Table S1. Detected genera that are linked to butyrate producers. For functional gene IDs associated with individual taxa see fungene (http://fungene.cme.msu.edu) and Vital et al (2013). The applied gene-association should not be regarded as strict for those taxa as several genera contain both *but* and *buk* as well as non-butyrate producing members (see main text). Thus, this type of analysis cannot substitute for a functional gene-targeted approach, but is used here for global comparisons. Individual (gene) categories are indicated: butyryl-CoA:acetate CoA-transferase (*but),* butyrate kinase (*buk*), alternative transferases (other) and amino acids fed butyrate-producing pathways (aa). Brachyspir. (*Brachyspiraceae*), Clost.IS_XI (*Clostridiales_Incertae Sedis XI*), Oxalobact. (*Oxalobacteraceae*).

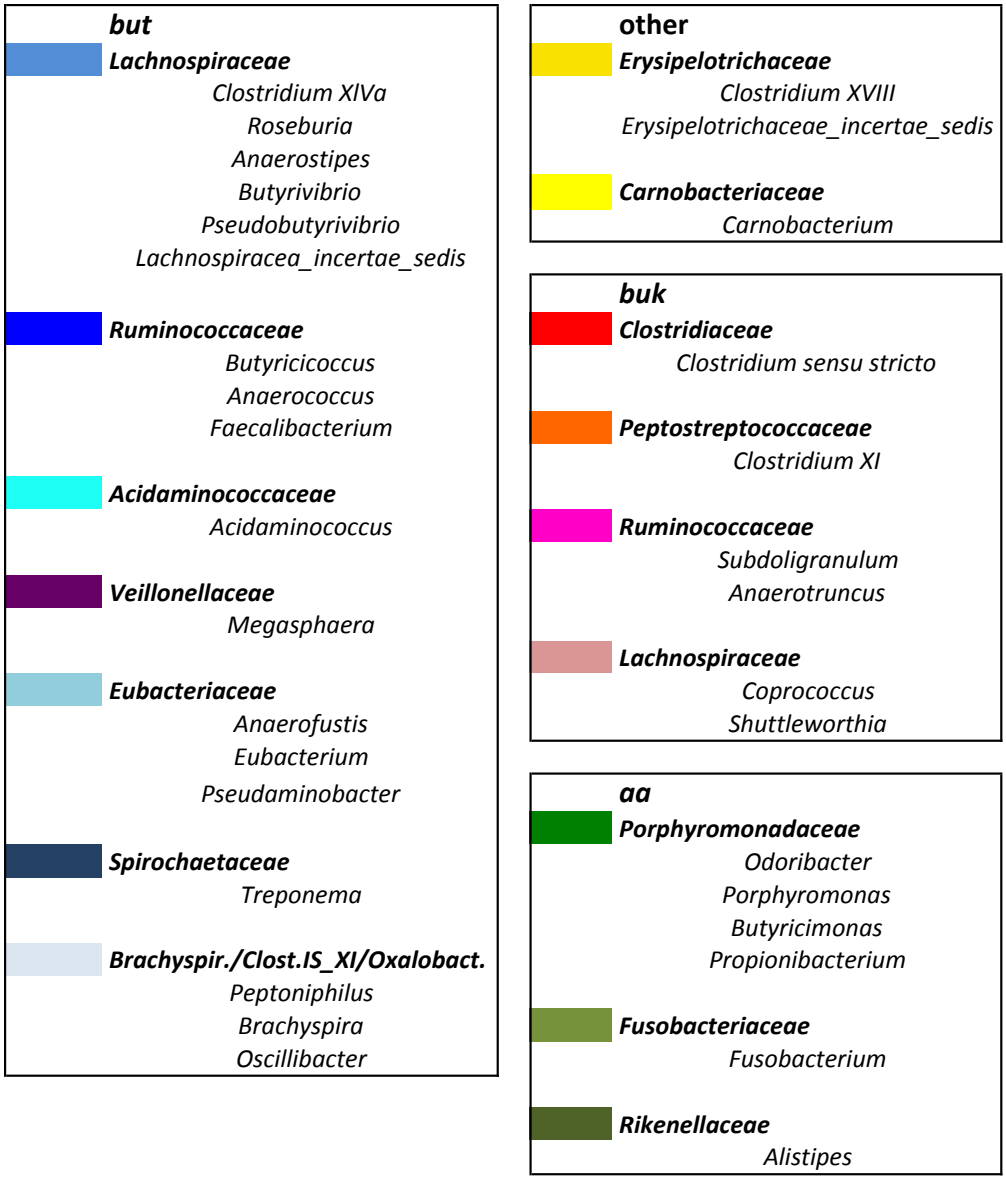
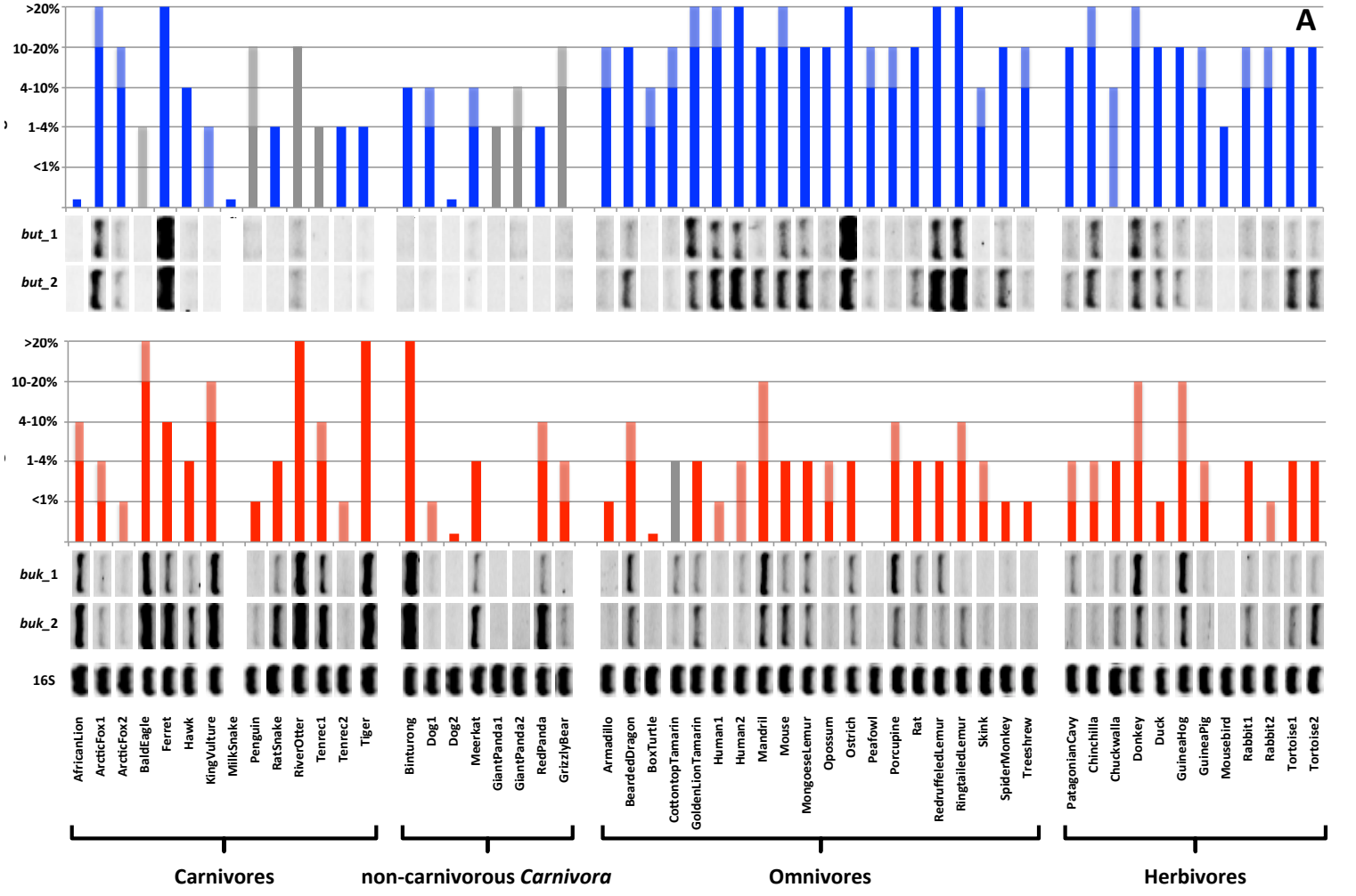


