

**SUPPLEMENTARY**

**Supplementary Table 1. Species with a relative abundance of >0.10% found in the antrum, body, and duodenum**

Phylum	Antrum (n = 98)		Body (n = 98)		Duodenum (n = 98)	
	Species	%	Species	%	Species	%
Proteobacteria	<i>Helicobacter pylori</i>	21.43	<i>Helicobacter pylori</i>	26.08	<i>Brevundimonas aurantiaca</i>	42.89
	<i>Dechloromonas sp.</i>	5.01	<i>Pseudomonas veronii</i>	5.00	<i>Methylobacterium longum</i>	2.56
	<i>Pseudomonas veronii</i>	2.97	<i>Dechloromonas sp.</i>	2.43	<i>Dechloromonas sp.</i>	0.93
	<i>Pseudomonas sp.</i>	1.12	<i>Pseudomonas sp.</i>	1.71	<i>Sphingomonas echinoides</i>	0.92
	<i>Haemophilus parainfluenzae</i>	0.85	<i>Haemophilus sp.</i>	1.50	<i>Cupriavidus necator</i>	0.74
	<i>Hydrogenophilus hirschii</i>	0.82	<i>Escherichia coli</i>	1.24	<i>Helicobacter pylori</i>	0.72
	<i>Moraxella osloensis</i>	0.58	<i>Moraxella osloensis</i>	1.11	<i>Pseudomonas grimontii</i>	0.63
	<i>Escherichia coli</i>	0.64	<i>Moraxella sp.</i>	0.78	<i>Bradyrhizobium pachyrrhizi</i>	0.59
	<i>Acinetobacter johnsonii</i>	0.53	<i>Haemophilus parainfluenzae</i>	0.54	<i>Schlegelella thermodepolymerans</i>	0.55
	<i>Haemophilus sp.</i>	0.49	<i>Enhydrobacter aerosaccus</i>	0.51	<i>Stenotrophomonas maltophilia</i>	0.49
	<i>Paracoccus sp.</i>	0.43	<i>Hydrogenophilus hirschii</i>	0.48	<i>Tepidimonas fonticaldi</i>	0.47
	<i>Brevundimonas sp.</i>	0.38	<i>Paracoccus sp.</i>	0.45	<i>Escherichia coli</i>	0.46
	<i>Sphingobacterium multivorum</i>	0.38	<i>Variovorax paradoxus</i>	0.37	<i>Massilia sp.</i>	0.32
	<i>Pantoea sp.</i>	0.37	<i>Brevundimonas sp.</i>	0.36	<i>Hydrogenophilus hirschii</i>	0.31
	<i>Sphingomonas sp.</i>	0.36	<i>Sphingomonas sp.</i>	0.31	<i>Haemophilus parainfluenzae</i>	0.31
	<i>Sphingomonas dokdonensis</i>	0.36	<i>Azospirillum sp.</i>	0.21	<i>Paracoccus sp.</i>	0.29
	<i>Azospirillum sp.</i>	0.34	<i>Sphingobacterium multivorum</i>	0.21	<i>Neisseria perflava</i>	0.28
	<i>Neisseria mucosa</i>	0.33	<i>Paracoccus aminovorans</i>	0.19	<i>Moraxella osloensis</i>	0.20
	<i>Moraxella sp.</i>	0.33	<i>Neisseria mucosa</i>	0.18	<i>Bradyrhizobium denitrificans</i>	0.20
	<i>Methylobacterium isbiliense</i>	0.33	<i>Actinobacillus parahaemolyticus</i>	0.16	<i>Neisseria flavescens</i>	0.12
	<i>Massilia sp.</i>	0.33	<i>Acinetobacter sp.</i>	0.13	<i>Actinobacillus parahaemolyticus</i>	0.11
	<i>Enhydrobacter aerosaccus</i>	0.30	<i>Caulobacter henricii</i>	0.12		
	<i>Methylobacterium sp.</i>	0.24	<i>Tepidiphilus succinatimandens</i>	0.12		
	<i>Herbaspirillum sp.</i>	0.22	<i>Neisseria elongata</i>	0.11		
	<i>Nevskia ramosa</i>	0.21				
	<i>Paracoccus aminovorans</i>	0.21				
	<i>Methylobacterium adhaesivum</i>	0.18				
	<i>Methylobacterium jeotgali</i>	0.17				
	<i>Acinetobacter schindleri</i>	0.15				
	<i>Neisseria elongata</i>	0.13				

