Supplementary Information (SI) for Journal of Materials Chemistry A.

Deciphering the Role of Hydrothermal Pretreatment on Biomass Waste for Derived Hard Carbon with Superior Electrochemical Performance in Sodium-ion Battery

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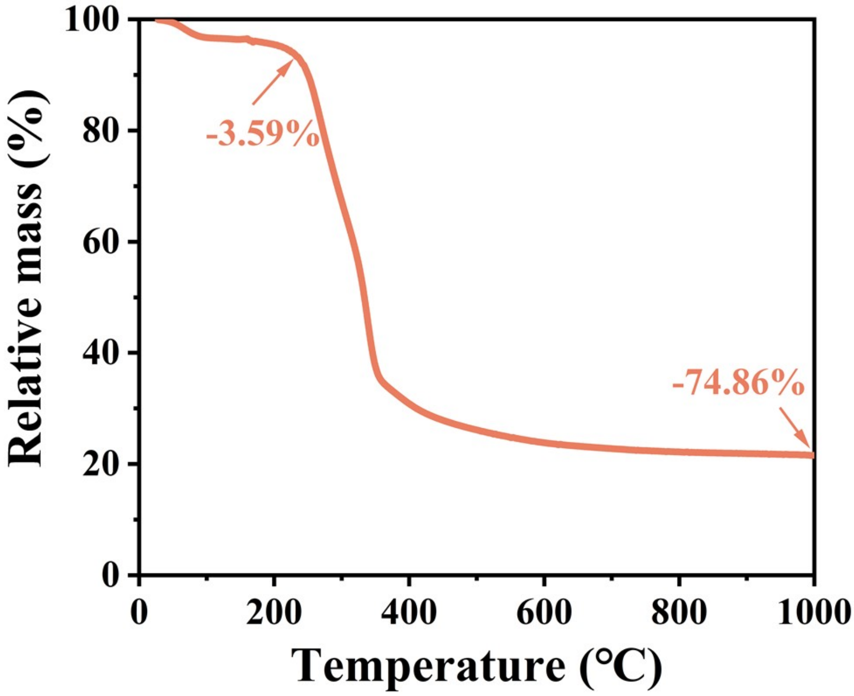

Fig. S1 TG curve of raw material.

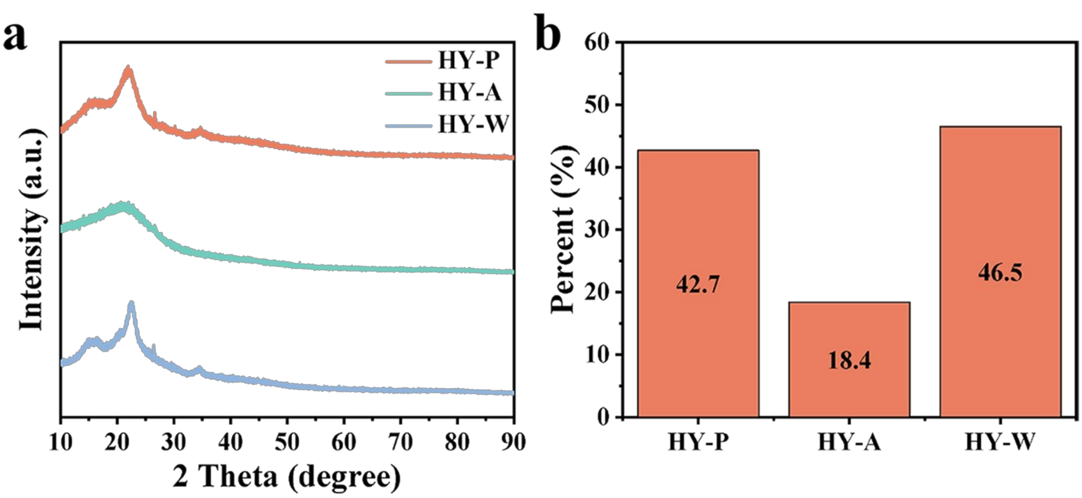

Fig. S2 (a) XRD patterns and (b) the relative crystallinity of HY-P, HY-A, HY-W.

