun, Yaounde, Cameroon

* These authors contributed equally to this work

** These authors contributed equally to this work

Supplementary Table S1: QIIME2 sequence data processing summary by sample

Extraction ID	Sample ID	Site	Species	Input sequences	Quality filtered sequences	% of input passed filter	Denoiised sequences	Pair end merged sequences	% of input merged	Non chimeric sequences	% of input non chimeric	Number of ASV after rarefaction at 200,000 reads
7	FB-002	Cameroon	Chimpanzee	779377	614206	78.81	612650	548023	70.32	492131	63.14	585
13	FB-004	Cameroon	Chimpanzee	1071327	828930	77.37	823161	688240	64.24	613704	57.28	686
32	FB-006	Cameroon	Chimpanzee	892730	781969	87.59	776915	706611	79.15	648157	72.6	834
34	FB-005	Cameroon	Chimpanzee	1004960	859909	85.57	853105	759498	75.57	701968	69.85	924
35	FB-001	Cameroon	Chimpanzee	977282	854903	87.48	848844	773779	79.18	687625	70.36	932
40	FB-003	Cameroon	Chimpanzee	883361	777470	88.01	772897	688985	78.00	619858	70.17	793
51	2017-B-05	Zoo	Chimpanzee	596845	470296	78.8	464659	412687	69.14	383835	64.31	878
54	2017-B-02	Zoo	Chimpanzee	1106236	945969	85.51	938455	804366	72.71	752581	68.03	1134
57	2017-B-01	Zoo	Chimpanzee	894835	765643	85.56	757274	638060	71.3	574249	64.17	1122
63	2017-B-03	Zoo	Chimpanzee	938472	824845	87.89	818624	714811	76.17	661436	70.48	1183
64	2017-B-06	Zoo	Chimpanzee	1081546	929799	85.97	924640	819432	75.76	735932	68.04	831
61BIS	2017-B-04	Zoo	Chimpanzee	3591434	3437099	95.7	3420867	3219109	89.63	2732097	76.07	1630
1	EA-001	Cameroon	Gorilla	887030	685547	77.29	681637	536280	60.46	498714	56.22	545
2	DA-007	Cameroon	Gorilla	689517	538812	78.14	536631	445122	64.56	436312	63.28	589
5	DA-009	Cameroon	Gorilla	858214	639931	74.57	634272	498936	58.14	457021	53.25	646
20	DA-003	Cameroon	Gorilla	764833	593154	77.55	589026	508728	66.51	495227	64.75	813
21	EA-004	Cameroon	Gorilla	838798	627393	74.8	623715	463292	55.23	429555	51.21	542
22	EA-002	Cameroon	Gorilla	1027815	783137	76.19	776270	569320	55.39	488506	47.53	629
23	EA-005	Cameroon	Gorilla	1107270	951438	85.93	945956	842316	76.07	791705	71.5	673
24	EA-003	Cameroon	Gorilla	991161	855999	86.36	850603	741905	74.85	677583	68.36	645
26	DA-004	Cameroon	Gorilla	921334	808300	87.73	802937	712469	77.33	667638	72.46	987
27	DA-001	Cameroon	Gorilla	1187800	1040254	87.58	1033460	922825	77.69	867548	73.04	923
33	EA-006	Cameroon	Gorilla	906695	773332	85.29	767822	667802	73.65	597806	65.93	686

36	DA-005	Cameroon	Gorilla	716923	590660	82.39	587010	541142	75.48	518576	72.33	724
37	DA-002	Cameroon	Gorilla	739696	594459	80.37	590371	527602	71.33	510247	68.98	832
41	DA-008	Cameroon	Gorilla	999521	874750	87.52	868974	768893	76.93	710259	71.06	704
39BIS	DA-006	Cameroon	Gorilla	2935809	2808803	95.67	2787968	2639966	89.92	2284488	77.81	1361
47	2017-C-05	Zoo	Gorilla	912566	777368	85.18	766861	629828	69.02	578951	63.44	1568
49	2017-C-02	Zoo	Gorilla	990595	871869	88.01	863567	729787	73.67	682077	68.86	1459
52	2017-C-04	Zoo	Gorilla	801034	627113	78.29	620344	524793	65.51	493683	61.63	1252
53	2017-C-06	Zoo	Gorilla	1098832	926930	84.36	917589	782543	71.22	744054	67.71	1684
55	2017-C-01	Zoo	Gorilla	742989	638399	85.92	632928	520665	70.08	480306	64.65	1112
56	2017-C-03	Zoo	Gorilla	875230	745493	85.18	736387	625597	71.48	591717	67.61	1479

