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Supplementary Information of

Chemical element concentrations and accumulation in boreal mire ecosystems in Finland

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Supplementary Information Table S1. Sample characteristics and the results of 14C analyses (166 samples) in 28 mire sites. Peat constituents: B= Bryales, C=Carex, Er=Eriophorum, Eq=Equisetum, L=wood, Mn= Menyanthes, N=shrub, Pr=Phragmites, S=Sphagnum, Sh = Scheuchzeria, H=degree of decomposition in von Post's (1922) 10-grade scale. Calendar date refers to the calibrated calendar years before present (BP) (Stuiver et al. 2022). The calibrated date range is given with I sigma (68%) probability.

Site	Mire type	Sample depth cm	Peat material	Laboratory number	$\delta^{13}C$ ‰	^{14}C date, yr BP	Calendar date range, cal. yr BP	Most probable date, cal. yr BP
Luovuoma, Enontekiö								
1	Flark fen	35-40	SC, H3	Su-3022	-30.3	2750±70	2925-2765	2855
		60-65	SC, H4	Su-3023	-29.1	3560±50	3960-3725	3855
		95-100	EqSC, H4	Su-3024	-30.5	5170±70	6100-5760	5930
		125-130	EQSC, H4	Su-3025	-28.0	5860±80	6780-6560	6675
		165-170	EqSC, H4	Su-3026	-29.5	7740±60	8590-8450	8510
		195-200	EqBC, H4	Su-3027	-28.4	8430±50	9525-9425	9460
2	Flark fen	45-50	CS, H3	Su-3029	-29.3	2590±70	2775-2515	2680
		70-75	CS, H4	Su-3030	-29.4	5360±60	6270-6010	6140
		95-100	CS, H4	Su-3031	-29.6	6570±50	7555-7430	7475
		110-115	CS, H4	Su-3032	-30.2	7620±70	8520-8365	8420
		125-130	CS, H4	Su-3033	-30.0	8080±90	9130-8775	8985
3	Flark fen	18-20	S, H4	Su-3686	-28.3	340±60	470-315	395
		27-30	SC, H5	Su-3690	-27.9	1220±50	1245-1070	1140
		31-36	SC, H6	Su-3687	-28.5	1800±60	1785-1605	1695
		51-56	SC, H7	Su-3688	-28.7	4150±70	4820-4580	4680
		85-90	EqMnBC, H5	Su-3689	-28.8	6670±50	7580-7490	7535
		174-180	EqMnCB, H4	Su-3052	-29.3	8760±40	9890-9680	9750
4	Flark fen	52-58	BS, H6	Su-3223	-29.7	3760±50	4230-4000	4125
		92-98	EqSB, H7	Su-3224	-28.3	7080±60	7965-7845	7900
5	Flark fen	30-36	NErS, H3	Su-3213	-28.1	660±50	665-560	615
		69-75	CS, H7	Su-3214	-29.1	3890±50	4410-4250	4320
		79-85	CS, H7	Su-3215	-29.2	5440±60	6300-6190	6235
6	Flark fen	43-49	CS, H7	Su-3211	-29.5	4060±60	4790-4425	4560
Koiransuo, Ii								
7	Flark fen	67-70	C, H4	Poz-144358	-	107±0	250-modern	125
		137-140	EqNSC, H4	Poz-144468	-	4460±35	5275-4980	5130
		207-210	EqSC, H5	Poz-144469	-	5920±40	6785-6675	6740
Hautasuo-Tupakkisuo, Pudasjärvi								
8	Flark fen	30-36	ShC, H3	Poz-18158	-	150±30	275-present	145
		60-66	SC, H4	Su-3298	-27.6	1470±60	1390-1305	1360
		75-81	SC, H4	Su-3485	-28.8	1920±70	1925-1740	1840
		88-94	SC, H4	Su-3299	-27.7	2520±50	2730-2495	2590
		100-106	ShSC, H4	Su-3486	-28.6	3180±70	3480-3270	3400
		128-134	ShSC, H4	Su-3300	-29.0	4040±50	4570-4425	4520
		178-184	ShSC, H4	Su-3301	-29.1	5410±70	6295-6025	6205
		228-234	SC, H5	Su-3302	-28.9	6030±70	6960-6750	6880
		274-280	SC, H5	Su-3303	-29.7	7770±60	8595-8455	8540
9	Ombro-trophic low sedge pine bog	34-37	ErCS, H5	Su-3551	-27.9	330±40	450-315	390
		81-84	CS, H6	Su-3552	-29.3	3790±60	4290-4015	4175
		115-118	SC, H5	Su-3553	-29.5	4870±60	5700-5480	5605
		137-140	SC, H6	Su-3550	-31.0	5580±50	6395-6310	6360
10	Low-sedge *S. papillosum* fen	56-59	S, H3	Su-3546	-28.8	360±50	490-320	405
		72-75	SC, H4	Su-3547	-29.0	1950±50	1975-1820	1875
		114-117	MnC, H4	Su-3548	-28.7	4430±50	5265-4880	5040
		131-134	MnC, H4	Su-3549	-29.2	4800±60	5590-5475	5520
		157-160	MnC, H4	Su-3545	-29.9	5810±70	6675-6500	6610

