Supplementary Files

Table S1 Basic information of 132 AS samples

Sample	latitude	longitude	NH_4	NO_2	COD	MLSS	TMLSS	DO	pH	Conductivity	SRT	Inf.TN	Inf.TP	Inf.NH4	Ca
CNBJ1AA	40.04	116.36	0.04		14.38	3794	26	4.60	6.7	511		51	6.5		45.6
CNBJ1AB	40.04	116.36	0.04		14.38	3794	26	4.40	6.7	556		51	6.5		45.6
CNBJ1AC	40.04	116.36	0.04		14.38	3794	27	1.35	6.7	520		51	6.5		45.6
CNBJ2A	40.01	116.43	0.03	0.02	27.87	9886	28	1.80	6.4	952		65	8.6	45	31.1
CNBJ2B	40.01	116.43	0.03	0.02	27.87	9886	28	3.10	6.5	949		65	8.6	45	31.1
CNBJ2C	40.01	116.43	0.03	0.02	27.87	9886	28	0.30	6.6	921		65	8.6	45	31.1
CNBJ3A	39.90	116.53	0.02	0.13	36.85	1412	26	2.09	7.2	870	5	35	6.6	26	30.0
CNBJ3B	39.90	116.53	0.02	0.13	36.85	1412	26	6.36	7.1	849	5	35	6.6	26	30.0
CNBJ3C	39.90	116.53	0.02	0.13	36.85	1412	26	6.28	7.2	846	5	35	6.6	26	30.0
CNBJ4A	39.83	116.43	0.43	0.01	16.63	2780	27	0.77	7.1	1172	12	55	5.5	48	34.2
CNBJ4B	39.83	116.43	0.43	0.01	16.63	2780	27	1.24	7.0	1141	12	55	5.5	48	34.2
CNBJ4C	39.83	116.43	0.43	0.01	16.63	2780	27	3.92	7.0	1111	12	55	5.5	48	34.2
CNDL1AA	38.88	121.63	0.22	0.03	26.96	6780	21	1.80		3690	30	20	5.3	16	74.1
CNDL1AB	38.88	121.63	0.22	0.03	26.96	6780	21	4.18		3870	30	20	5.3	16	74.1
CNDL1AC	38.88	121.63	0.22	0.03	26.96	6780	21	5.80		4170	30	20	5.3	16	74.1
CNDL1BA	38.88	121.63	2.53	0.25	25.65	4744	22	0.57	6.5	3690	30	20	5.3	16	62.1
CNDL1BB	38.88	121.63	2.53	0.25	25.65	4744	21	2.40	6.5	3680	30	20	5.3	16	62.1
CNDL1BC	38.88	121.63	2.53	0.25	25.65	4744	21	5.30	6.5	3880	30	20	5.3	16	62.1
CNDL2AA	38.87	121.54	5.95	0.16	36.96	4620	20	1.67	6.8	895	20	33	3.0	20	59.7
CNDL2AB	38.87	121.54	5.95	0.16	36.96	4620	22	1.56	6.8	874	20	33	3.0	20	59.7
CNDL2AC	38.87	121.54	5.95	0.16	36.96	4620	21	1.51	6.7	902	20	33	3.0	20	59.7
CNDL2BA	38.87	121.54	1.48	0.03	107.83	3836	24	1.86	7.1	838	20	33	3.0	20	66.3
CNDL2BB	38.87	121.54	1.48	0.03	107.83	3836	21	2.48	7.2	832	20	33	3.0	20	66.3