Supplementary Methods S1: Semi-directed interview guides

For great ape zookeepers

1. How long have you worked at this zoo?
2. How long and in what capacity have you worked with this species of great ape?
3. Can you describe for me a typical day working with these animals?
4. Do your daily activities change seasonally, and if so, how?
5. Can you tell me more about feeding of these animals? (timing, dietary composition and quantities for each animal by age and sex, seasonal changes, other relevant practices)
6. From where do you obtain these foods?
7. How do you organize their time outdoors? Are there ever times when they do not go outdoors?
8. Do they eat plant material in the outdoor enclosure or drink from the canal around the island?
9. Do you provide additional supplements from time to time? What?
10. Can you describe any daily physical interactions that you have with these animals? Do you ever touch them? When and why?
11. Have these great apes been sick recently (within the last two months)? If so, which one(s)? What did you do? Did you provide treatment, and if so, what?
12. In your experience, is it possible for disease to pass between humans and captive animals in this zoo setting? Why or why not? Have you ever witnessed such transmission, and if so, when?

For inhabitants of southeastern Cameroon

1. What environmental changes have you observed or heard about in this forest ? Over what period of time ? What do you think of these changes ?

2. In your language, how do you refer to a gorilla/chimpanzee?
3. Where do gorillas/chimpanzees reside in this forest? What are their preferred habitats? Do they stay in the same place or do they move around?
4. Do you find gorillas/chimpanzees in close proximity to your village (use map)?
5. Do you hunt gorillas/chimpanzees? Were these animals hunted in the past? When, and by whom?
6. Who hunts gorillas/chimpanzees now?
7. What weapons are used to hunt gorillas/chimpanzees?
8. How are gorillas/chimpanzees usually butchered? Where and by whom?
9. What do you do with the different parts of the animals?
10. Can you describe for me the qualities/personality traits of gorillas/chimpanzees?
11. How do they behave with one another? Have you observed their behavior? What features strike you as most important?
12. Do gorillas/chimpanzees have certain kinds of powers? Which ones ? These powers, have they changed over time?
13. Do gorillas/chimpanzees have knowledge? Of what?
14. What do people think about these animals?
15. How do you behave when you meet one? Why?
16. How do gorillas/chimpanzees behave when they see you?
17. Do people and gorillas/chimpanzees share certain capacities or knowledge ?
18. Do you think that relations between people and gorillas/chimpanzees have changed ? If so, since when ? and why ?
19. Do gorillas/chimpanzees ever fall sick ? How do you know?

20. What do gorillas/chimpanzees do when they are sick ? How do they take care of themselves? (If animal uses leaves for self-treatment, ask person to show leaves. Ask if people use these leaves as well.

21. Is it possible for an illness to be transmitted from a gorilla/chimpanzee to a human? Or from a human to a gorilla/chimpanzee? If so, which illness? How does this happen?

Supplementary Table S2: Results of pairwise permanova statistics between groups based on a) Bray Curtis distance, b) Unweighted Unifrac distance and c) Weighted Unifrac distance

a) Bray Curtis distance

Group 1	Group 2	Sample size	Permutations	Sums of squares	F. Model	R²	p-value	Corrected p-value
Cameroon Chimpanzees	Cameroon Gorillas	21	5000	0.16	168.04	0.90	< 0.001	0.002
Cameroon Chimpanzees	Zoo Chimpanzees	12	5000	0.04	77.56	0.88	0.002	0.005
Cameroon Chimpanzees	Zoo Gorillas	12	5000	0.04	60.04	0.86	0.002	0.005
Cameroon Gorillas	Zoo Chimpanzees	21	5000	0.19	208.28	0.92	< 0.001	0.001
Cameroon Gorillas	Zoo Gorillas	21	5000	0.18	181.3	0.91	< 0.001	0.001
Zoo Chimpanzees	Zoo Gorillas	12	5000	0.02	32.2	0.76	0.002	0.005