Table S2. Main ingredients and major enrichments of animal diets.

SampleID	Diet	Main Ingredients	Major Enrichments
BaldEagle	C	Natural Balance® Meat eating bird diet, fish, mice, rat, rabbit	
Duck	H	Corn, scratch, Mazuri® Waterfowl Maintenance	Crickets
Mousebird	H	Fruit and Mazuri® Softbill	
Hawk	C	Nebraska Brand® Bird of Prey diet	Prey items
Peafowl	O	Corn, scratch, Mazuri® Waterfowl Maintenance, bugs, worms	Produce, bugs, worms
KingVulture	C	Fish, Nebraska Brand® Premium Meat, rabbit	Raw eggs
Penguin	C	Fish	
Ostrich	O	Ratite pellets	Produce, corn, starch, browsw
Tenrec1	C	Insecticore diet, meal worms, cricket, Science Diet® Feline Adult Lite, apple	
Tenrec2	C	Insecticore diet, meal worms, cricket, Science Diet® Feline Adult Lite, apple	
GuineaHog	H	Grass, hay, Mazuri® Mini-pig Elder	Omolene® Sweet Feed, oats, scratch, mealworms, eggs, bread, cereal
Dog1	O	Wellness® natural dry dog food	
Dog2	O	Wellness® natural dry dog food	
ArcticFox1	C	Natural Balance® Carnivore Diet, Science Diet® K-9 Small Bites dry, rib bone, dog food	Frozen fish, live fish, deer meat, eggs, dog treats, peanut butter tubes
ArcticFox2	C	Natural Balance® Carnivore Diet, Science Diet® K-9 Small Bites dry, rib bone, dog food	Frozen fish, live fish, deer meat, eggs, dog treats, peanut butter tubes
AfricanLion	C	Carnivore diet, rib bone, femur bone	Herring, rabbits, venison, chicken, melon, pumpkin
Tiger	C	Nebraska Brand® Exotic Feline Diet	
Meerkat	O	Insectivore diet, cat food, crickets, mealworms, hard boiled eggs, fruit, veggies, greens, fuzzy mice	Nuts, seeds, grains, cereal, pasta, dried fruit, honey
Ferret	C	Meat, eggs, pinky mice, bugs	
RiverOtter	C	Fish, Science Diet® Active Longevity	Earthworms, mice, carrots, apples, pumpkin
RedPanda	H	Banana, apple, Marion™ Leafeater diet, Marion™ Leafeater Lemur Biscuits, bamboo	
GrizzlyBear	C	Mazuri® Omnivore 5635, produce, bones	
GiantPanda1	H	Bamboo	
GiantPanda2	H	Bamboo	
Binturong	O	Mazuri® Leaf Eater Stickes, dry dog food, banana, fruit, half egg	
Armadillo	O	Insectivore pellets, potato, apple, grape, waxworm	Crickets
Opossum	O	Veggies, fruit, Science Diet® Canine Small Bites, adult mouse whole	Produce
Rabbit1	H	Oxbow basix bunny/T pellets, hay, fresh produce	
Rabbit2	H	Oxbow basix bunny/T pellets, hay, fresh produce	
Donkey	H	Hay, mineral pellet	
CottontopTamarin	O	Mazuri® Marmoset Jelly, banana, Mazuri® High Protein Primate Stick, fruit, bugs	
GoldenLionTamarin	O	Tamarin diet, waxworms, mealworms	Peanut butter, honey, dried fruit, cereal, cooked pasta, popcorn, yogurt
Human1	O	North american omnivoric diet	
Human2	O	North american omnivoric diet	
Mandril	O	Mazuri® Primate Browse Biscuits, glucosamine	
MongooseLemur	O	Mazuri® Primate Browse Biscuits, greens	*Peanut butter, honey, dried fruit, cereal, cooked pasta, popcorn, yogurt, crickets, earthworms, bread, mealworms, waxworms (for all Lemurs and SpiderMonkey)*
RedruffeledLemur	O	Mazuri® Primate Browse Biscuits, greens	
RingtailedLemur	O	Mazuri® Primate Browse Biscuits, greens, browse, flowers, fruit, veggies	
SpiderMonkey	O	Marion™ Leafeater Lemur Biscuit, Mazuri® New World Primate diet, fruit, veggie	
GuineaPig	H	Hay, Kaytee® Timothy Complete Fiber diet	
PatagonianCavy	H	Grass, hay, Mazuri® Primate Browse Biscuits, greens, veggies, guinea pig diet, seeds, scratch, rodent chow, fruit	
Chinchilla	H	Hay, Mazuri® Chin Chow, cheerios, vegetables, fresh and dried fruit, grains	
Porcupine	H	Mazuri® Primate Browse Biscuits, Science Diet® Active Longevity	Browse, pumpkins, melons, corn stalks, corn on the cob, scents, spices
Mouse	O	Kaytee® healthy support diet	
Rat	O	Kaytee® healthy support diet	
Treeshrew	O	Insectivore diet, cat food, mixed fruit, veggies, bugs	
BeardedDragon	O	Greens topped with fruit or vegetables, insects	Fuzzy mice
MilkSnake	C	Dead Fuzzies (mice)	
RatSnake	C	Dead Fuzzies (mice)	
Chuckwalla	H	Greens, carrot, potato, beet, and seed	
Skink	O	Produce, crickets, worms, pinky mouse	
BoxTurtle	O	Fruit, vegetables, earthworms, crickets	
Tortoise1	H	Diced greens, carrot, potato, tortoise chow pellets, hay/grass mix	Fruits
Tortoise2	H	Diced greens, carrot, potato, tortoise chow pellets, hay/grass mix	Fruits