CNDL2BC	38.87	121.54	1.48	0.03	107.83	3836	21	3.40	7.3	831	20	33	3.0	20	66.3
CNHB3A	45.82	126.71	####		25.22	9092	20	0.05	7.0	807					49.2
CNHB3B	45.82	126.71	####		25.22	9092	21	0.29	7.0	716					49.2
CNHB3C	45.82	126.71	####		25.22	9092	21	0.15	7.0	654					49.2
CNHB4A	45.82	126.72	7.64		19.57	5648	20	0.05	7.0	807					53.3
CNHB4B	45.82	126.72	7.64		19.57	5648	21	0.29	7.0	716					53.3
CNHB4C	45.82	126.72	7.64		19.57	5648	21	0.15	7.0	654					53.3
CNHB5A	45.82	126.72	0.31	1.28	31.74	9796	20	0.72	6.9	691				50	49.9
CNHB5B	45.82	126.72	0.31	1.28	31.74	9796	21	5.18	6.9	623				50	49.9
CNHB5C	45.82	126.72	0.31	1.28	31.74	9796	21	1.40	6.9	627				50	49.9
CNHB7A	45.76	126.75	0.05		17.83	4854	23	0.71	7.3	935	23	50	5.0	40	55.0
CNHB7B	45.76	126.75	0.05		17.83	4854	23	6.54	7.3	925	23	50	5.0	40	55.0
CNHB7C	45.76	126.75	0.05		17.83	4854	23	4.31	7.3	977	23	50	5.0	40	55.0
CNJN1A	36.70	117.04	####	0.64	60.00	2876	28	1.00	6.9	1457	13	45	8.0	36	88.6
CNJN1B	36.70	117.04	####	0.64	60.00	2876	26	3.17	7.2	1448	13	45	8.0	36	88.6
CNJN1C	36.70	117.04	####	0.64	60.00	2876	28	1.90	7.0	1406	13	45	8.0	36	88.6
CNJN2A	36.69	116.95	0.51	0.04	38.26	2486	26	1.50	6.8	1467	12	45	7.0	45	107.2
CNJN2B	36.69	116.95	0.51	0.04	38.26	2486	26	0.61	7.4	1430	12	45	7.0	45	107.2
CNJN2C	36.69	116.95	0.51	0.04	38.26	2486	26	1.29	7.3	1419	12	45	7.0	45	107.2
CNJN3A	36.73	117.10	0.03	0.00	57.39	10108	28	0.52	7.1	1452	13	43	5.0	38	122.0
CNJN3B	36.73	117.10	0.03	0.00	57.39	10108	27	4.12	7.2	1438	13	43	5.0	38	122.0
CNJN3C	36.73	117.10	0.03	0.00	57.39	10108	27	4.33	7.1	1444	13	43	5.0	38	122.0
CNJN4A	36.69	116.90	0.04	0.00	40.00	1222	26	0.58	7.3	1200	13	25	2.5	20	120.3
CNJN4B	36.69	116.90	0.04	0.00	40.00	1222	25	5.23	7.4	1184	13	25	2.5	20	120.3
CNJN4C	36.69	116.90	0.04	0.00	40.00	1222	27	8.03	7.4	1027	13	25	2.5	20	120.3
CNQD1A	36.11	120.33	2.30	0.13	21.12	3688	27	4.81	6.7	2110	15	60	9.0	45	43.8
CNQD1B	36.11	120.33	2.30	0.13	21.12	3688	27	4.27	6.6	2102	15	60	9.0	45	43.8
CNQD1C	36.11	120.33	2.30	0.13	21.12	3688	27	4.25	6.8	2110	15	60	9.0	45	43.8

CNQD2A	36.21	120.36	0.32		41.35	3368	26	3.48	7.0	3300	20	45	5.0	21	67.3
CNQD2B	36.21	120.36	0.32		41.35	3368	27	3.11	6.9	3290	20	45	5.0	21	67.3
CNQD2C	36.21	120.36	0.32		41.35	3368	27	1.23	6.9	3260	20	45	5.0	21	67.3
CNQD3AA	36.06	120.29				4140	29	2.53	7.3		12	124	10.0	80	
CNQD3AB	36.06	120.29				4140	29	2.39	7.2		12	124	10.0	80	
CNQD3AC	36.06	120.29				4140	29	2.15	7.3		12	124	10.0	80	
CNQD4AA	36.15	120.36				4000	27	2.20	7.3		21	75	10.0	58	
CNQD4AB	36.15	120.36				4000	27	2.67	7.0		21	75	10.0	58	
CNQD4AC	36.15	120.36				4000	28	2.02	7.0		21	75	10.0	58	
CNXA1A	34.30	109.04	0.29	0.10	16.63	2958	28	2.03	7.3	1116	22	35	6.5	25	44.3
CNXA1B	34.30	109.04	0.29	0.10	16.63	2958	28	1.55	7.3	1116	22	35	6.5	25	44.3
CNXA1C	34.30	109.04	0.29	0.10	16.63	2958	28	0.69	7.2	1108	22	35	6.5	25	44.3
CNXA2A	34.37	108.91	0.44	0.07	25.62	5438	27	0.33	7.1	855	14	45	4.0	34	29.0
CNXA2B	34.37	108.91	0.44	0.07	25.62	5438	27	0.70	7.1	940	14	45	4.0	34	29.0
CNXA2C	34.37	108.91	0.44	0.07	25.62	5438	27	0.58	7.2	949	14	45	4.0	34	29.0
CNXA3A	34.37	109.00	0.40	0.01	18.88	3996	28	0.43	7.0	929	16	65	1.7	39	32.0
CNXA3B	34.37	109.00	0.40	0.01	18.88	3996	27	0.51	7.0	920	16	65	1.7	39	32.0
CNXA3C	34.37	109.00	0.40	0.01	18.88	3996	27	0.35	7.1	943	16	65	1.7	39	32.0
CNXA4A	34.21	108.84	0.84	0.01	21.12	2814	26	1.47	7.4	730	16	43	3.5	21	35.6
CNXA4B	34.21	108.84	0.84	0.01	21.12	2814	26	1.10	7.5	843	16	43	3.5	21	35.6
CNXA4C	34.21	108.84	0.84	0.01	21.12	2814	26	0.90	7.5	843	16	43	3.5	21	35.6
CNCD1A	30.58	104.08	####	0.00	73.04	2958	25	0.91	7.0	800	16	40	3.0	35	57.2
CNCD1B	30.58	104.08	0.08		37.91	2958	24	1.04	7.5	742	16	40	3.0	35	62.6
CNCD1C	30.58	104.08	0.02		74.43	2958	26	4.80	7.0	746	16	40	3.0	35	61.3
CNCD2A	30.66	104.12	1.89		57.04	2300	23	0.27	6.9	670	18	60	8.0	30	57.4
CNCD2B	30.66	104.12	1.89		57.04	2300	23	0.34	7.1	643	18	60	8.0	30	57.4
CNCD2C	30.66	104.12	1.89		57.04	2300	24	0.50	7.2	638	18	60	8.0	30	57.4
CNCD3A	30.47	104.05	3.84		39.30	1728	23	2.07	7.1	750	26	20	2.4	12	69.5