b) Unweighted Unifrac distance

Group 1	Group 2	Sample size	Permutations	Sums of squares	F. Model	R²	p-value	Corrected p-value
Cameroon Chimpanzees	Cameroon Gorillas	21	5000	0.12	19.99	0.51	< 0.001	0.002
Cameroon Chimpanzees	Zoo Chimpanzees	12	5000	0.06	9.32	0.48	0.003	0.005
Cameroon Chimpanzees	Zoo Gorillas	12	5000	0.06	9.29	0.48	0.001	0.004
Cameroon Gorillas	Zoo Chimpanzees	21	5000	0.09	21.41	0.53	< 0.001	0.001
Cameroon Gorillas	Zoo Gorillas	21	5000	0.07	15.75	0.45	< 0.001	0.001
Zoo Chimpanzees	Zoo Gorillas	12	5000	0.02	6.51	0.39	0.003	0.005

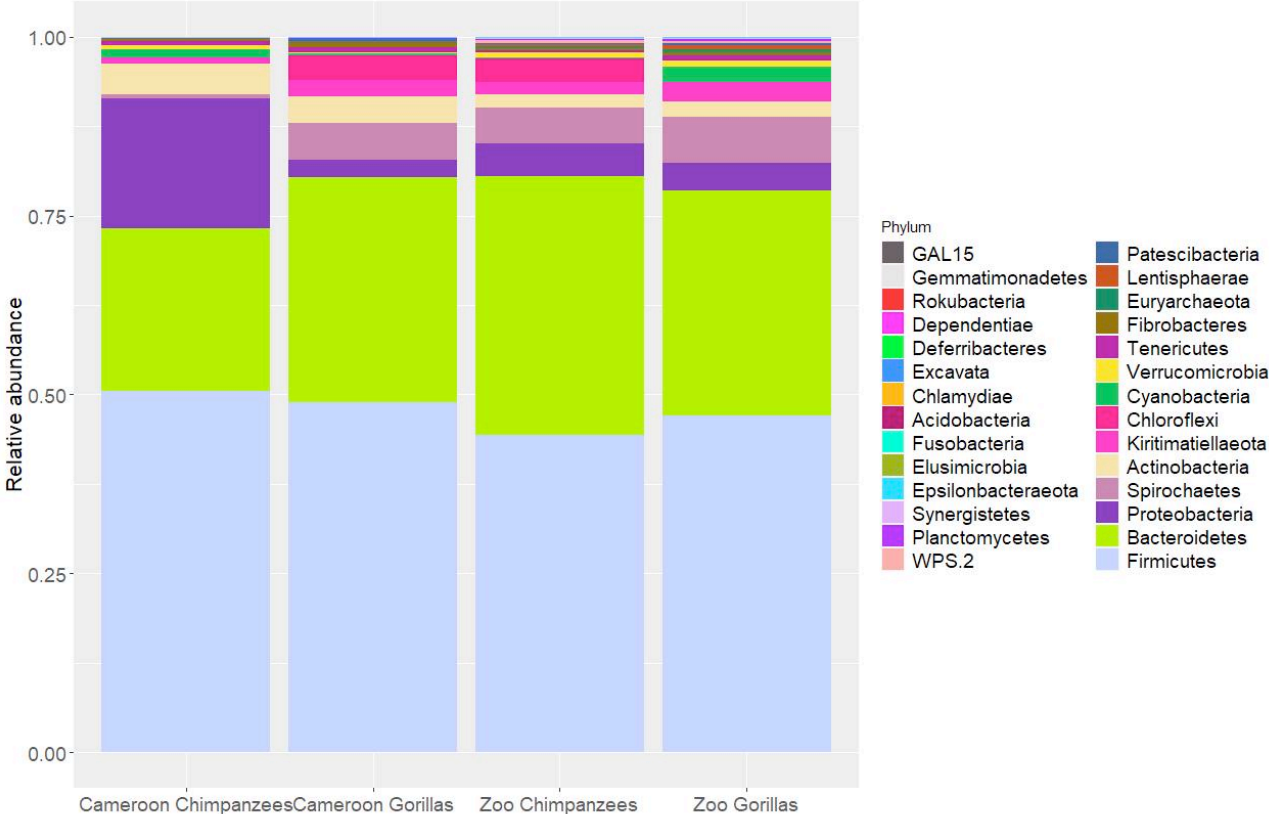
c) Weigthed Unifrac distance

Group 1	Group 2	Sample size	Permutations	Sums of squares	F. Model	R²	p-value	corrected p-value
Cameroon Chimpanzees	Cameroon Gorillas	21	5000	0.06	29.28	0.61	< 0.001	0.001
Cameroon Chimpanzees	Zoo Chimpanzees	12	5000	0.04	21.05	0.68	0.002	0.004
Cameroon Chimpanzees	Zoo Gorillas	12	5000	0.05	32.29	0.76	0.001	0.004
Cameroon Gorillas	Zoo Chimpanzees	21	5000	0.12	65.95	0.78	< 0.001	0.002
Cameroon Gorillas	Zoo Gorillas	21	5000	0.14	84.45	0.82	< 0.001	0.002
Zoo Chimpanzees	Zoo Gorillas	12	5000	0.01	9.95	0.50	0.002	0.004

Supplementary Table S3: Percentage of analyzed reads assigned to a known taxa for each taxonomic level

Group	Phylum	Class	Order	Family	Genus
Cameroon Chimpanzees	100.0	100.0	99.8	96.0	81.7
Cameroon Gorillas	100.0	100.0	99.9	94.8	71.1
Zoo Chimpanzees	100.0	99.5	99.5	95.8	72.9
Zoo Gorillas	100.0	99.7	99.7	91.6	65.5
Cameroon	100.0	100.0	99.9	95.1	74.1
Zoo	100.0	99.6	99.6	93.7	69.2
Chimpanzees	100.0	99.8	99.7	95.9	77.3
Gorillas	100.0	99.9	99.9	93.9	69.5
