

Supplementary material

Elevation and land use as drivers of macroinvertebrate functional composition in Afromontane headwater streams

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Table S1. Elevation and mean (\pm s.d.) values for physico-chemical characteristics and stream size variables of the study sites

Site	Altitude (m)	Depth (m)	Width (m)	Velocity (m s ⁻¹)	Discharge (m ³ s ⁻¹)	Temp (°C)	DO (mg L ⁻¹)	pH	EC (μ s cm ⁻¹)	TDS (mg L ⁻¹)	TSS (mg L ⁻¹)	CPOM (g m ⁻²)
1A ^A	2317	0.1 \pm 0.01	1.7 \pm 0.2	0.3 \pm 0.04	0.02 \pm 0.002	16.0 \pm 0.1	8.2 \pm 0.02	7.0 \pm 0.02	79.5 \pm 2.1	0.1 \pm 0.001	89.4 \pm 9.4	85.5 \pm 2.2
2A ^A	2407	0.2 \pm 0.01	7.0 \pm 1.4	0.9 \pm 0.01	0.9 \pm 0.05	14.4 \pm 0.1	8.0 \pm 0.01	7.1 \pm 0.05	60.0 \pm 1.4	0.04 \pm 0.001	31.9 \pm 3.3	145.5 \pm 0.9
2B ^A	2380	0.1 \pm 0.02	1.5 \pm 0.7	0.2 \pm 0.01	0.02 \pm 0.01	12.9 \pm 0.1	7.9 \pm 0.07	7.1 \pm 0.01	41.0 \pm 1.4	0.03 \pm 0.02	29.2 \pm 2.8	93.3 \pm 0.7
3A ^A	2239	0.4 \pm 0.01	10.0 \pm 2.8	0.9 \pm 0.02	1.8 \pm 0.02	15.6 \pm 0.01	8.0 \pm 0.06	7.0 \pm 0.01	85.0 \pm 1.4	0.1 \pm 0.001	20.4 \pm 4.6	174 \pm 2.2
3B ^A	2435	0.1 \pm 0.02	2.0 \pm 0.6	0.5 \pm 0.1	0.2 \pm 0.02	15.2 \pm 0.05	15.3 \pm 0.01	8.0 \pm 0.07	71.0 \pm 1.4	0.1 \pm 0.001	21.4 \pm 3.4	220.7 \pm 2.1
3C ^A	2347	0.2 \pm 0.01	4.5 \pm 2.1	0.7 \pm 0.1	1.2 \pm 0.01	14.5 \pm 0.1	11.9 \pm 0.06	7.8 \pm 0.04	55.5 \pm 0.7	0.03 \pm 0.002	43.6 \pm 2.0	136.2 \pm 0.2
4A ^A	2293	0.3 \pm 0.02	9.1 \pm 1.6	0.7 \pm 0.02	0.9 \pm 0.02	15.4 \pm 0.2	7.2 \pm 0.03	7.0 \pm 0.03	86.5 \pm 0.7	0.1 \pm 0.003	43.2 \pm 3.0	108.2 \pm 0.3
4B ^A	2350	0.1 \pm 0.01	1.6 \pm 0.8	0.4 \pm 0.1	0.1 \pm 0.03	15.2 \pm 0.1	10.8 \pm 0.02	7.0 \pm 0.05	91.5 \pm 2.1	0.1 \pm 0.002	29.2 \pm 3.0	226.7 \pm 0.8
4C	1896	0.2 \pm 0.01	5.5 \pm 0.7	1.0 \pm 0.1	0.9 \pm 0.02	17.5 \pm 0.6	8.4 \pm 0.01	7.1 \pm 0.07	124.5 \pm 3.5	0.1 \pm 0.003	213.3 \pm 30.6	170.8 \pm 1.5
4D	1660	0.3 \pm 0.03	5.8 \pm 0.4	1.6 \pm 0.1	1.0 \pm 0.01	17.6 \pm 0.1	10.7 \pm 0.03	7.0 \pm 0.01	144.0 \pm 2.8	0.1 \pm 0.001	264.4 \pm 15.5	69.3 \pm 0.9
5A	1950	0.2 \pm 0.01	1.4 \pm 0.3	0.8 \pm 0.1	0.2 \pm 0.01	18.4 \pm 0.5	11.3 \pm 0.08	7.1 \pm 0.01	170.5 \pm 2.1	0.1 \pm 0.001	301.2 \pm 45.6	59.4 \pm 1.7
6A	1881	0.3 \pm 0.01	3.9 \pm 1.3	0.6 \pm 0.1	0.4 \pm 0.01	19.5 \pm 0.1	8.3 \pm 0.03	7.1 \pm 0.01	153.5 \pm 2.1	0.1 \pm 0.01	147.7 \pm 21.2	67.1 \pm 0.4
7A	1878	0.2 \pm 0.01	2.6 \pm 0.4	0.6 \pm 0.2	0.2 \pm 0.02	20.4 \pm 0.2	8.9 \pm 0.08	7.0 \pm 0.01	191.0 \pm 2.8	0.1 \pm 0.001	397.6 \pm 29.1	7.2 \pm 2.2
8A	1633	0.3 \pm 0.01	8.1 \pm 3.0	0.6 \pm 0.01	1.6 \pm 0.2	19.8 \pm 0.01	10.5 \pm 0.03	7.1 \pm 0.01	222.0 \pm 2.8	0.2 \pm 0.01	450 \pm 31.9	74.3 \pm 0.1
9A ^A	2246	0.1 \pm 0.01	1.9 \pm 0.5	0.3 \pm 0.01	0.1 \pm 0.01	15.6 \pm 0.1	7.2 \pm 0.04	7.6 \pm 0.13	72.5 \pm 0.7	0.1 \pm 0.001	3.2 \pm 1.6	336.6 \pm 1.0
9B ^A	2298	0.3 \pm 0.02	4.9 \pm 0.2	1.0 \pm 0.1	1.2 \pm 0.02	13.4 \pm 0.1	8.7 \pm 0.01	7.7 \pm 0.07	71.5 \pm 0.7	0.1 \pm 0.001	13.9 \pm 0.9	240.6 \pm 1.6
9C	1624	0.4 \pm 0.01	5.3 \pm 1.1	0.9 \pm 0.01	1.4 \pm 0.01	16.1 \pm 0.2	10.7 \pm 0.10	7.1 \pm 0.04	126.5 \pm 0.7	0.01 \pm 0.001	79 \pm 12.2	105.7 \pm 7.8
10A	1701	0.1 \pm 0.01	1.6 \pm 0.1	0.7 \pm 0.1	0.1 \pm 0.01	20.3 \pm 0.1	10.6 \pm 0.09	7.0 \pm 0.01	182.5 \pm 0.7	0.1 \pm 0.01	46.7 \pm 7.2	110.1 \pm 0.8
11A	1676	0.8 \pm 0.1	2.9 \pm 0.5	1.0 \pm 0.04	0.7 \pm 0.04	19.3 \pm 0.04	11.3 \pm 0.03	7.1 \pm 0.01	201.0 \pm 1.4	0.1 \pm 0.001	176 \pm 6.5	28.5 \pm 0.01
12A	1662	0.2 \pm 0.03	2.1 \pm 0.8	0.8 \pm 0.02	0.2 \pm 0.01	19.0 \pm 0.03	10.9 \pm 0.06	7.0 \pm 0.01	147.0 \pm 1.4	0.1 \pm 0.001	181.7 \pm 9.2	55.4 \pm 0.7