	<i>Campylobacter showae</i>	0.12				
Actinobacteria	<i>Propionibacterium acnes</i>	7.27	<i>Propionibacterium acnes</i>	9.42	<i>Propionibacterium acnes</i>	15.02
	<i>Corynebacterium vitaeruminis</i>	1.86	<i>Corynebacterium vitaeruminis</i>	1.08	<i>Corynebacterium tuberculostearicum</i>	1.67
	<i>Corynebacterium sp.</i>	0.89	<i>Propionibacterium granulosum</i>	0.74	<i>Corynebacterium vitaeruminis</i>	1.01
	<i>Dermacoccus sp.</i>	0.85	<i>Dermacoccus sp.</i>	0.77	<i>Corynebacterium accolens</i>	0.58
	<i>Propionibacterium granulosum</i>	0.74	<i>Corynebacterium segmentosum</i>	0.51	<i>Corynebacterium sp.</i>	0.32
	<i>Corynebacterium macginleyi</i>	0.45	<i>Corynebacterium macginleyi</i>	0.49	<i>Propionibacterium granulosum</i>	0.21
	<i>Corynebacterium segmentosum</i>	0.42	<i>Corynebacterium sp.</i>	0.40	<i>Actinomyces odontolyticus</i>	0.15
	<i>Corynebacterium mastitidis</i>	0.31	<i>Corynebacterium doosanense</i>	0.26	<i>Rothia mucilaginoso</i>	0.15
	<i>Geodermatophilus sp.</i>	0.26	<i>Corynebacterium aurimucosum</i>	0.20	<i>Dermacoccus sp.</i>	0.12
	<i>Corynebacterium mucifaciens</i>	0.24	<i>Actinomyces graevenitzii</i>	0.17		
	<i>Actinomyces sp.</i>	0.15	<i>Corynebacterium mastitidis</i>	0.13		
	<i>Propionibacterium thoenii</i>	0.14	<i>Rhodococcus erythropolis</i>	0.11		
	<i>Arthrobacter sp.</i>	0.13				
	<i>Dermabacter hominis</i>	0.13				
	Bacteroidetes	<i>Cloacibacterium rupense</i>	14.27	<i>Cloacibacterium rupense</i>	10.73	<i>Cloacibacterium rupense</i>
<i>Prevotella melaninogenica</i>		1.75	<i>Prevotella melaninogenica</i>	2.25	<i>Prevotella melaninogenica</i>	1.29
<i>Sediminibacterium sp.</i>		0.98	<i>Sediminibacterium sp.</i>	1.60	<i>Sediminibacterium sp.</i>	0.77
<i>Prevotella pallens</i>		0.77	<i>Prevotella nanceiensis</i>	0.67	<i>Porphyromonas endodontalis</i>	0.38
<i>Prevotella nanceiensis</i>		0.43	<i>Prevotella pallens</i>	0.64	<i>Prevotella pallens</i>	0.26
<i>Porphyromonas endodontalis</i>		0.43	<i>Porphyromonas endodontalis</i>	0.53	<i>Porphyromonas catoniae</i>	0.25
<i>Prevotella intermedia</i>		0.41	<i>Porphyromonas gingivalis</i>	0.36	<i>Capnocytophaga granulosa</i>	0.17
<i>Prevotella copri</i>		0.38	<i>Prevotella sp.</i>	0.35	<i>Prevotella histicola</i>	0.16
<i>Capnocytophaga gingivalis</i>		0.35	<i>Prevotella copri</i>	0.30	<i>Alloprevotella rava</i>	0.14
<i>Porphyromonas gingivalis</i>		0.24	<i>Capnocytophaga gingivalis</i>	0.24	<i>Prevotella copri</i>	0.14
<i>Alloprevotella rava</i>		0.24	<i>Alloprevotella rava</i>	0.22	<i>Capnocytophaga sputigena</i>	0.13
<i>Porphyromonas catoniae</i>		0.23	<i>Capnocytophaga sputigena</i>	0.20	<i>Bacteroides sp.</i>	0.13
<i>Chryseobacterium hominis</i>		0.20	<i>Cloacibacterium normanense</i>	0.19	<i>Prevotella nanceiensis</i>	0.13
<i>Bacteroides sp.</i>		0.19	<i>Capnocytophaga granulosa</i>	0.17	<i>Prevotella nigrescens</i>	0.12
<i>Prevotella sp.</i>		0.19	<i>Tannerella forsythia</i>	0.16		
<i>Chryseobacterium aquaticum</i>		0.14	<i>Prevotella nigrescens</i>	0.13		
<i>Flavobacterium succinicans</i>		0.13	<i>Chryseobacterium hominis</i>	0.12		
<i>Prevotella tannerae</i>		0.13				
<i>Prevotella nigrescens</i>		0.13				
<i>Cloacibacterium normanense</i>		0.12				
<i>Flavobacterium sp.</i>	0.12					
Firmicutes	<i>Staphylococcus epidermidis</i>	2.17	<i>Staphylococcus epidermidis</i>	2.89	<i>Bacillus sp.</i>	4.30
	<i>Streptococcus mitis</i>	1.94	<i>Bacillus sp.</i>	2.60	<i>Staphylococcus epidermidis</i>	1.67