Total	100.0	99.9	99.8	94.6	72.3

Supplementary Figure S1: Mean taxonomic composition (relative abundance) of samples by group, at phyla level



Supplementary Table S4: Mean and Standard Deviation of phyla with significant differences of relative abundance between zoo and Cameroon forest for chimpanzees and gorillas. Pairwise wilcoxon tests have been performed with Bonferroni correction. $N_{\text{Cameroon chimpanzee}}=6$; $N_{\text{Zoochimpanzee}}=6$; $N_{\text{Cameroon gorilla}}=15$; $N_{\text{Cameroon gorilla}}=6$.

Species	Phylum	Mean Cameroon	Mean Zoo	Adjusted p value
Chimpanzee	Bacteroidetes	45636 ± SD=4855	72268 ± SD=9121	0.013
Chimpanzee	Chloroflexi	41 ± SD=69	6542 ± SD=4681	0.013
Chimpanzee	Cyanobacteria	2065 ± SD=818	273 ± SD=186	0.013
Chimpanzee	Epsilonbacteraeota	171 ± SD=84	36 ± SD=47	0.03
Chimpanzee	Euryarchaeota	271 ± SD=183	769 ± SD=268	0.013
Chimpanzee	Spirochaetes	1284 ± SD=387	10148 ± SD=4518	0.013
Gorilla	Chloroflexi	6969 ± SD=4329	0 ± SD=1	0.003
Gorilla	Cyanobacteria	569 ± SD=520	4222 ± SD=808	< 0.001
Gorilla	Lentisphaerae	133 ± SD=300	1106 ± SD=464	0.005
Gorilla	Synergistetes	0 ± SD=0	402 ± SD=427	< 0.001
Gorilla	Verrucomicrobia	159 ± SD=437	1860 ± SD=1255	0.01
Gorilla	WPS.2	2 ± SD=4	527 ± SD=403	< 0.001

Supplementary Table S5: Mean and Standard Deviation of families with significant differences of relative abundance between zoo and Cameroon forest for chimpanzees and gorillas. Pairwise wilcoxon tests have been performed with Bonferroni correction. $N_{\text{Cameroon chimpanzee}}=6$; $N_{\text{Zoochimpanzee}}=6$; $N_{\text{Cameroon gorilla}}=15$; $N_{\text{Cameroon gorilla}}=6$.