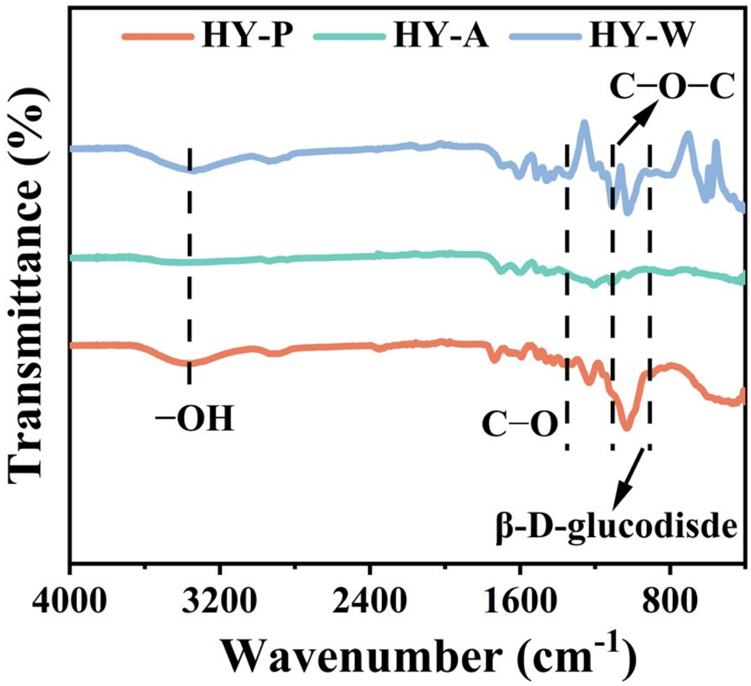

Fig. S3 Infrared spectra of HY-P, HY-A, HY-W.

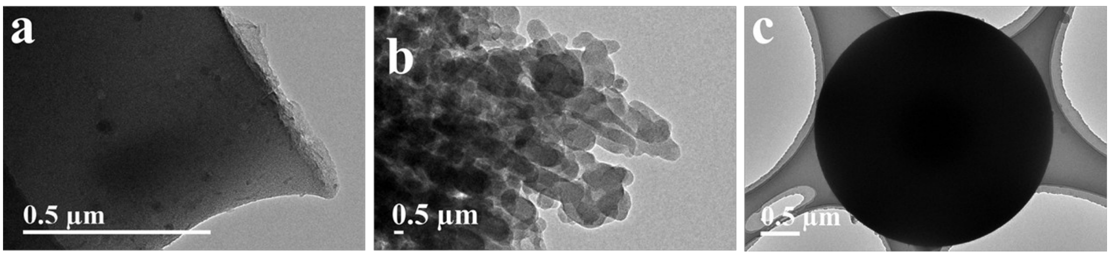

Fig. S4 TEM images of (a) HC-P, (b) HC-A, (c) HC-W.