	<i>Bacillus sp.</i>	1.73	<i>Streptococcus mitis</i>	1.67	<i>Staphylococcus hominis</i>	0.46
	<i>Peptoniphilus sp.</i>	0.84	<i>Peptoniphilus sp.</i>	1.42	<i>Peptoniphilus sp.</i>	0.43
	<i>Streptococcus infantis</i>	0.56	<i>Streptococcus sp.</i>	0.62	<i>Enterococcus cecorum</i>	0.36
	<i>Streptococcus sp.</i>	0.30	<i>Streptococcus infantis</i>	0.24	<i>Streptococcus sp.</i>	0.15
	<i>Streptococcus anginosus</i>	0.17	<i>Enterococcus cecorum</i>	0.16		
	<i>Streptococcus salivarius</i>	0.13	<i>Mycoplasma faucium</i>	0.14		
			<i>Finegoldia sp.</i>	0.12		
Fusobacteria	<i>Fusobacterium periodonticum</i>	0.98	<i>Fusobacterium periodonticum</i>	0.98	<i>Fusobacterium periodonticum</i>	0.56
	<i>Fusobacterium nucleatum</i>	0.69	<i>Fusobacterium nucleatum</i>	0.55	<i>Fusobacterium nucleatum</i>	0.33
	<i>Leptotrichia genomosp.</i>	0.36	<i>Leptotrichia genomosp.</i>	0.50	<i>Leptotrichia genomosp.</i>	0.19
	<i>Leptotrichia sp.</i>	0.19	<i>Leptotrichia sp.</i>	0.21		
Other phyla	<i>Deinococcus caeni</i>	0.18	<i>Treponema sp.</i>	0.12	None	-

**Supplementary Table 2. Relative abundance of significant species and updated Sydney system scores according to the presence of regular arrangement of collecting venules**