A
>20%
10-20%
4-10%
1-4%
<1%
but_1
but_2
buk_1
buk_2
16S
AfricanLion
ArcticFox1
ArcticFox2
BaldEagle
Ferret
Hawk
KingVulture
MilkSnake
Penguin
RatSnake
RiverOtter
Tenrec1
Tenrec2
Tiger
Binturong
Dog1
Dog2
Meerkat
GiantPanda1
GiantPanda2
RedPanda
GrizzlyBear
Armadillo
BeardedDragon
BoxTurtle
CottontopTamarin
GoldenLionTamarin
Human1
Human2
Mandril
Mouse
MongooseLemur
Opossum
Ostrich
Peafowl
Porcupine
Rat
RedruffledLemur
RingtailedLemur
Skink
SpiderMonkey
Treeshrew
PatagonianCavy
Chinchilla
Chuckwalla
Donkey
Duck
GuineaHog
GuineaPig
Mousebird
Rabbit1
Rabbit2
Tortoise1
Tortoise2
Carnivores
non-carnivorous Carnivora
Omnivores
Herbivores

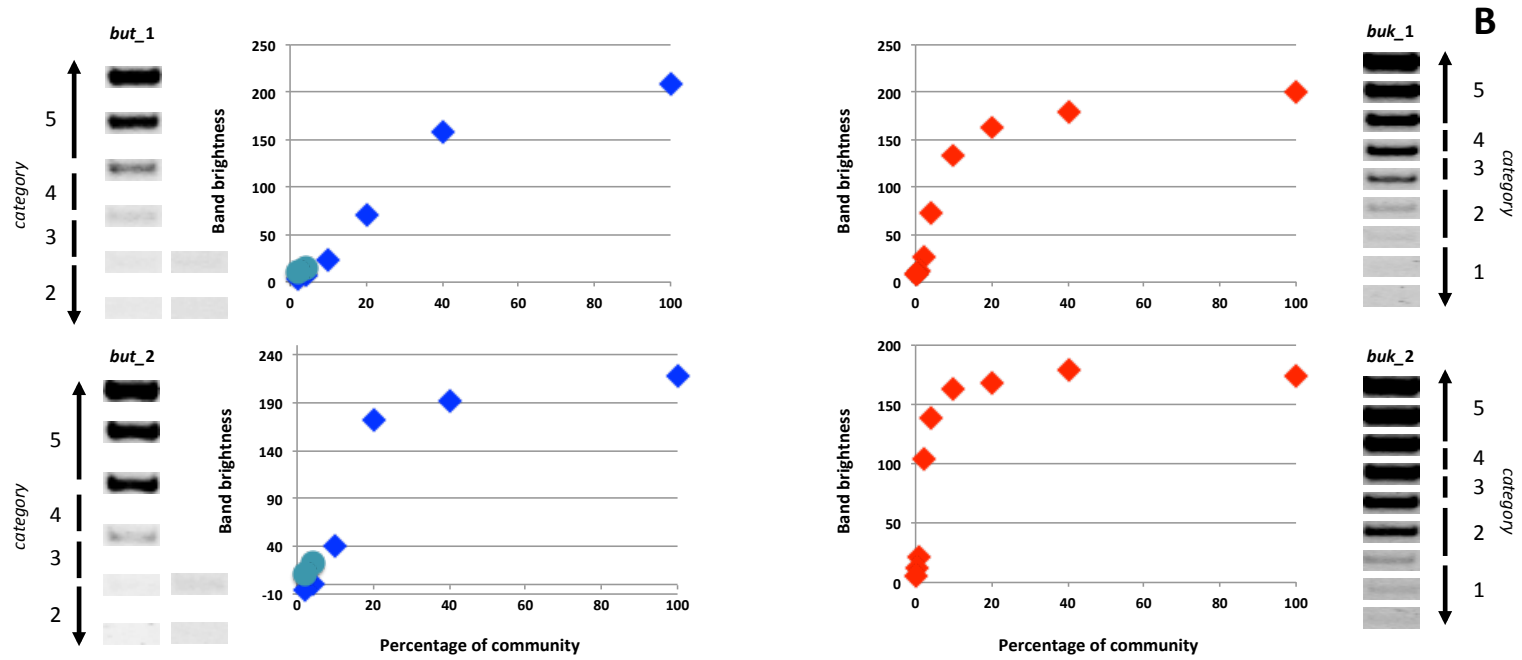

B
but_1
but_2
buk_1
buk_2
category
Band brightness
Percentage of community

Figure S1. Estimating gene abundances of butyryl-CoA:acetate CoA-transferase (blue) and butyrate kinase (red) for all samples (panel A). Band intensities of PCR products were categorized into six distinct brightness groups (0-5) based on established standard curves from reference genomes (shown in panel B; gel background was subtracted from intensity values). Two experiments were performed for each gene. In order to increase detection confidence for *but* at low intensities two reference samples were analyzed at lowest concentrations and median values were used for calculations. Intensities of samples that were categorized as zero, but yielded sequences after re-amplification, are indicated as well (bars exhibiting 0.2 intensity). Samples where the majority of reads (>=97 %) were filtered out during the pipelining (see material and methods) are marked grey (also grizzly bear is marked grey as only 12 % of reads were considered as real *but*). For more details see materials and methods. No data is available for milk snake. Since no bands were visible for both genes in previous experiments (16S *rRNA* amplification displayed a bright band) we categorized estimated gene abundance as 0 % for both genes in this animal.