11	Low sedge *S. papillosum* pine fen	62-68	CS, H6	Su-3304	-29.0	830±50	775-685	735
		68-74	SC, H4	Su-3487	-28.9	1750±50	1705-1585	1640
		88-94	SC, H4	Su-3488	-29.0	3430±60	3820-3580	3680
		106-112	ShSC, H4	Su-3305	-28.6	4340±60	4975-4845	4930
		150-156	ShSC, H4	Su-3306	-28.8	5510±70	6395-6215	6310
		191-197	EqSC, H5	Su-3307	-29.1	6600±70	7565-7430	7495
		228-234	EqSC, H4	Su-3308	-29.5	7490±70	8375-8205	8295
		272-276	EqSC, H5	Su-3309	-27.9	8000±60	8995-8775	8855
		305-311	EqCS, H5	Su-3310	-29.3	8070±60	9090-8780	8975
12	Ombro-trophic low sedge pine bog	39-45	SC, H6	Su-3181	-28.7	1070±70	1060-920	985
13	Low sedge *S. papillosum* fen	64-67	ErS, H2	Su-3558	-28.0	430±50	525-340	480
		129-134	NCS, H5	Su-3559	-27.7	3230±50	3480-3385	3445
		179-182	NSC, H4	Su-3560	-27.5	4180±70	4835-4615	4705
		224-227	LSC, H8	Su-3557	-29.8	6140±50	7155-6950	7035
14	Low-sedge *S. papillosum* fen	197-200	LSC, H7	Su-3591	-29.5	5880±60	6785-6635	6700
Ruosuo, Pudasjärvi								
15	Low-sedge *S. papillosum* fen	40-45	ErCS, H3	Su-2973	-27.6	360±60	490-320	405
		70-75	CS, H5	Su-2974	-28.4	1140±50	1175-960	1045
		95-100	CS, H5	Su-2975	-28.7	2000±60	2000-1835	1935
		130-135	ShSC, H4	Su-2976	-29.0	3920±90	4515-4185	4345
		165-170	NSC, H5	Su-2977	-28.4	5060±70	5900-5735	5800
		205-210	NCS, H4	Su-2978	-28.2	6560±80	7565-7365	7465
		255-260	CS, H4	Su-2979	-29.6	7790±60	8635-8460	8560
		275-280	CS, H5	Su-2980	-29.3	8350±70	9465-9285	9355
16	Flark fen	30-35	ShSC, H4	Su-2963	-28.5	95±40	255-present	115
		35-40	ShSC, H4	Su-2964	-28.6	210±50	305-present	185
		65-70	SC, H4	Su-3065	-29.4	750±60	725-655	685
		80-85	NSC, H7	Su-2965	-29.4	1210±60	1245-1060	1130
		95-100	NSC, H7	Su-2966	-29.1	2430±60	2695-2355	2500
		125-130	EqCS, H5	Su-2967	-29.1	4240±50	4860-4655	4755
		160-165	N1EqCS, H7	Su-2968	-28.7	5890±50	6780-6660	6710
		200-205	EqCS, H5	Su-2969	-29.4	7200±60	8160-7940	8010
		220-225	EqCS, H5	Su-2970	-29.5	7710±60	8540-8430	8490
		240-245	EqCS, H5	Su-2971	-29.9	8100±80	9255-8785	9030
		270-275		Su-2972	-29.0	8300±70	9425-9140	9300
17	Flark fen	57-60	SC, H5	Poz-138000	-	1670±30	1685-1530	1560
		91-94	CS, H8	Poz-138070	-	5415±35	6280-6200	6235
Siikaneva, Ruovesi								
18	Ombro-trophic low sedge bog	135-140	ShCS, H4	Su-586	-	440±60	535-335	480
		264-270	ShCS, H5	Su-587	-	2770±70	2935-2780	2880
		400-405	ShSC, H6	Su-588	-	4640±80	5550-5150	5380
		435-440	LSC, H6	Su-589	-	5530±90	6435-6210	6330
		565-570	LEqC, H7	Su-590	-	8150±120	9400-8815	9100
		645-650	EqBC, H8	Su-591	-	8870±150	10180-9755	9940
Suurisuo, Janakkala								
19	Herb-rich sedge birch-pine fen	50-54	SC, H4	Hel-2931	-29.3	160±90	285-modern	170
		99-104	SC, H4	Hel-2932	-27.9	1250±100	1280-1070	1160
		144-154	MnSC, H4	Hel-2933	-28.8	1790±100	1820-1550	1690
		194-204	MnSC, H4	Hel-2934	-27.5	2390±110	2700-2335	2465
		244-254	SC, H4	Hel-2935	-28.9	2680±90	2920-2725	2805
		294-304	MnSC, H4	Hel-2936	-27.7	3090±90	3395-3175	3285
		361-366	NSC, H5	Hel-2930	-28.4	4330±110	5265-4725	4940