Common species and pathology findings		Regular arrangement of collecting venules (n = 62)	Irregular arrangement of collecting venules (n = 36)	p-value
Antrum	<i>Helicobacter pylori</i>	0.03 (0 - 50.0)	74.85 (0 - 94.0)	< 0.001
	<i>Pseudomonas veronii</i>	3.75 (0 - 14.2)	0.29 (0 - 9.9)	< 0.001
	<i>Pseudomonas sp.</i>	1.15 (0 - 5.6)	0.07 (0 - 3.8)	< 0.001
	<i>Dechloromonas sp.</i>	4.20 (0 - 38.4)	0.99 (0 - 17.4)	0.009
	<i>Propionibacterium acnes</i>	9.70 (0 - 27.3)	1.95 (0 - 13.8)	< 0.001
	<i>Cloacibacterium rupense</i>	14.65 (0 - 76.5)	6.15 (0.3 - 42.8)	0.009
	<i>Staphylococcus epidermidis</i>	1.80 (0 - 31.6)	0.06 (0 - 6.2)	0.004
	<i>Streptococcus mitis</i>	0.15 (0 - 63.2)	0.04 (0 - 5.5)	0.108
	<i>Bacillus sp.</i>	0.35 (0 - 32.6)	0.10 (0 - 15.8)	0.310
	<i>Variovorax paradoxus</i>	0.02 (0 - 1.0)	0.01 (0 - 0.01)	0.180
	<i>Porphyromonas gingivalis</i>	0.07 (0 - 4.0)	0.11 (0 - 3.0)	0.016
	Neutrophil (0 : 1 : 2 : 3)	4 : 55 : 3 : 0	0 : 9 : 21 : 6	< 0.001
	Mononuclear cell (0 : 1 : 2 : 3)	60 : 1 : 0 : 1	10 : 11 : 12 : 3	< 0.001
	Atrophy (0 : 1 : 2 : 3)	38 : 24 : 0 : 0	17 : 19 : 0 : 0	0.176
Intestinal metaplasia (0 : 1 : 2 : 3)	62 : 0 : 0 : 0	31 : 4 : 1 : 0	0.011	
Body	<i>Helicobacter pylori</i>	0.43 (0 - 27.0)	89.40 (0 - 98.0)	< 0.001
	<i>Pseudomonas veronii</i>	5.93 (0 - 25.1)	0.29 (0 - 14.3)	< 0.001
	<i>Pseudomonas sp.</i>	2.23 (0 - 12.2)	0.08 (0 - 4.2)	< 0.001
	<i>Dechloromonas sp.</i>	1.70 (0 - 22.5)	0.06 (0 - 3.9)	< 0.001
	<i>Propionibacterium acnes</i>	12.30 (0 - 29.1)	1.48 (0 - 23.1)	< 0.001
	<i>Cloacibacterium rupense</i>	7.55 (0 - 66.4)	1.45 (0 - 54.9)	0.002
	<i>Staphylococcus epidermidis</i>	3.15 (0 - 15.9)	0.10 (0 - 26.8)	0.010
	<i>Streptococcus mitis</i>	0.19 (0 - 34.9)	0.03 (0 - 4.4)	0.022
	<i>Bacillus sp.</i>	1.50 (0 - 32.0)	0.05 (0 - 6.0)	0.002
	<i>Variovorax paradoxus</i>	0.09 (0 - 29.0)	0.14 (0 - 4.9)	0.552
	<i>Porphyromonas gingivalis</i>	0.11 (0 - 4.2)	0.16 (0 - 6.1)	0.024
	Neutrophil (0 : 1 : 2 : 3)	1 : 60 : 0 : 1	0 : 12 : 21 : 3	< 0.001
	Mononuclear cell (0 : 1 : 2 : 3)	61 : 0 : 0 : 1	10 : 6 : 19 : 1	< 0.001
	Atrophy (0 : 1 : 2 : 3)	37 : 25 : 0 : 0	25 : 11 : 0 : 0	0.334
Intestinal metaplasia (0 : 1 : 2 : 3)	62 : 0 : 0 : 0	35 : 1 : 0 : 0	0.367	

Using the Kruskal-Wallis test, the relative abundance of species is presented as median values with range (minimum - maximum). Using the Fisher's exact test, pathological findings are shown as the numbers of subjects with no (score 0), mild (score 1), moderate (score 2), and marked (score 3) degrees based on the updated Sydney classification system.

**Supplementary Table 3. Differences in PAGA-SYM scores according to endoscopic findings**

Endoscopic findings Symptom subscales	Hemorrhagic spots		Thickened rugae		Advanced atrophy		Mucosal nodularity		Regular arrangement of collecting venules	
	Present (n = 6)	Absent (n = 92)	Present (n = 7)	Absent (n = 91)	Present (n = 9)	Absent (n = 89)	Present (n = 13)	Absent (n = 85)	Present (n = 62)	Absent (n = 36)
Heartburn & regurgitation	<b>17.0 (8 - 19)</b>	<b>7.5 (0 - 23)</b>	10.0 (0 - 22)	7.8 (0 - 23)	5.7 (0 - 20)	8.2 (0 - 23)	9.0 (0 - 20)	7.8 (0 - 23)	7.6 (0 - 23)	9.0 (0 - 22)
Bloating	<b>6.0 (5 - 14)</b>	<b>3.6 (0 - 10)</b>	4.3 (0 - 10)	3.7 (0 - 14)	4.4 (0 - 7)	3.7 (0 - 14)	5.0 (1 - 14)	3.6 (0 - 10)	3.3 (0 - 9)	4.6 (0 - 14)
Nausea & vomiting	6.5 (4 - 10)	3.2 (0 - 11)	3.7 (0 - 9)	3.4 (0 - 11)	5.0 (0 - 11)	3.4 (0 - 10)	5.4 (0 - 11)	3.1 (0 - 10)	3.0 (0 - 10)	4.6 (0 - 11)
Upper abdominal pain	5.7 (4 - 8)	4.2 (0 - 9)	4.0 (0 - 7)	4.4 (0 - 9)	4.0 (0 - 8)	4.5 (0 - 9)	5.0 (2 - 8)	4.4 (0 - 9)	4.2 (0 - 9)	4.6 (0 - 8)
Fullness & early satiety	7.0 (2 - 11)	4.2 (0 - 15)	5.0 (0 - 9)	4.3 (0 - 15)	5.0 (0 - 9)	4.3 (0 - 15)	6.5 (0 - 12)	3.9 (0 - 15)	3.6 (0 - 15)	5.5 (0 - 12)
Lower abdominal pain	<b>5.7 (1 - 8)</b>	<b>1.8 (0 - 8)</b>	4.3 (0 - 6)	1.9 (0 - 8)	1.4 (0 - 8)	2.1 (0 - 8)	3.0 (0 - 8)	1.9 (0 - 8)	1.6 (0 - 8)	3.1 (0 - 8)