Species	Phylum	Famille	Mean Cameroon	Mean Zoo	Adjusted p value
Chimpanzee	Actinobacteria	Coriobacteriales.Incertae.Sedis	116 ± SD=98	578 ± SD=217	0.013
Chimpanzee	Actinobacteria	Bifidobacteriaceae	1418 ± SD=739	102 ± SD=190	0.013
Chimpanzee	Bacteroidetes	Paludibacteraceae	733 ± SD=618	5651 ± SD=1234	0.03
Chimpanzee	Bacteroidetes	Tannerellaceae	769 ± SD=320	2352 ± SD=353	0.013
Chimpanzee	Bacteroidetes	Weeksellaceae	3186 ± SD=5790	0 ± SD=0	0.048
Chimpanzee	Chloroflexi	Anaerolineaceae	41 ± SD=69	6541 ± SD=4681	0.013
Chimpanzee	Epsilonbacteraeota	Campylobacteraceae	156 ± SD=73	30 ± SD=40	0.049
Chimpanzee	Firmicutes	Clostridiaceae.1	85 ± SD=88	3447 ± SD=1964	0.013
Chimpanzee	Firmicutes	Acidaminococcaceae	689 ± SD=251	5239 ± SD=3795	0.026
Chimpanzee	Firmicutes	Planococcaceae	14219 ± SD=9665	0 ± SD=0	0.014
Chimpanzee	Lentisphaerae	Victivallaceae	1 ± SD=2	194 ± SD=104	0.022
Chimpanzee	Proteobacteria	Desulfovibrionaceae	190 ± SD=111	1667 ± SD=781	0.013
Chimpanzee	Proteobacteria	Enterobacteriaceae	669 ± SD=1013	1 ± SD=1	0.026
Chimpanzee	Proteobacteria	Moraxellaceae	26099 ± SD=20183	0 ± SD=0	0.014
Chimpanzee	Spirochaetes	Spirochaetaceae	1284 ± SD=386	10145 ± SD=4520	0.013
Gorilla	Actinobacteria	Coriobacteriales.Incertae.Sedis	550 ± SD=316	141 ± SD=61	0.006
Gorilla	Actinobacteria	Eggerthellaceae	3433 ± SD=2812	765 ± SD=340	0.007
Gorilla	Bacteroidetes	Bacteroidales.UCG.001	0 ± SD=0	1368 ± SD=1502	< 0.001
Gorilla	Bacteroidetes	F082	0 ± SD=0	10423 ± SD=5114	< 0.001
Gorilla	Bacteroidetes	Rikenellaceae	12022 ± SD=6775	4632 ± SD=1752	0.007
Gorilla	Bacteroidetes	Tannerellaceae	441 ± SD=306	1847 ± SD=875	< 0.001
Gorilla	Chloroflexi	Anaerolineaceae	6965 ± SD=4330	0 ± SD=1	0.003
Gorilla	Firmicutes	Clostridiales.vadinBB60.group	3573 ± SD=2727	8713 ± SD=1705	0.007

Gorilla	Firmicutes	Family.XIII	5365 ± SD=1887	1069 ± SD=336	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	27560 ± SD=6688	16590 ± SD=3001	0.004
Gorilla	Lentisphaerae	Victivallaceae	0 ± SD=0	488 ± SD=573	< 0.001
Gorilla	Synergistetes	Synergistaceae	0 ± SD=0	402 ± SD=427	< 0.001
Gorilla	Tenericutes	Acholeplasmataceae	384 ± SD=400	0 ± SD=0	0.039
Gorilla	Verrucomicrobia	Puniceicoccaceae	150 ± SD=429	1860 ± SD=1255	0.01

Supplementary Table S6: Mean and Standard Deviation of genera with significant differences of relative abundance between zoo and Cameroon forest for chimpanzees and gorillas. Pairwise wilcoxon tests have been performed with Bonferroni correction. $N_{\text{Cameroon chimpanzee}}=6$; $N_{\text{Zoochimpanzee}}=6$; $N_{\text{Cameroon gorilla}}=15$; $N_{\text{Cameroon gorilla}}=6$.