^AForested sites.**Table S2. Elevation and land-use characterisation in the study sites**

Site	Altitude (m)	Elevation class	Percentage forest cover	Percentage shrub cover	Percentage crop cover
1A ^A	2317	High	75.00	0.00	25.00
2A ^A	2407	High	100.00	0.00	0.00
	2380	High	100.00	0.00	0.00
3A ^A	2239	High	89.10	0.00	10.81
3B ^A	2435	High	96.87	0.00	3.13
3C ^A	2347	High	100.00	0.00	0.00
4A ^A	2293	High	84.85	0.00	15.15
4B ^A	2350	High	93.75	0.00	6.25
4C	1896	Mid	21.21	0.00	78.79
4D	1660	Low	12.90	3.23	83.87
5A	1950	Mid	15.62	6.25	78.13
6A	1881	Mid	25.81	0.00	74.19
7A	1878	Mid	24.24	3.03	72.73
8A	1633	Low	0.00	0.00	100.00
9A ^A	2246	High	96.97	0.00	3.03
9B ^A	2298	High	100	0.00	0.00
9C	1624	Low	0.00	0.00	100.00
10A	1701	Low	0.00	0.00	100.00
11A	1676	Low	0.00	0.00	100.00
12A	1662	Low	12.50	0.00	87.50

^AForested sites.