CNCD3B	30.47	104.05	3.84		39.30	1728					26	20	2.4	12	69.5
CNCD3C	30.47	104.05	3.84		39.30	1728	24	2.12	6.9	745	26	20	2.4	12	69.5
CNCD4A	30.51	103.96	0.18			2960	25	0.45	7.0	683	13	30	4.0	20	49.9
CNCD4B	30.51	103.96	0.18			2960	25	0.31	7.0	686	13	30	4.0	20	49.9
CNCD4C	30.51	103.96	0.18			2960	25	6.80	6.9	708	13	30	4.0	20	49.9
CNCQ1A	29.55	106.37	0.75	0.02	62.26	1476	27	0.72			20	27	3.2	16	78.1
CNCQ1B	29.55	106.37	0.31	0.01	69.57	1476	27	2.41			20	27	3.2	16	74.0
CNCQ1C	29.55	106.37	0.81	0.05	56.35	1476	27	1.20			20	27	3.2	16	79.6
CNCQ2A	29.60	106.62	####		32.70	2246	26	3.90	7.0	942	21	40	5.0	30	61.8
CNCQ2B	29.60	106.62	8.91	0.00	24.70	2246	27	1.20	7.2	920	21	40	5.0	30	64.1
CNCQ2C	29.60	106.62	5.50		30.96	2246	27	0.12	6.8	893	21	40	5.0	30	67.3
CNCQ3A	29.44	106.49	4.76	0.03	52.87	3478	27	0.32	7.1	837		40	2.0	20	59.9
CNCQ3B	29.44	106.49	4.76	0.03	52.87	3478	27	0.41	7.0	843		40	2.0	20	59.9
CNCQ3C	29.44	106.49	4.76	0.03	52.87	3478	27	0.29	6.8	835		40	2.0	20	59.9
CNCQ4A	29.47	106.52	2.65	0.06	34.09	1526	25	3.25	7.0	831		36	3.5	23	65.6
CNCQ4B	29.47	106.52	2.65	0.06	34.09	1526	25	2.32	7.0	843		36	3.5	23	65.6
CNCQ4C	29.47	106.52	2.65	0.06	34.09	1526	25	3.02	7.0	834		36	3.5	23	65.6
CNCS1A	28.28	112.94	0.48		20.95	1956	26	0.10	6.7	458	14	37	2.7	30	38.4
CNCS1B	28.28	112.94	0.48		20.95	1956	26	0.10	6.8	458	14	37	2.7	30	38.4
CNCS1C	28.28	112.94	0.48		20.95	1956	26	0.40	6.6	456	14	37	2.7	30	38.4
CNCS2A	28.25	112.98	0.05	0.03	15.51	4676	26	0.23	7.2	481	8	25	2.0	18	45.2
CNCS2B	28.25	112.98	0.05	0.03	15.51	4676	26	3.40	7.1	474	8	25	2.0	18	45.2
CNCS2C	28.25	112.98	0.05	0.03	15.51	4676	26	5.40	7.2	473	8	25	2.0	18	45.2
CNCS3AA	28.25	112.98	0.96	0.00	27.24	2032	25	0.31	6.9	600		25	3.0	19	48.2
CNCS3AB	28.25	112.98	0.96	0.00	27.24	2032	25	0.40	6.8	595		25	3.0	19	48.2
CNCS3AC	28.25	112.98	0.96	0.00	27.24	2032	25	0.56	7.0	594		25	3.0	19	48.2
CNCS3BA	28.25	112.98	0.98	0.01	26.40	4050	26	0.28	6.8	583		25	3.0	19	45.2
CNCS3BB	28.25	112.98	0.98	0.01	26.40	4050	26	0.12	6.7	580		25	3.0	19	45.2