Species	Phylum	Famille	Genre	Mean Cameroon	Mean Zoo	Adjusted p value
Chimpanzee	Actinobacteria	Coriobacteriales Incertae Sedis	Phoenicibacter	79 ± SD=62	576 ± SD=216	0.013
Chimpanzee	Actinobacteria	Bifidobacteriaceae	Bifidobacterium	1418 ± SD=739	102 ± SD=190	0.013
Chimpanzee	Actinobacteria	Atopobiaceae	Olsenella	777 ± SD=510	0 ± SD=0	0.017
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotella 2	0 ± SD=0	1431 ± SD=1030	0.017
Chimpanzee	Bacteroidetes	Rikenellaceae	dgA 11 gut group	17 ± SD=29	707 ± SD=350	0.03
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotella 1	62 ± SD=105	773 ± SD=347	0.049
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotellaceae UCG 001	1815 ± SD=802	10295 ± SD=5570	0.013
Chimpanzee	Bacteroidetes	Tannerellaceae	Parabacteroides	526 ± SD=311	2352 ± SD=353	0.013
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotella 9	8255 ± SD=3449	16131 ± SD=4640	0.026
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotella 7	10565 ± SD=4126	0 ± SD=1	0.022
Chimpanzee	Bacteroidetes	Prevotellaceae	Prevotellaceae NK3B31 group	1173 ± SD=1743	0 ± SD=0	0.017
Chimpanzee	Bacteroidetes	Muribaculaceae	metagenome	708 ± SD=818	0 ± SD=0	0.017
Chimpanzee	Bacteroidetes	Flavobacteriaceae	Flavobacterium	1129 ± SD=2658	0 ± SD=0	0.048
Chimpanzee	Bacteroidetes	Weeksellaceae	Empedobacter	595 ± SD=1436	0 ± SD=0	0.029
Chimpanzee	Chloroflexi	Anaerolineaceae	Flexilinea	41 ± SD=69	6541 ± SD=4681	0.013
Chimpanzee	Epsilonbacteraeota	Campylobacteraceae	Campylobacter	156 ± SD=73	30 ± SD=40	0.049
Chimpanzee	Euryarchaeota	Methanomethylophilaceae	Candidatus Methanomethylophilus	0 ± SD=0	59 ± SD=58	0.017
Chimpanzee	Firmicutes	Clostridiaceae 1	Clostridium sensu stricto 1	0 ± SD=0	1724 ± SD=2133	0.017
Chimpanzee	Firmicutes	Ruminococcaceae	Ruminiclostridium 6	10 ± SD=23	586 ± SD=707	0.037
Chimpanzee	Firmicutes	Clostridiaceae 1	Sarcina	85 ± SD=88	1721 ± SD=1103	0.013