Table S3. Macroinvertebrate taxa composition, functional feeding groups (FFGs) (according to Merritt *et al.* 2008; Masee *et al.* 2014) and abundance (individuals m⁻²) in the Nzoia River basin streams

CF, collecting filterers; CG, collecting gatherers; PRD, predators; SCR, scrapers; SHR, shredders

Order	Family	Genus	Sites																			FFG		
			1A	2A	2B	3A	3B	3C	4A	4B	4C	4D	5A	6A	7A	8A	9A	9B	9C	10A	11A		12A	
Oligochaeta	Oligochaeta	Oligochaeta	1200	16	112	48	96	-	16	6352	48	128	80	96	32	16	1296	16	32	160	-	-	CG	
Tricladida	Planariidae	Planaria	-	32	96	240	496	256	80	176	128	48	48	-	-	-	208	-	16	48	-	-	PRD	
Hirudinea	Glossiphoniidae	Glossiphoniidae	-	-	-	16	352	-	-	-	-	-	-	-	-	-	800	-	-	-	-	-	PRD	
Gastropoda	Physidae	Physidae	-	-	32	-	-	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	SCR	
	Planorbidae	Planorbidae	16	-	-	-	-	-	-	-	-	-	-	-	-	32	-	-	-	32	32	-	SCR	
Bivalvia	Sphaeriidae	<i>Pisidium</i>	288	96	256	1536	992	96	400	736	16	48	32	-	16	48	6048	64	-	16	32	-	CF	
Decapoda	Potamonautidae	<i>Potamonautes</i>	16	272	16	32	-	96	480	528	96	-	-	-	-	-	80	368	16	-	-	-	SHR	
Ephemeroptera	Baetidae	<i>Baetis</i> (3-tailed)	-	2752	1840	3792	4896	4768	8960	3856	1952	912	1040	3056	80	352	4448	5728	640	3696	3456	400	CG&SCR	
		Type B (3-tailed)	96	480	48	224	240	896	464	480	144	16	32	448	-	96	144	352	16	192	896	32	CG&SCR	
		Type C (2-tailed)	-	-	-	16	-	288	-	-	416	96	-	272	-	-	-	-	112	-	-	32	16	CG&SCR
	Caenidae	<i>Afrocaenis</i>	-	-	80	-	96	-	16	-	-	-	-	-	-	-	80	-	-	-	-	-	-	CG&SCR
		<i>Caenis</i>	256	128	1136	32	1424	-	688	16	48	-	-	32	16	32	992	48	224	32	2112	48	CG&SCR	
	Heptageniidae	<i>Afronurus</i>	96	720	-	656	480	800	576	32	352	528	16	-	-	576	-	1200	576	32	1696	560	SCR	
	Leptophlebiidae	<i>Euthraulus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	SCR&CG
		Leptophlebiidae	-	-	16	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SCR&CG
	Oligoneuriidae	<i>Oligoneuriopsis</i>	-	544	-	176	-	752	144	-	112	32	-	-	-	-	-	240	-	-	-	-	-	CF
	Prosopistomatidae	<i>Prosopistoma</i>	-	16	-	-	-	-	128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PRD
	Tricorythidae	<i>Tricorythus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	32	-	-	16	-	-	-	-	CG
	Odonota	Coenagrionidae	Coenagrionidae	-	-	-	-	-	-	-	16	-	16	-	-	-	144	32	736	48	160	-	-	PRD
Gomphidae		Gomphidae	-	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PRD	
Libellulidae or Corduliidae		Libellulidae or Corduliidae	-	-	-	-	-	-	-	-	16	-	-	-	64	-	-	-	-	-	-	-	PRD	
Plecoptera	Perlidae	<i>Neoperla</i>	-	656	-	384	-	480	32	-	-	-	-	-	-	-	224	-	-	-	-	-	PRD	
Hemiptera	Gerridae	Gerridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	-	-	PRD	
	Mesoveliidae	Mesoveliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	-	-	PRD	
Coleoptera	Dytiscidae	Dytiscidae	-	-	-	-	16	-	-	-	-	-	-	-	-	176	-	-	-	-	-	-	PRD	
	Elmidae	Elmidae	-	-	-	16	-	-	-	160	-	-	-	16	-	-	-	-	-	16	-	-	SCR	
	Gyrinidae	Gyrinidae	-	-	-	176	-	16	-	16	-	16	16	16	-	-	-	-	-	48	32	-	PRD	
	Hydrophilidae	Hydrophilidae	-	16	-	-	-	-	-	16	-	-	-	-	16	32	-	-	-	-	-	-	PRD	
	Scirtidae	Scirtidae	-	128	336	-	240	-	-	224	-	-	-	-	16	832	16	-	-	-	-	-	SCR	
Trichoptera	Calamoceratidae	<i>Anisocentropus</i>	-	-	112	32	-	-	-	208	-	16	-	-	-	64	-	-	-	96	-	-	SHR	
	Hydropsychidae	<i>Cheumatopsyche</i> A	-	240	-	-	-	-	-	-	-	-	-	32	-	-	-	80	-	-	-	-	CF	
		<i>Cheumatopsyche</i> B	-	-	-	32	-	-	-	32	-	-	-	-	-	160	16	208	-	80	160	48	CF	
		<i>Cheumatopsyche</i> C	-	672	32	288	-	240	144	-	1728	2464	160	320	-	-	-	80	304	80	-	-	-	CF
		<i>Diplectrona</i>	912	304	-	64	272	80	48	720	144	16	-	64	-	48	208	-	-	64	-	-	CF	
		<i>Hydropsyche</i>	-	-	-	-	-	16	-	-	512	-	-	-	-	-	-	-	-	32	-	-	CF	
	Hydroptilidae	<i>Orthothrichia</i>	-	16	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	16	-	-	SCR	
	Lepidostomatidae	<i>Lepidostoma</i>	256	32	304	96	1712	16	64	560	16	64	-	16	-	48	208	-	448	-	960	16	SHR	
	Leptoceridae	<i>Adicella</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	32	-	-	32	-	-	-	-	SHR
		<i>Oecetis</i>	-	-	-	48	-	-	16	64	-	-	-	16	-	-	-	-	-	-	64	16	PRD	
<i>Triaenodes</i>		-	240	-	128	1200	80	80	240	-	-	-	-	-	-	96	48	96	-	-	-	-	SHR	
	<i>Trichosetodes</i>	-	-	-	-	32	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CG		