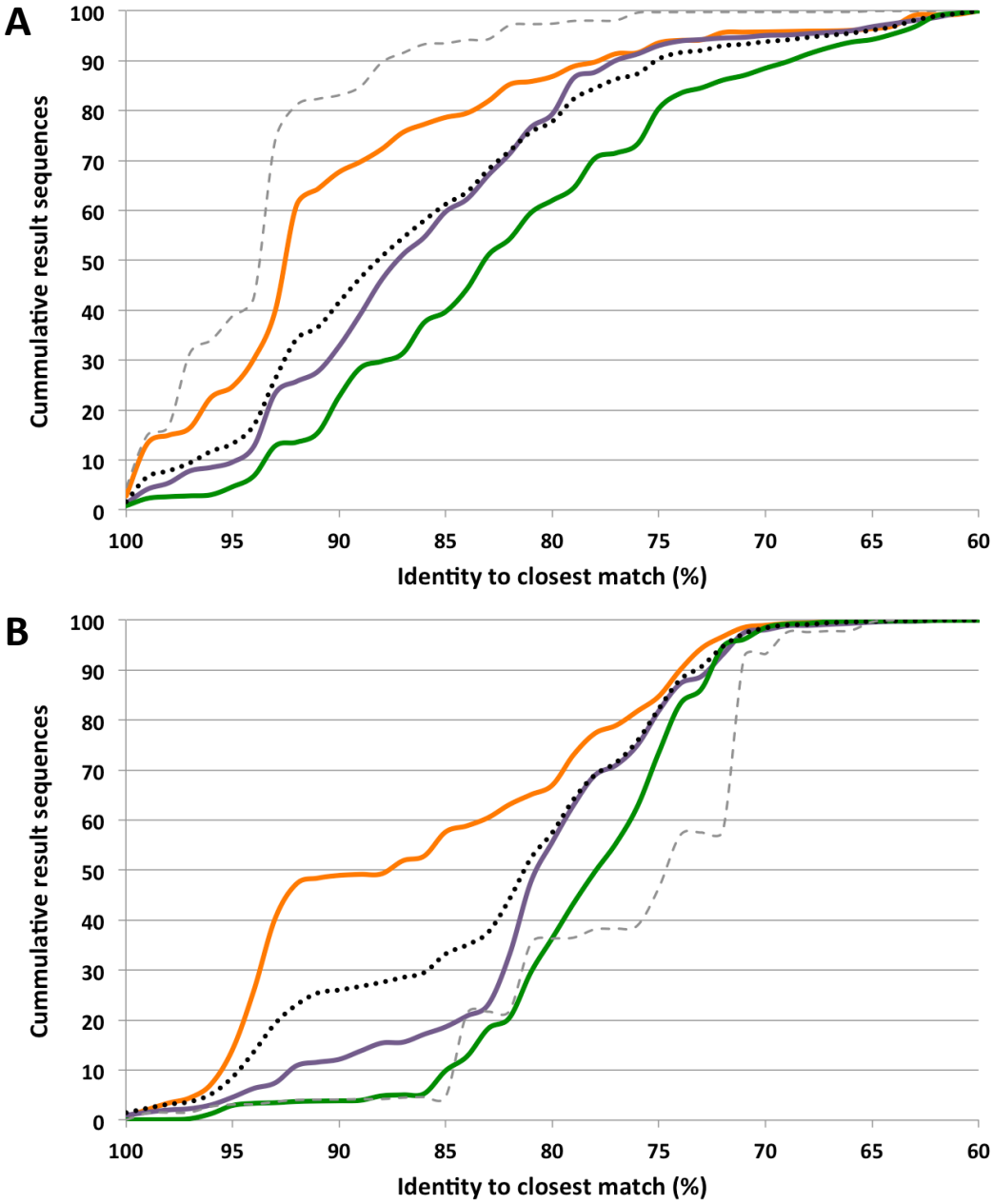


Figure S2. Identity values of all obtained sequences to a reference (on protein level) for butyryl-CoA:acetate CoA-transferase (A) and butyrate kinase (B) is shown. Individual diet groups are indicated as orange (carnivores including non-carnivorous *Carnivora*), violet (omnivores), green (herbivores), grey-dashed line (human) and black-dotted line (all groups together). The data is displayed as a cumulative percentage of sequence identities to a reference gene in our database.