Chimpanzee	Firmicutes	Lachnospiraceae	Acetitomaculum	70 ± SD=22	1271 ± SD=848	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	Ruminococcus gauvreauii group	43 ± SD=34	522 ± SD=508	0.03
Chimpanzee	Firmicutes	Ruminococcaceae	Ruminococcus 1	202 ± SD=92	2163 ± SD=1846	0.013
Chimpanzee	Firmicutes	Acidaminococcaceae	Phascolarctobacterium	689 ± SD=251	5239 ± SD=3795	0.026
Chimpanzee	Firmicutes	Clostridiales vadinBB60 group	gut metagenome	194 ± SD=121	669 ± SD=258	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	Roseburia	1310 ± SD=580	368 ± SD=223	0.013
Chimpanzee	Firmicutes	Ruminococcaceae	Butyricicoccus	233 ± SD=168	45 ± SD=21	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	Lachnoclostridium	1532 ± SD=392	271 ± SD=160	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	Oribacterium	7104 ± SD=1197	887 ± SD=532	0.013
Chimpanzee	Firmicutes	Ruminococcaceae	Ruminococcaceae UCG 008	6492 ± SD=4439	804 ± SD=605	0.026
Chimpanzee	Firmicutes	Family XIII	Family XIII UCG 001	440 ± SD=223	46 ± SD=13	0.03
Chimpanzee	Firmicutes	Lachnospiraceae	Lachnospiraceae UCG 004	1792 ± SD=610	179 ± SD=105	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	Anaerostipes	446 ± SD=202	36 ± SD=32	0.013
Chimpanzee	Firmicutes	Ruminococcaceae	Ruminiclostridium 5	1307 ± SD=587	86 ± SD=88	0.013
Chimpanzee	Firmicutes	Lachnospiraceae	GCA 900066575	514 ± SD=259	28 ± SD=25	0.03
Chimpanzee	Firmicutes	Planococcaceae	Rummeliibacillus	960 ± SD=1068	0 ± SD=0	0.008
Chimpanzee	Firmicutes	Planococcaceae	Kurthia	8568 ± SD=8385	0 ± SD=0	0.008
Chimpanzee	Proteobacteria	Desulfovibrionaceae	Desulfovibrio	190 ± SD=111	1556 ± SD=745	0.013
Chimpanzee	Proteobacteria	Burkholderiaceae	Comamonas	1737 ± SD=4172	0 ± SD=0	0.048
Chimpanzee	Proteobacteria	Moraxellaceae	Acinetobacter	26099 ± SD=20183	0 ± SD=0	0.014
Chimpanzee	Spirochaetes	Spirochaetaceae	Sphaerochaeta	284 ± SD=221	2452 ± SD=1158	0.013
Chimpanzee	Spirochaetes	Spirochaetaceae	Treponema 2	1000 ± SD=207	7670 ± SD=5015	0.013
Gorilla	Actinobacteria	Atopobiaceae	Libanicoccus	718 ± SD=789	0 ± SD=0	0.003
Gorilla	Actinobacteria	Eggerthellaceae	Senegalimassilia	777 ± SD=752	66 ± SD=94	0.012
Gorilla	Bacteroidetes	Prevotellaceae	Prevotella 1	89 ± SD=129	3277 ± SD=2944	0.003
Gorilla	Bacteroidetes	Prevotellaceae	Prevotellaceae UCG 001	2063 ± SD=1823	5416 ± SD=2194	0.028
Gorilla	Bacteroidetes	Prevotellaceae	Prevotellaceae UCG 003	482 ± SD=326	2051 ± SD=940	0.004
Gorilla	Bacteroidetes	Prevotellaceae	Prevotellaceae UCG 004	2393 ± SD=2692	186 ± SD=171	< 0.001