Haukkasuo, Kouvola								
20	Ridge-hollow	25-29	S, H2	Su-3435	-27.7	200±40	295-modern	180
	pine bog	46-50	S, H2	Su-3436	-26.8	330±60	455-315	390
		68-72	S, H2	Su-3437	-26.9	480±30	530-505	520
		82-88	S, H4	Su-1953	-27.9	800±45	730-680	710
		116	S, H7	Poz-4373	-	815±30	730-690	715
		120-124	S, H6	Su-3438	-27.8	1540±50	1515-1360	1425
		146	S, H6	Poz-4374	-	1670±30	1685-1530	1560
		150-154	S, H3	Su-3439	-27.8	2000±60	2000-1835	1935
		190-196	S, H4	Su-1954	-27.6	2555±50	2750-2520	2625
		249-255	S, H3	Su-2001	-26.8	2845±60	3060-2870	2965
		289-295	S, H3	Su-1955	-25.2	3110±55	3390-3245	3315
		326-330	S, H3	Su-3440	-27.2	3930±60	4505-4250	4360
		341-347	ShS, H5	Su-2002	-30.0	3980±70	4530-4300	4445
		352	S, H3	Poz-4184	-	4100±35	4795-4525	4615
		370-374	S, H3	Su-3441	-26.8	4740±50	5580-5330	5480
		404-410	CS, H5	Su-1956	-26.3	4840±60	5650-5480	5560
		443-449	CS, H5	Su-2003	-26.4	5530±55	6395-6290	6335
		462-468	NShCS, H4	Su-2004	-27.2	5610±70	6445-6310	6395
		484-490	NShSC, H5	Su-2005	-27.5	5870±60	6780-6570	6690
		585-591	NSC, H4	Su-1957	-28.5	7480±70	8370-8205	8285
		702-705	EqC, H5	Su-1958	-30.2	9250±90	10555-10290	10425
		705-708	EqC, H5	Su-1959	-29.7	9140±100	10485-10225	10330
		705-710	EqC, H5	Su-1479	-29.2	9430±120	11070-10445	10695
21	*S. fuscum*	135-140	NShCS, H6	Su-3453	-27.2	1370±50	1345-1180	1290
	pine bog	235-240	SC, H4	Su-3454	-28.6	4260±50	4870-4655	4830
		335-340	MnNC, H8	Su-3455	-28.7	6100±70	7155-6855	6975
		368-373	MnC, H9	Su-3456	-29.2	6630±60	7570-7435	7510
22	Dwarf shrub	36-41	S, H3	Su-3459	-28.2	230±50	420-modern	210
	pine bog	75-80	NErS, H5	Su-3460	-27.0	1120±50	1065-960	1025
		123-128	LErS, H9	Su-3461	-29.0	3250±70	3560-3395	3470
		170-175	NSC, H8	Su-3462	-29.4	4490±50	5285-5050	5150
23	*S. fuscum*	42	ErS, H4	Poz-18043	-	115±30	260-modern	110
	pine bog	85-90	ErS, H3	Su-3464	-25.6	790±60	770-670	715
		140-145	ShS, H4	Su-3465	-26.9	1220±50	1245-1070	1140
		195-200	ShSC, H6	Su-3466	-28.9	2470±40	2705-2470	2565
		228-233	SC, H7	Su-3467	-28.7	4350±50	4965-4855	4930
		285-290	SC, H6	Su-3468	-27.8	5850±70	6745-6560	6660
		335-340	LSC, H7	Su-3469	-29.2	6820±60	7690-7590	7655
24	Tall sedge	113-118	MnCS, H4	Su-3475	-26.1	1240±50	1265-1075	1165
	pine fen	240-245	MnC, H5	Su-3474	-29.6	3200±50	3455-3375	3420
25	Tall sedge fen	61-66	CS, H5	Su-3470	-27.5	1760±50	1710-1590	1645
		140-145	EqMnC, H8	Su-3471	-28.8	3090±50	3370-3240	3295
		191-196	EqMnC, H8	Su-3472	-29.4	3710±50	4145-3980	4050
		240-245	EqC, H6	Su-3473	-29.0	8600±60	9660-9500	9580