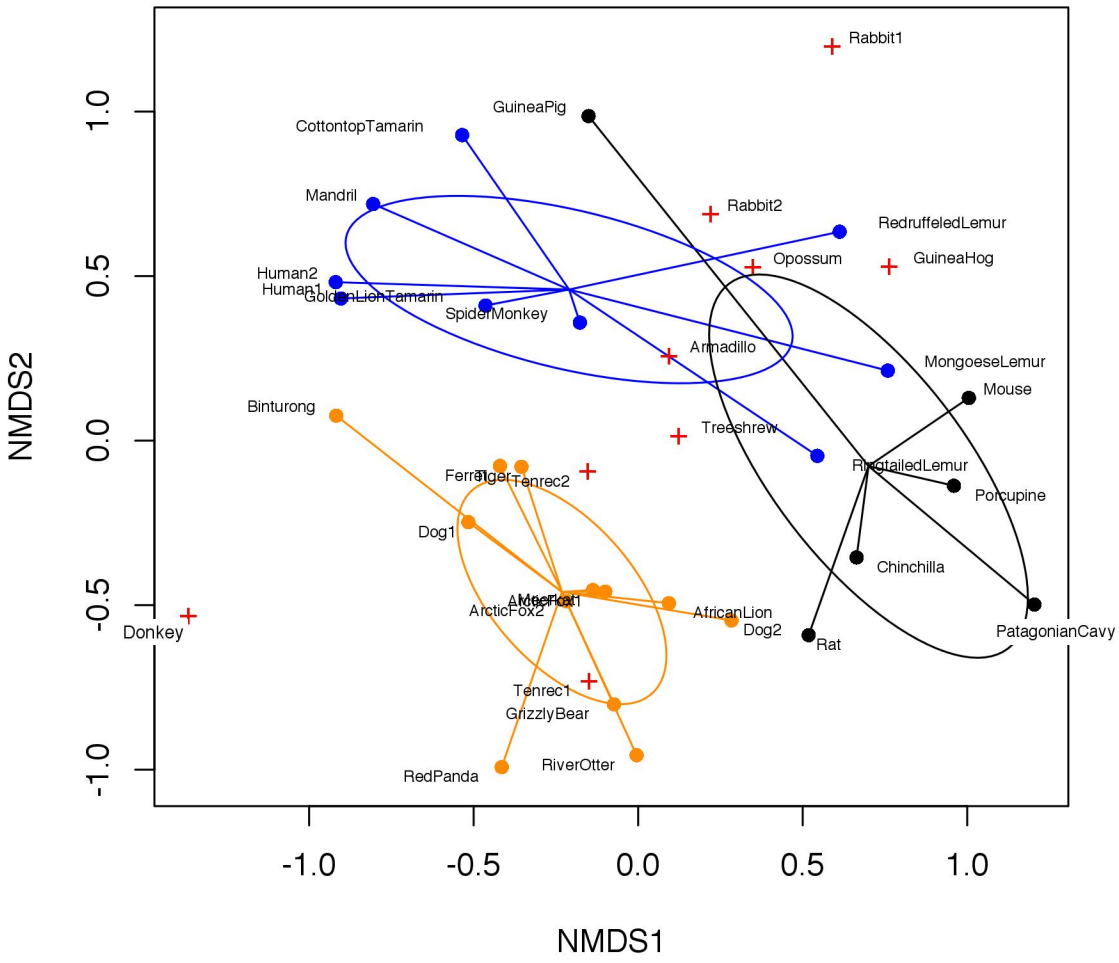
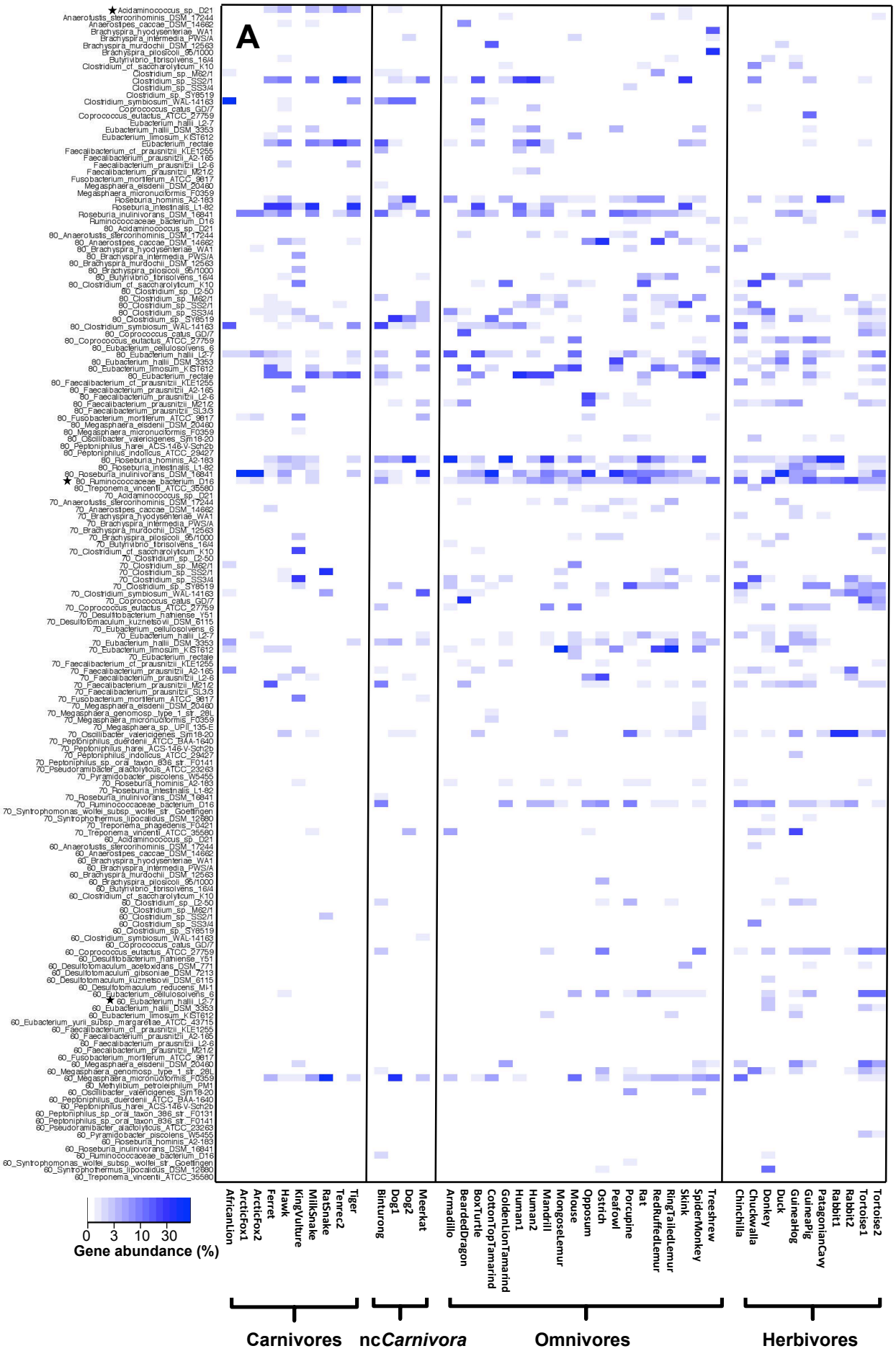


Figure S3. Non-metric multidimensional scaling (NMDS) of combined gene data (butyryl-CoA:acetate CoA-transferase and butyrate kinase) based on multi-linkage clustering (5% cut-off on protein level) for *Mammalia* only is shown. Individual orders are indicated as orange (*Carnivora*), blue (*Primates*) and black (*Rodentia*). Other subjects are displayed as well.


A
0 3 10 30
Gene abundance (%)
AfricanLion
ArcticFox1
ArcticFox2
Ferret
Hawk
KingVulture
MilkSnake
RatSnake
Tenrec2
Tiger
Binturong
Dog1
Dog2
Meerkat
Armadillo
BeardedDragon
BoxTurtle
CottonTopTamarind
GoldenLionTamarind
Human1
Human2
Mandrill
Mongoselemur
Mouse
Opposum
Ostrich
Peafowl
Porcupine
Rat
RedRuffedLemur
RingTailedLemur
Skink
SpiderMonkey
Treeshrew
Chinchilla
Chuckwalla
Donkey
Duck
GuineaHog
GuineaPig
PatagonianCavy
Rabbit1
Rabbit2
Tortoise1
Tortoise2
Carnivores
ncCarnivora
Omnivores
Herbivores

