

# Flexible Spandrels of the Global Plant Virome: Proteomic-Wide Evolutionary Patterns of Structural Intrinsic Protein Disorder Elucidate Modulation at the Functional Virus-Host Interplay

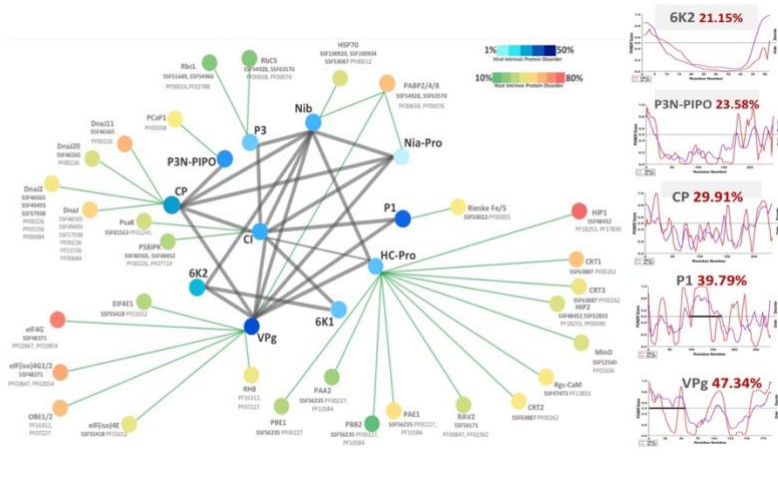
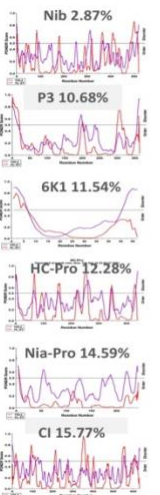
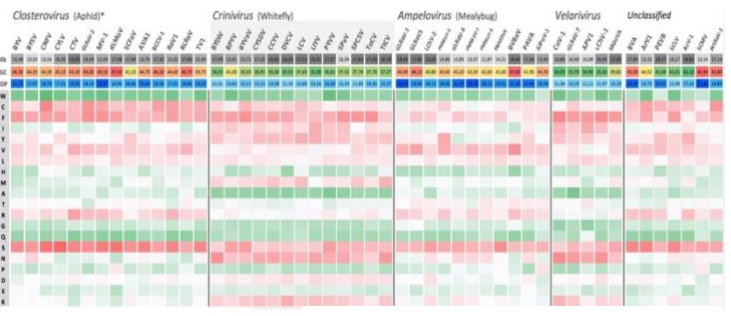
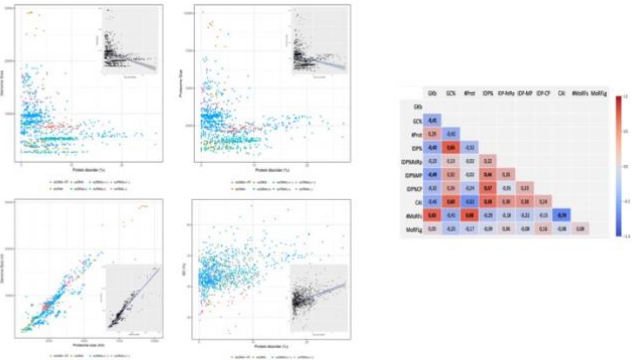
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Intrinsically disordered proteins and regions (IDPs/IDRs) make up a large part of viral proteomes, but their real prevalence across the global plant virome are still poorly understood, partly because of their massive diversity. Here we propose an evolutionary quantitative proteomic approach to foray into genomic signatures that are preserved in the amino acid sequences of orthologous IDRs. Markedly, we found that relatively abundant IDP varies substantially between viral species and within plant virus families, including according to genome size, partition or replication strategies. We also demonstrate that most encoded proteomic modules of the plant virome contain multiple disordered features that are phylogenomically preserved, and can be correlated to genomic, bio-physical and evolutionary strategies. Furthermore, our focused interactome-wide analysis highlights lines of evidence indicating that various IDPs with similar evolutionary signatures modulate viral multifunctionality. Moreover, estimated fractions of IDR in the vicinity of pivotal evolutionary structural signatures embedded in interaction modules are strongly enriched with affinity binding functional annotations and relate to vector-borne virus transmission modes. Importantly, Molecular Recognition Features (MoRFs) are abundantly widespread in IDRs of viral modules and their binding partners. Finally, we propose a coarse-grained conceptual framework in which evolutionary proteome-wide IDP/IDRs patterns can be, rather, reliably exploited to elucidate their foundational fine-tuning role in plant virus transmission mechanisms. While opening unexplored avenues for consistently predicting virus-host functions for many new or uncharacterized plant viruses based on their proteomic repertoire, other considerations advocating further structural IDP research in Plant Virology are thoroughly discussed in light of viral evolution.