Kilpisuo, Hausjärvi								
26	Ridge-hollow	80-86	S, H5	Su-2897	-25.8	1110±50	1060-960	1020
	pine bog	110-116	S, H3	Su-2898	-24.5	1450±70	1390-1295	1350
		160-166	S, H4	Su-2899	-25.9	2200±70	2310-2125	2205
		229-235	ErS, H3	Su-2900	-25.1	3300±70	3620-3450	3530
		276-282	ShS, H3	Su-2901	-26.9	3550±70	3960-3720	3840
		354-360	ShS, H6	Su-2902	-26.1	4870±70	5710-5480	5605
		404-410	S, H5	Su-2903	-26.3	5520±70	6395-6225	6320
		432-438	ErS, H7	Su-2904	-26.7	5990±80	6940-6740	6835
		473-479	S, H4	Su-2905	-27.4	7120±70	8015-7865	7940
		524-530	S, H4	Su-2906	-27.0	7750±70	8590-8450	8525
		582-588	CS, H5	Su-2907	-27.5	8090±70	9130-8780	9015
		620-626	EqSC, H5	Su-2908	-27.8	8180±60	9260-9020	9135
		665-671	PrEqC, H6	Su-2909	-28.7	8510±60	9540-9480	9505
		736-739	PrEqC, H6	Su-2910	-28.6	8850±70	10150-9775	9940
		740-750	PrEqC, H6	Su-1723	-29.4	8840±60	10125-9770	9925
27	Cottongrass	110-116	ErS, H3	Su-2941	-27.5	620±70	650-555	600
	pine bog	158-164	SC, H6	Su-2942	-29.5	4380±60	5040-4860	4965
28	Ridge-hollow	80-86	S, H4	Su-2927	-27.4	380±70	500-320	420
	pine bog	129-135	S, H3	Su-2928	-28.2	970±70	930-790	860
		204-210	S, H3	Su-2929	-26.1	1830±70	1825-1625	1735
		264-270	S, H3	Su-2930	-26.9	2400±60	2675-2350	2465
		314-320	S, H3	Su-2931	-26.8	2480±70	2715-2470	2560
		380-386	S, H3	Su-2932	-27.0	3510±70	3880-3695	3780
		404-410	ErS, H3	Su-2933	-25.9	3730±50	4150-3985	4080
		510-516	ErS, H8	Su-2934	-27.1	5500±80	6395-6210	6300
		614-620	S, H6	Su-2935	-28.9	8000±80	9000-8725	8850
		687-693	EqSC, H4	Su-2936	-28.6	8300±80	9430-9140	9295
		740-746	MnEqC, H4	Su-2937	-28.5	8380±80	9485-9295	9380
		787-793	EqMnBC, H4	Su-2938	-28.7	8550±50	9545-9490	9525