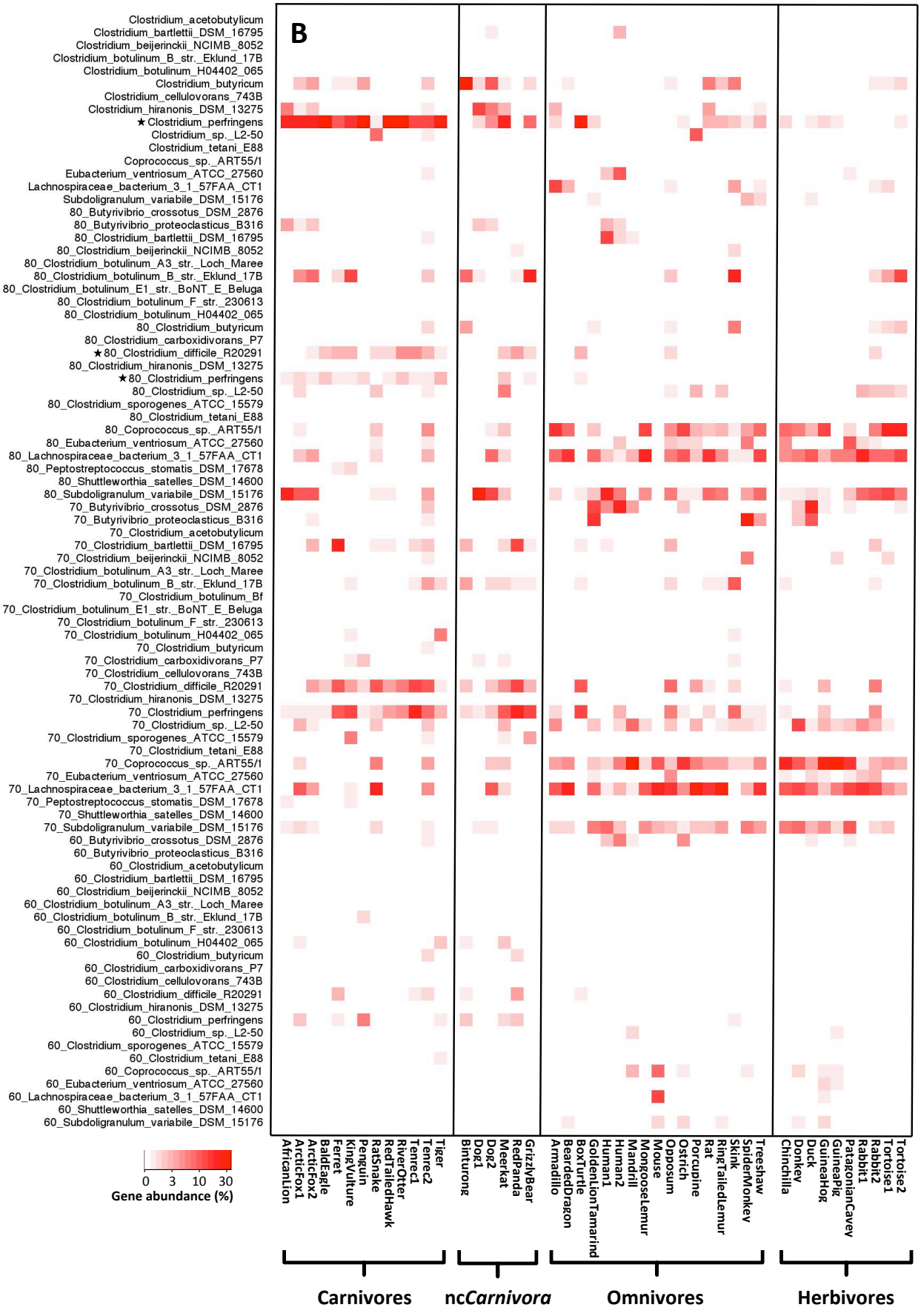

B
Clostridium_acetobutylicum
Clostridium_bartlettii_DSM_16795
Clostridium_beijerinckii_NCIMB_8052
Clostridium_botulinum_B_str._Eklund_17B
Clostridium_botulinum_H04402_065
Clostridium_butyricum
Clostridium_cellulovorans_743B
Clostridium_hiranonis_DSM_13275
★Clostridium_perfringens
Clostridium_sp._L2-50
Clostridium_tetani_E88
Coprococcus_sp._ART55/1
Eubacterium_ventriosum_ATCC_27560
Lachnospiraceae_bacterium_3_1_57FAA_CT1
Subdoligranulum_variabile_DSM_15176
80_Butyrivibrio_crossotus_DSM_2876
80_Butyrivibrio_proteoclasticus_B316
80_Clostridium_bartlettii_DSM_16795
80_Clostridium_beijerinckii_NCIMB_8052
80_Clostridium_botulinum_A3_str._Loch_Maree
80_Clostridium_botulinum_B_str._Eklund_17B
80_Clostridium_botulinum_E1_str._BoNT_E_Beluga
80_Clostridium_botulinum_F_str._230613
80_Clostridium_botulinum_H04402_065
80_Clostridium_butyricum
80_Clostridium_carboxidivorans_P7
★80_Clostridium_difficile_R20291
80_Clostridium_hiranonis_DSM_13275
★80_Clostridium_perfringens
80_Clostridium_sp._L2-50
80_Clostridium_sporogenes_ATCC_15579
80_Clostridium_tetani_E88
80_Coprococcus_sp._ART55/1
80_Eubacterium_ventriosum_ATCC_27560
80_Lachnospiraceae_bacterium_3_1_57FAA_CT1
80_Peptostreptococcus_stomatis_DSM_17678
80_Shuttleworthia_satelles_DSM_14600
80_Subdoligranulum_variabile_DSM_15176
70_Butyrivibrio_crossotus_DSM_2876
70_Butyrivibrio_proteoclasticus_B316
70_Clostridium_acetobutylicum
70_Clostridium_bartlettii_DSM_16795
70_Clostridium_beijerinckii_NCIMB_8052
70_Clostridium_botulinum_A3_str._Loch_Maree
70_Clostridium_botulinum_B_str._Eklund_17B
70_Clostridium_botulinum_Bf
70_Clostridium_botulinum_E1_str._BoNT_E_Beluga
70_Clostridium_botulinum_F_str._230613
70_Clostridium_botulinum_H04402_065
70_Clostridium_butyricum
70_Clostridium_carboxidivorans_P7
70_Clostridium_cellulovorans_743B
70_Clostridium_difficile_R20291
70_Clostridium_hiranonis_DSM_13275
70_Clostridium_perfringens
70_Clostridium_sp._L2-50
70_Clostridium_sporogenes_ATCC_15579
70_Clostridium_tetani_E88
70_Coprococcus_sp._ART55/1
70_Eubacterium_ventriosum_ATCC_27560
70_Lachnospiraceae_bacterium_3_1_57FAA_CT1
70_Peptostreptococcus_stomatis_DSM_17678
70_Shuttleworthia_satelles_DSM_14600
70_Subdoligranulum_variabile_DSM_15176
60_Butyrivibrio_crossotus_DSM_2876
60_Butyrivibrio_proteoclasticus_B316
60_Clostridium_acetobutylicum
60_Clostridium_bartlettii_DSM_16795
60_Clostridium_beijerinckii_NCIMB_8052
60_Clostridium_botulinum_A3_str._Loch_Maree
60_Clostridium_botulinum_B_str._Eklund_17B
60_Clostridium_botulinum_F_str._230613
60_Clostridium_botulinum_H04402_065
60_Clostridium_butyricum
60_Clostridium_carboxidivorans_P7
60_Clostridium_cellulovorans_743B
60_Clostridium_difficile_R20291
60_Clostridium_hiranonis_DSM_13275
60_Clostridium_perfringens
60_Clostridium_sp._L2-50
60_Clostridium_sporogenes_ATCC_15579
60_Clostridium_tetani_E88
60_Coprococcus_sp._ART55/1
60_Eubacterium_ventriosum_ATCC_27560
60_Lachnospiraceae_bacterium_3_1_57FAA_CT1
60_Shuttleworthia_satelles_DSM_14600
60_Subdoligranulum_variabile_DSM_15176
0 3 10 30
Gene abundance (%)
AfricanLion
ArcticFox1
ArcticFox2
BaldEagle
Ferret
KingVulture
Penguin
RatSnake
RedTailedHawk
RiverOtter
Tenrec1
Tenrec2
Tiger
Binturong
Dog1
Dog2
Meerkat
RedPanda
GrizzlyBear
Armadillo
BeardedDragon
BoxTurtle
GoldenLionTamarind
Human1
Human2
Mandrill
MongooseLemur
Mouse
Opposum
Ostrich
Porcupine
Rat
RingTailedLemur
Skink
SpiderMonkey
Treeshaw
Chinchilla
Donkey
Duck
GuineaHog
GuineaPig
PatagonianCavey
Rabbit1
Rabbit2
Tortoise1
Tortoise2
Carnivores
nc*Carnivora*
Omnivores
Herbivores