Order	Family	Genus	Sites																		FFG		
			1A	2A	2B	3A	3B	3C	4A	4B	4C	4D	5A	6A	7A	8A	9A	9B	9C	10A		11A	12A
Diptera	Philopotamidae	<i>Wormaldia</i>	-	-	-	-	48	-	64	96	-	-	-	-	-	912	-	-	-	-	-	-	CF
	Pisuliidae	Pisuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	SHR
	Polycentropodidae	<i>Polycentropus</i>	-	-	-	48	-	144	432	-	-	-	48	16	-	560	-	-	-	-	-	-	PRD
	Psychomyiidae	<i>Tinodes</i>	32	64	192	48	128	128	16	80	-	-	-	-	-	144	48	-	-	-	-	-	SCR
	Ceratopogonidae	Ceratopogonidae	-	-	32	-	-	-	-	-	-	-	-	16	-	16	-	-	-	-	-	-	PRD
	Chironomidae	Chironomidae	160	112	160	352	1152	-	144	1312	448	368	-	224	-	160	1648	160	112	48	96	16	PRD&CG
	Dixidae	Dixidae	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PRD
	Dolichopodidae	Dolichopodidae	-	32	-	16	64	-	-	208	-	-	-	-	-	-	-	-	-	-	-	-	PRD
	Empididae	Empididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	PRD
	Ephydriidae	Ephydriidae	16	32	-	-	-	-	-	-	-	-	-	-	16	-	-	16	-	-	-	-	COL
	Limoniidae	Limoniidae	16	48	160	128	32	-	16	272	-	-	-	-	-	-	32	-	32	-	-	-	SHR
	Muscidae	Muscidae	16	-	-	32	16	64	-	-	-	48	-	32	-	-	16	-	-	-	32	-	PRD
	Simuliidae	Simuliidae	2560	1504	448	3056	28064	10304	7168	18512	32016	15072	960	7888	80	48	6416	464	144	224	-	192	CF
	Stratiomyidae	Stratiomyidae	-	-	-	-	-	-	-	64	-	32	-	-	-	-	-	-	-	16	32	-	SCR
	Tabanidae	Tabanidae	16	-	-	-	-	-	-	720	-	-	-	-	-	-	48	-	-	-	-	-	PPR
Tipulidae	Tipulidae	16	-	64	32	64	16	-	368	48	32	16	16	16	-	128	-	16	16	32	-	SHR	
Number of taxa		17	25	21	30	23	22	23	24	21	18	11	17	10	17	30	21	17	21	19	10		
Total (individuals m ⁻²)		5968	9152	5488	11776	42112	19568	20176	35840	38448	19936	2416	12608	304	1776	25904	9520	3456	4912	10016	1344	281024	



Fig. S1. Land-use in each catchment (a, forested catchment; b, agricultural catchment) and pictures of each stream channel (c, d, streams in forested land use; e, f, streams in agricultural land use).