Supplementary Information S2

Study sites

1. Luovuoma (68º24'N, 23º32'E) is an aapa mire covering 186 ha in Enontekiö, northern Finland (site 1, Fig. 1A). Luovuoma is located in the northern boreal vegetation zone, representing the northern aapa mires (Hämet-Ahti 1981, Ruuhijärvi 1983). Most of the area is treeless and the most common mire types are oligo-mesotrophic flark fen and tall-sedge fen. The mean peat thickness is 1.1 m and the maximum thickness 4.5 m. Approximately 70% of the peat deposits are composed of *Carex* peat and 30% of *Sphagnum* peat. Most of the peat deposits are weakly-moderately decomposed with a mean H3.8 ($H_{1\text{-}10}$, von Post 1922). The most common subsoil type under peat deposits is till and the bedrock consists of quartzites (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). For a more detailed description of the study site, see Mäkilä and Moisanen (2007). A total of six dated fen profiles were analysed (Supplementary Information Table S1).

2. Koiransuo (65º41'N, 25º58'E) is an aapa mire covering 100 ha in Ii, central Finland (site 2, Fig. 1A-D). Koiransuo is located in the middle boreal vegetation zone, representing the southern aapa mires (Hämet-Ahti 1981, Ruuhijärvi 1983). The most common mire types are eutrophic and oligotrophic flark fen, and meso – eutrophic sparsely treed mire. The mean peat thickness is 1.6 m and the maximum thickness 3.8 m. Approximately 90% of the peat deposits are composed of *Carex* or mixed *Sphagnum-Carex* peat. Most of the peat deposits are moderately decomposed with a mean H4.6 ($H_{1\text{-}10}$, von Post 1922). The most common subsoil type under peat deposits is till and the bedrock consists mainly of gneiss (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). One dated eutrophic flark fen profile was analysed (Supplementary Information Table S1).

3. Hautasuo-Tupakkisuo (65º39'N, 27º03'E) is a large aapa mire covering 456 ha in Pudasjärvi, central Finland (site 3, Fig. 1A-D). Hautasuo-Tupakkisuo is located in the middle boreal vegetation zone representing the southern aapa mires (Hämet-Ahti 1981, Ruuhijärvi 1983). The most common mire types are minerotrophic low-sedge fen, low-sedge *Sphagnum papillosum* pine fen, tall-sedge fen and flark fen. In the marginal parts, *Carex globularis* pine swamp and *Sphagnum fuscum* pine bog are common. The mean peat thickness is 1.3 m and the maximum thickness 5.4 m. Approximately 93% of the peat deposits are composed of mixed *Sphagnum-Carex* or *Carex-Sphagnum* peat. Most of the peat deposits are moderately decomposed with a mean H4.5 ($H_{1\text{-}10}$, von Post 1922). The most common subsoil type under peat deposits is sand and the bedrock consists of gneiss and migmatites (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). A total of seven dated profiles were analysed which include five fens and two bogs (Supplementary Information Table S1).

4. Ruosuo (65º39'N, 27º19'E) is a large aapa mire covering 475 ha in Pudasjärvi, central Finland (site 4, Fig. 1A). Ruosuo is located on the border of the middle and northern boreal vegetation zones, representing the southern aapa mires (Hämet-Ahti 1981, Ruuhijärvi 1983). The most common mire types are tall-sedge fen, flark fen and low-sedge fen. The peat thickness is 1.2 m and the maximum thickness 2.8 m. Approximately 80% of the peat deposits are composed of *Carex* or mixed *Carex-Sphagnum* peat. Most of the peat deposits are moderately decomposed with a mean H4.6 ($H_{1\text{-}10}$, von Post 1922). The most common subsoil type under peat

deposits is sand and the bedrock consists of gneiss and migmatites (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). For a more detailed description of the study site, see Mäkilä *et al.* (2001). A total of three dated fen profiles were analysed (Supplementary Information Table S1).