PAGA-SYM scores are shown as median values with ranges (minimum - maximum) using the Kruskal–Wallis test. For each subscales,

statistical significance was set at  $p < 0.0083$  ( $p < 0.05$  divided by 6 subscales) after multiple testing correction. Significant scores are rendered

in boldface. PAGA-SYM, Patient Assessment of Gastrointestinal Disorders Symptom Severity Index.

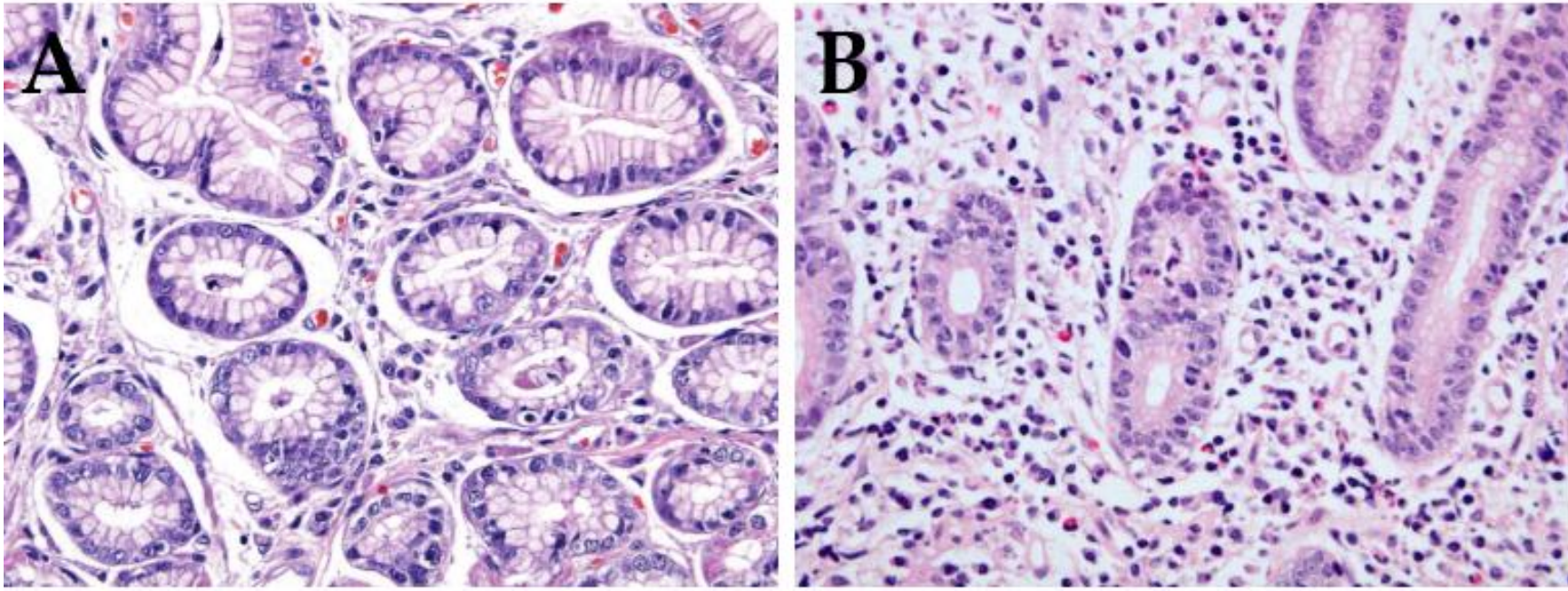


Figure S1: Microscopic findings of the biopsy specimens