Viral Module	Protein Function Descriptor	Host Interacting Partner	Host Protein	Score
P1	Linear protease	Agp-CaM	Agglossin/Agglossin-PROTEIN	0.44
HC-Pro	Protease with RNA silencing suppressor and viral movement	Agg-CaM	Agglossin/Agglossin-PROTEIN	0.43
		CP2	Agglossin/Agglossin-PROTEIN	0.41
		CP1	Agglossin/Agglossin-PROTEIN	0.41
		CP3	Agglossin/Agglossin-PROTEIN	0.41
		MP1/TAM6B	Agglossin/Agglossin-PROTEIN	0.41
		VP2	Agglossin/Agglossin-PROTEIN	0.41
		VP3	Agglossin/Agglossin-PROTEIN	0.41
		VP4	Agglossin/Agglossin-PROTEIN	0.41
		VP5	Agglossin/Agglossin-PROTEIN	0.41
		VP6	Agglossin/Agglossin-PROTEIN	0.41
		VP7	Agglossin/Agglossin-PROTEIN	0.41
		VP8	Agglossin/Agglossin-PROTEIN	0.41
		VP9	Agglossin/Agglossin-PROTEIN	0.41
		VP10	Agglossin/Agglossin-PROTEIN	0.41
		VP11	Agglossin/Agglossin-PROTEIN	0.41
		VP12	Agglossin/Agglossin-PROTEIN	0.41
		VP13	Agglossin/Agglossin-PROTEIN	0.41
		VP14	Agglossin/Agglossin-PROTEIN	0.41
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		VP99	Agglossin/Agglossin-PROTEIN	0.41
		VP100	Agglossin/Agglossin-PROTEIN	0.41

Order	Rep. type	Family	Genus	Viral Species	Accession	ORF	ORF1	ORF2	ORF3	ORF4	ORF5	ORF6	ORF7	ORF8	ORF9	ORF10	ORF11	ORF12	ORF13	ORF14	ORF15	ORF16	ORF17	ORF18	ORF19	ORF20	ORF21	ORF22	ORF23	ORF24	ORF25	ORF26	ORF27	ORF28	ORF29	ORF30	ORF31	ORF32	ORF33	ORF34	ORF35	ORF36	ORF37	ORF38	ORF39	ORF40	ORF41	ORF42	ORF43	ORF44	ORF45	ORF46	ORF47	ORF48	ORF49	ORF50	ORF51	ORF52	ORF53	ORF54	ORF55	ORF56	ORF57	ORF58	ORF59	ORF60	ORF61	ORF62	ORF63	ORF64	ORF65	ORF66	ORF67	ORF68	ORF69	ORF70	ORF71	ORF72	ORF73	ORF74	ORF75	ORF76	ORF77	ORF78	ORF79	ORF80	ORF81	ORF82	ORF83	ORF84	ORF85	ORF86	ORF87	ORF88	ORF89	ORF90	ORF91	ORF92	ORF93	ORF94	ORF95	ORF96	ORF97	ORF98	ORF99	ORF100
Magyvirales	ssRNA(-)	Nepovirales	Isorhabdovirus	Bonoma bunyion virus	BNTV	U01	U02	U03	U04	U05	U06	U07	U08	U09	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	U26	U27	U28	U29	U30	U31	U32	U33	U34	U35	U36	U37	U38	U39	U40	U41	U42	U43	U44	U45	U46	U47	U48	U49	U50	U51	U52	U53	U54	U55	U56	U57	U58	U59	U60	U61	U62	U63	U64	U65	U66	U67	U68	U69	U70	U71	U72	U73	U74	U75	U76	U77	U78	U79	U80	U81	U82	U83	U84	U85	U86	U87	U88	U89	U90	U91	U92	U93	U94	U95	U96	U97	U98	U99	U100	