Gorilla	Bacteroidetes	Rikenellaceae	dgA 11 gut group	0 ± SD=0	491 ± SD=382	< 0.001
Gorilla	Bacteroidetes	Rikenellaceae	Rikenellaceae RC9 gut group	12000 ± SD=6776	3904 ± SD=1836	0.007
Gorilla	Bacteroidetes	Tannerellaceae	Parabacteroides	439 ± SD=304	1847 ± SD=875	< 0.001
Gorilla	Chloroflexi	Anaerolineaceae	Flexilinea	6965 ± SD=4330	0 ± SD=1	0.003
Gorilla	Euryarchaeota	Methanomethylophilaceae	Candidatus Methanomethylophilus	361 ± SD=321	13 ± SD=18	0.003
Gorilla	Firmicutes	Clostridiaceae 1	Clostridium sensu stricto 1	28 ± SD=99	322 ± SD=436	0.026
Gorilla	Firmicutes	Family XIII	Family XIII AD3011 group	4185 ± SD=1520	313 ± SD=46	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	Eubacterium eligens group	2 ± SD=6	107 ± SD=68	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	Eubacterium hallii group	1284 ± SD=808	73 ± SD=75	0.003
Gorilla	Firmicutes	Lachnospiraceae	Eubacterium ruminantium group	46 ± SD=63	482 ± SD=447	0.04
Gorilla	Firmicutes	Lachnospiraceae	Acetitomaculum	392 ± SD=339	50 ± SD=36	0.006
Gorilla	Firmicutes	Lachnospiraceae	Agathobacter	652 ± SD=578	46 ± SD=61	0.01
Gorilla	Firmicutes	Lachnospiraceae	GCA 900066575	0 ± SD=0	81 ± SD=75	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	Lachnospiraceae ND3007 group	4202 ± SD=3244	94 ± SD=88	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	Lachnospiraceae NK3A20 group	704 ± SD=442	101 ± SD=226	0.016
Gorilla	Firmicutes	Lachnospiraceae	Lachnospiraceae NK4A136 group	18 ± SD=48	724 ± SD=561	0.001
Gorilla	Firmicutes	Lachnospiraceae	Lachnospiraceae XPB1014 group	0 ± SD=0	3992 ± SD=2363	< 0.001
Gorilla	Firmicutes	Lachnospiraceae	Pseudobutyrvibrio	4267 ± SD=2037	37 ± SD=26	< 0.001
Gorilla	Firmicutes	Ruminococcaceae	Eubacterium coprostanoligenes group	12311 ± SD=4829	4785 ± SD=2319	0.004
Gorilla	Firmicutes	Ruminococcaceae	Candidatus Soleaferrea	91 ± SD=78	701 ± SD=293	0.006
Gorilla	Firmicutes	Ruminococcaceae	Hydrogenoanaerobacterium	640 ± SD=287	64 ± SD=41	< 0.001
Gorilla	Firmicutes	Ruminococcaceae	Oscillibacter	124 ± SD=99	370 ± SD=107	0.016
Gorilla	Firmicutes	Ruminococcaceae	Ruminiclostridium 5	1954 ± SD=1797	70 ± SD=48	< 0.001
Gorilla	Firmicutes	Ruminococcaceae	Ruminiclostridium 6	12 ± SD=30	962 ± SD=621	0.001
Gorilla	Firmicutes	Ruminococcaceae	Ruminococcaceae UCG 002	1175 ± SD=517	4267 ± SD=1613	< 0.001
Gorilla	Firmicutes	Ruminococcaceae	Ruminococcaceae UCG 003	29 ± SD=62	432 ± SD=351	0.006
Gorilla	Firmicutes	Ruminococcaceae	Ruminococcaceae UCG 005	2970 ± SD=1196	5665 ± SD=1671	0.02
Gorilla	Firmicutes	Ruminococcaceae	Ruminococcaceae UCG 013	177 ± SD=191	1017 ± SD=379	< 0.001

Gorilla	Firmicutes	Erysipelotrichaceae	Erysipelotrichaceae UCG 006	0 ± SD=0	38 ± SD=41	< 0.001
Gorilla	Firmicutes	Erysipelotrichaceae	Holdemanella	307 ± SD=316	10 ± SD=15	0.003
Gorilla	Firmicutes	Erysipelotrichaceae	Ileibacterium	0 ± SD=0	773 ± SD=1777	0.002
Gorilla	Firmicutes	Erysipelotrichaceae	Solobacterium	1241 ± SD=869	209 ± SD=350	0.01
Gorilla	Proteobacteria	uncultured	gut metagenome	3 ± SD=12	216 ± SD=165	< 0.001
Gorilla	Proteobacteria	Succinivibrionaceae	Ruminobacter	1 ± SD=3	601 ± SD=248	< 0.001
Gorilla	Proteobacteria	Burkholderiaceae	Parasutterella	0 ± SD=0	2458 ± SD=3104	< 0.001
Gorilla	Spirochaetes	Spirochaetaceae	Sphaerochaeta	796 ± SD=505	5838 ± SD=3142	< 0.001
Gorilla	Tenericutes	Acholeplasmataceae	Acholeplasma	384 ± SD=400	0 ± SD=0	0.039
Gorilla	Verrucomicrobia	Puniceicoccaceae	Cerasicoccus	112 ± SD=430	1441 ± SD=1235	0.003