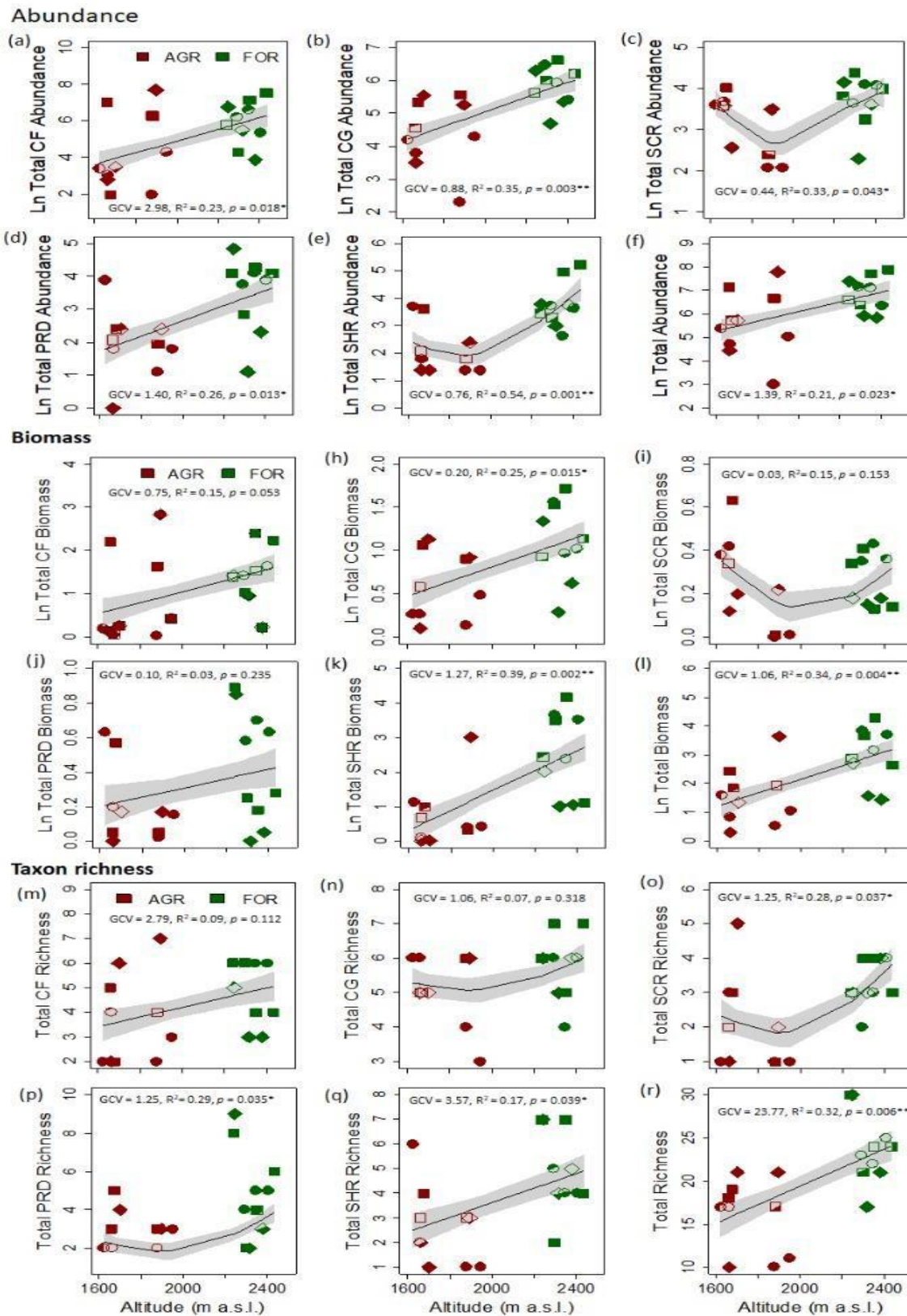


Fig. S2. GAM plots for abundance, richness and biomass of macroinvertebrate functional feeding groups (FFGs).

References

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