Figure S4. FrameBot closest match analysis of butyryl-CoA:acetate CoA-transferase (A: blue) and butyrate kinase (B: red) for all samples is shown. Closest match results were separated into distinct categories based on their percent identity to a reference gene (bins containing 10% identity ranges were created, where the number preceding the reference name specifies the lowest identity in that group; e.g. "70_reference name" is the combined percentage of all sequences that show 70%-79% identity to that reference; no number indicates categories from 90%-100% identity). nc*Carnivora*: non-carnivorous *Carnivora*. A black star indicates taxa significantly different ($p < 0.05$) between diet groups (non-carnivorous *Carnivora* were excluded from the analysis).

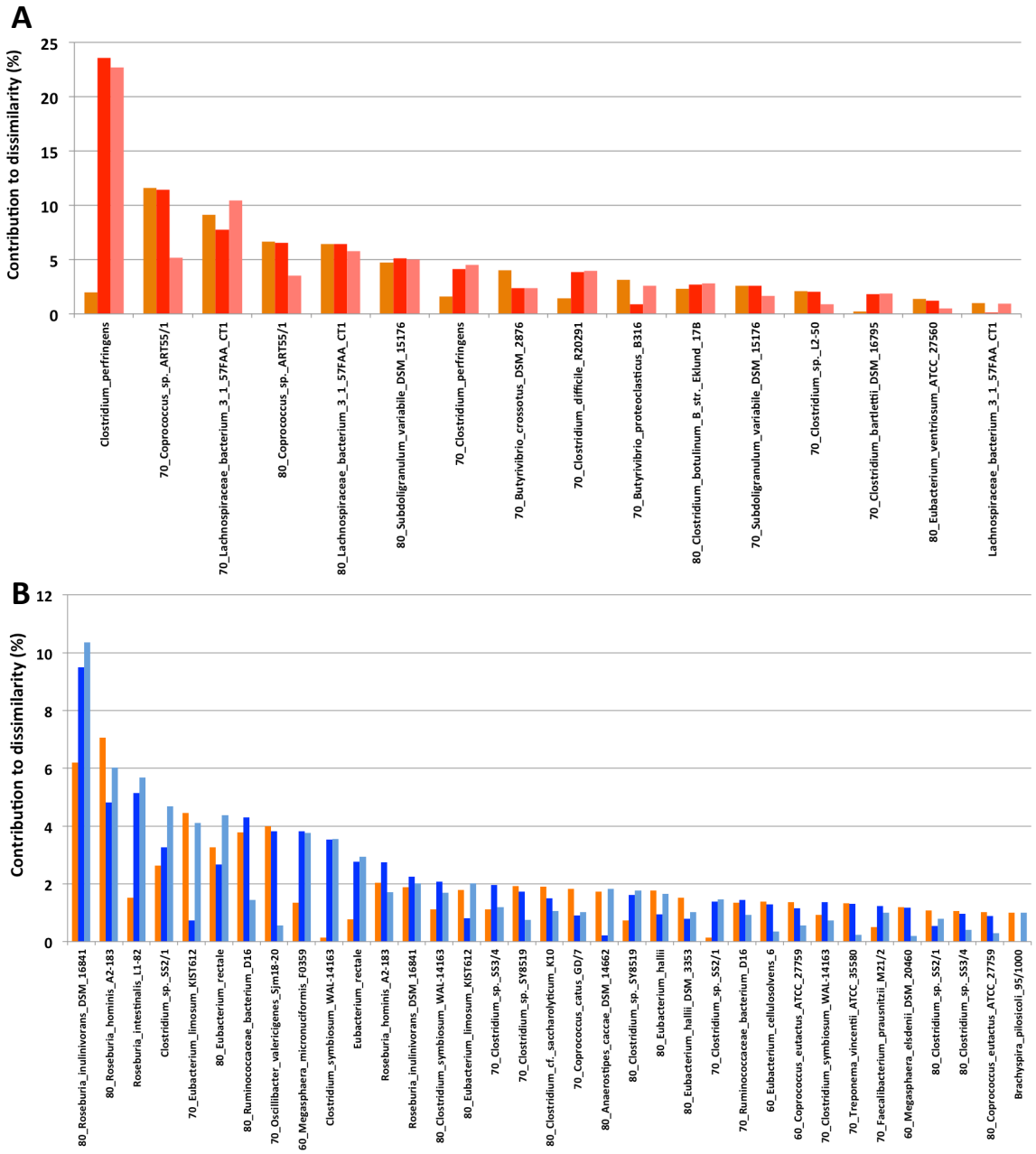


Figure S5. Simper analysis of butyryl-CoA:acetate CoA-transferase (A) and butyrate kinase (B) is shown. Analysis comparing herbivores/omnivores (orange bar), carnivores/herbivores (red, blue) and carnivores/omnivores (light red, light blue) are indicated. Only taxa contributing more than 1 % are displayed. Non-carnivorous *Carnivora* were excluded from the analysis.