CNCS3BC	28.25	112.98	0.98	0.01	26.40	4050	26	0.26	6.8	578		25	3.0	19	45.2
CNSZ1A	22.51	113.89	2.32	0.03	88.00	564	31	7.81	6.5	726	13	55	4.5	30	24.5
CNSZ1B	22.51	113.89	2.32	0.03	88.00	564	30	7.81	6.6	742	13	55	4.5	30	24.5
CNSZ1C	22.51	113.89	2.32	0.03	88.00	564	30	7.62	6.7	753	13	55	4.5	30	24.5
CNSZ2A	22.56	114.25	0.80	0.18	12.00	1806	30	2.91	6.5	14230	15	24	4.0	20	94.8
CNSZ2B	22.56	114.25	0.80	0.18	12.00	1806	31	6.19	6.4	14290	15	24	4.0	20	94.8
CNSZ2C	22.56	114.25	0.80	0.18	12.00	1806	31	6.45	6.5	14250	15	24	4.0	20	94.8
CNSZ3AA	22.54	114.10			16.00	2860	31	3.40	6.7	457	13	43	4.0	27	15.7
CNSZ3AB	22.54	114.10			16.00	2860	32	3.26	7.9	451	13	43	4.0	27	15.7
CNSZ3AC	22.54	114.10			16.00	2860	31	3.32	6.3	472	13	43	4.0	27	15.7
CNSZ4AA	22.54	114.14			8.00	2014	34	2.93	6.3	631	12	30	3.0	20	18.4
CNSZ4AB	22.54	114.14			8.00	2014	34	3.14	6.3	637	12	30	3.0	20	18.4
CNSZ4AC	22.54	114.14			8.00	2014	34	2.91	6.4	649	12	30	3.0	20	18.4
CNXM1A	24.47	118.17	4.58	0.01	111.47	2852	31	0.68	6.9	3510	10	50	5.5	40	47.0
CNXM1B	24.47	118.17	4.58	0.01	111.47	2852	31	1.58	7.1	3250	10	50	5.5	40	47.0
CNXM1C	24.47	118.17	4.58	0.01	111.47	2852	31	1.03	7.0	3260	10	50	5.5	40	47.0
CNXM2A	24.56	118.04	3.50	0.04	63.28	1890	32	1.04	6.9	2829	20	35	5.0	13	48.4
CNXM2B	24.56	118.04	3.50	0.04	63.28	1890	32	1.96	6.9	2665	20	35	5.0	13	48.4
CNXM2C	24.56	118.04	3.50	0.04	63.28	1890	33	5.25	6.8	2445	20	35	5.0	13	48.4
CNXM3A	24.46	118.02	3.08	0.06	94.71	1066	33	1.03	7.0	6410	15	35	5.0	13	47.8
CNXM3B	24.46	118.02	3.08	0.06	94.71	1066	33	1.17	7.1	5620	15	35	5.0	13	47.8
CNXM3C	24.46	118.02	3.08	0.06	94.71	1066	33	1.37	7.1	5450	15	35	5.0	13	47.8
CNXM4A	24.58	118.11	1.36		56.99	2710	30	2.13	6.7	1450	17	40	2.5	33	29.9
CNXM4B	24.58	118.11	1.36		56.99	2710	30	2.00	6.8	1504	17	40	2.5	33	29.9
CNXM4C	24.58	118.11	1.36		56.99	2710	30	1.98	7.1	1468	17	40	2.5	33	29.9

Table S2. Topological properties of the empirical pMEN and its associated random pMEN

	Empirical networks						Random networks		
S_t	R square of power-law	Network size	Avg. connectivity	Avg. geodesic distance	Avg. clustering coefficient	Modularity	Avg. geodesic distance ±SD	Avg. clustering coefficient ±SD	Modularity ±SD
0.53	0.813	305	3.108	5.002	0.171	0.675	3.806±0.063	0.054 ± 0.010	0.575±0.006