5. Siikaneva (61º50'N, 24º10'E) is large mire covering 1247 ha in Ruovesi, southern Finland (site 5, Fig. 1A). Siikaneva is located on the border of the southern and middle boreal vegetation zones (Hämet-Ahti 1981, Ruuhijärvi 1983). The mire is also in the border area between the coastal concentric raised bogs and the eccentric bogs of central Finland. The area consists of several eccentric raised bogs and treeless oligo-minerotrophic fens within the mire. The most common mire types in the raised bog area are ridge-hollow pine bog and cottongrass pine bog. In the aapa mire area, oligotrophic low-sedge fen and tall-sedge fen are the most common mire types (Raikamo 1977). The mean peat thickness is 2.5 m and the maximum thickness 7.60 m. Approximately 70% of the peat deposits are composed of *Sphagnum* peat and 30% of *Carex* peat. Most of the peat deposits are moderately decomposed with a mean H4.6 (H_{1-10}, von Post 1922). The most common subsoil type under peat deposits is sand and the bedrock consists of granite (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). One dated ombrotrophic low sedge bog profile was analysed (Supplementary Information Table S1).

6. Suurisuo (60º60'N, 24º48'E) is a large mire covering 230 ha in Janakkala, southern Finland (site 6, Fig. 1A). Suurisuo is located in the southern boreal vegetation zone (Hämet-Ahti 1981, Ruuhijärvi 1983). The mire is in the transitional zone between the coastal concentric raised bogs and the eccentric bogs of central Finland. The mire types vary from ombrotrophic to meso-eutrophic mires. However, the most common mire types are oligotrophic low-sedge fen, cottongrass pine bog and tall-sedge fen. The mean peat thickness is 4.4 m and the maximum thickness 7.4 m. Approximately 80% of the peat deposits are composed of *Sphagnum* peat and 20% of *Carex* peat. Most of the peat deposits are weakly-moderately decomposed with a mean H4.0 (H_{1-10}, von Post 1922). The most common subsoil type under peat deposits is clay and the bedrock consists of granite (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). One dated mesotrophic herb-rich sedge birch-pine fen profile was analysed (Supplementary Information Table S1).

7. Haukkasuo (60º49'N, 26º57'E) is a large, raised bog covering 281 ha in Kouvola, southern Finland (site 7, Fig. 1A). Haukkasuo is located in the southern boreal vegetation zone, representing the concentric raised bogs (Hämet-Ahti 1981, Ruuhijärvi 1983). The most common mire types are ridge-hollow pine bog and *Sphagnum fuscum* pine bog. In the southern part of the mire, tall-sedge pine fen and low-sedge fen are found. The mean peat thickness is 3.4 m and the maximum thickness 7.3 m. Approximately 70% of the peat deposits are composed of *Sphagnum* peat and 30% of *Carex* peat. Most of the peat deposits are moderately decomposed with a mean H4.2 (H_{1-10}, von Post 1922). The most common subsoil type under peat deposits is clay and the bedrock consists of rapakivi granite (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). For a more detailed description of the study site, see Mäkilä *et al.* (1997). A total of six dated profiles were analysed which include four fens and two bogs (Supplementary Information Table S1).

8. Kilpisuo (60º43'N, 25º08'E) is a large, raised bog covering 407 ha in Hausjärvi, southern Finland (site 8, Fig. 1A). Kilpisuo is located in the southern boreal vegetation zone, representing the concentric raised bogs (Hämet-Ahti 1981, Ruuhijärvi 1983). The most common mire types are ridge-hollow pine bog and cottongrass pine bog with dwarf-shrub pine bog in the marginal areas. The mean peat thickness is 4.8 m and the maximum thickness 7.7 m. Approximately 75% of the peat deposits are composed of *Sphagnum* peat and 25% of *Carex* peat. Most of the peat deposits are moderately decomposed with a mean H4.4 (H_{1-10}, von Post 1922). The most common subsoil type under peat deposits is clay and the bedrock consists of granite (Superficial deposits and bedrock of Finland, https://hakku.gtk.fi/). A total of three dated bog profiles were analysed (Supplementary Information Table S1).