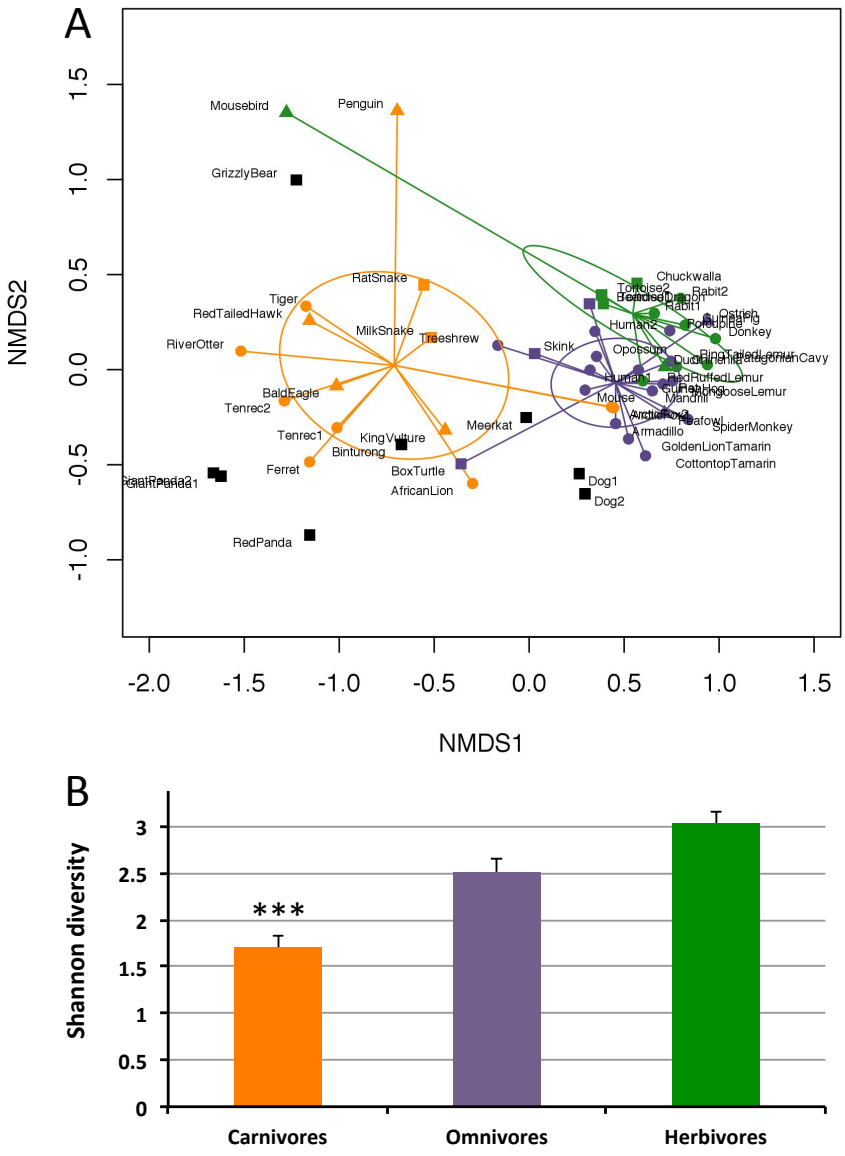


Figure S6. In panel A non-metric multidimensional scaling (NMDS) of entire bacterial *16S rRNA* data is shown (stress = 0.13). Individual diet groups are indicated as orange (carnivores), violet (omnivores) and green (herbivores). Distinct *Vertebrate* classes are specified with symbols. Non-carnivorous *Carnivora* are presented as black squares. Ellipses represent the standard deviations of points. Diet was revealed as a significant factor ($p <$

0.01 based on permutational anova analysis). Shannon diversity is indicated in panel B where error bars indicate standard error of the mean. ***: $p << 0.01$.

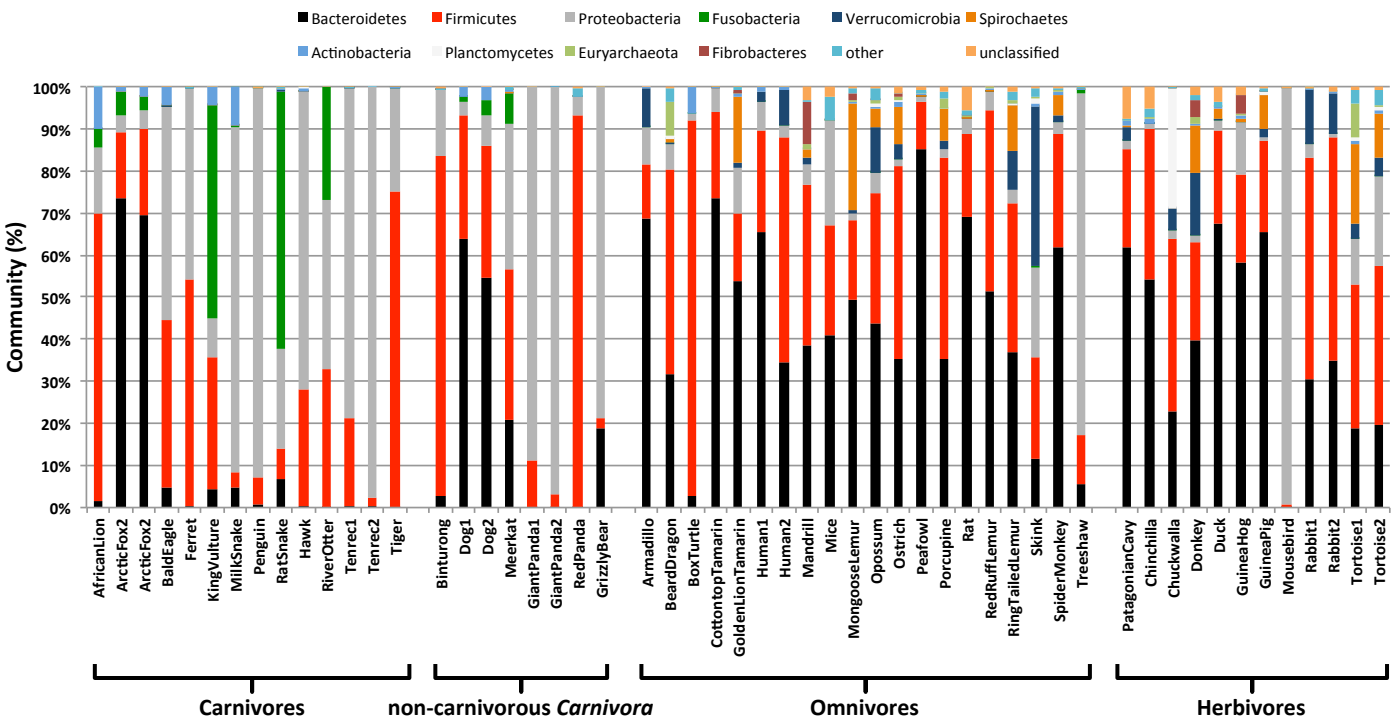


Figure S7 *16S rRNA* analysis on phylum level for all samples is shown.