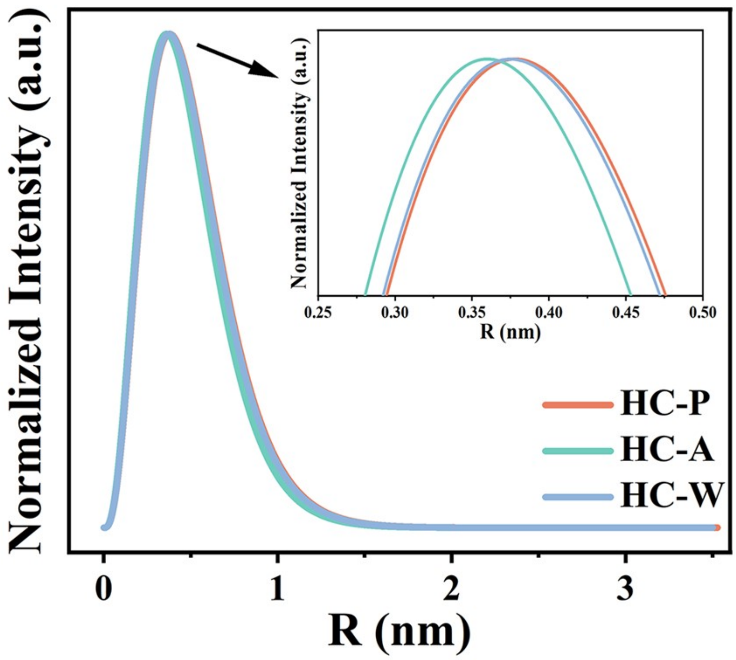

Fig. S5 Closed pore size distribution of HC-P, HC-A and HC-W.

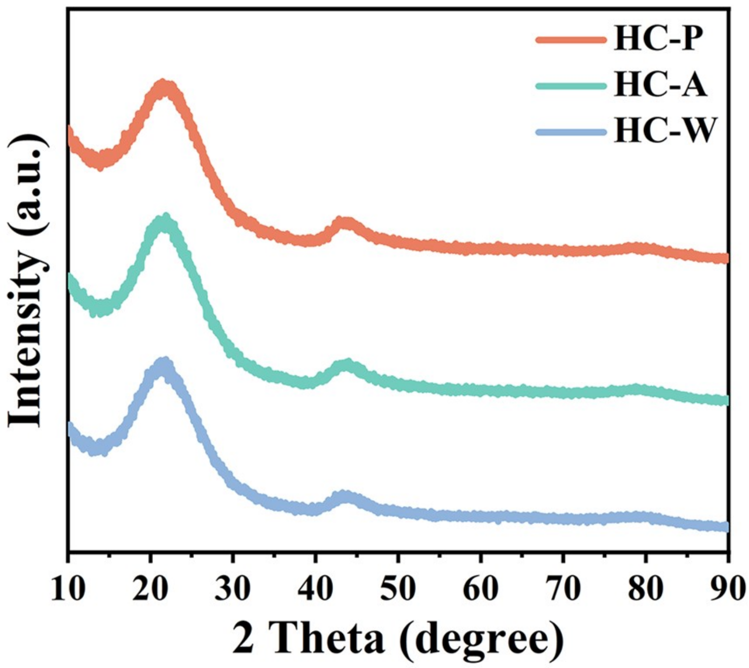

Fig. S6 XRD patterns of HC-P, HC-A and HC-W.

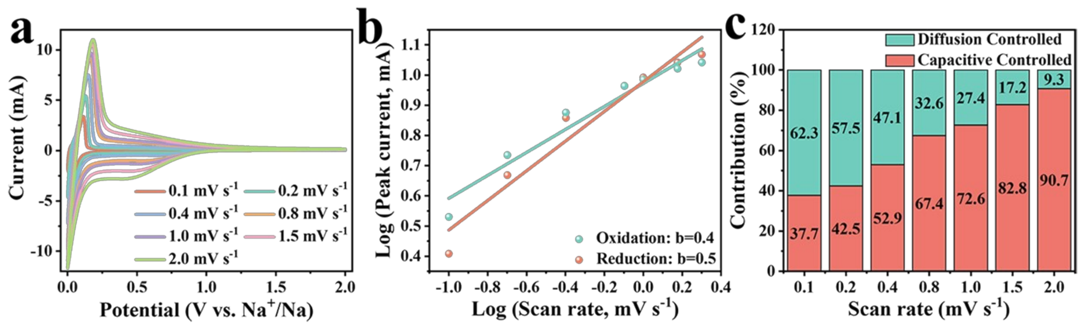

Fig. S7 (a) CV curves at different scan rates from 0.1 to 2.0 mV s^{-1} and (b) b-values of HC-P. (c) Capacitive contribution at different scan rates of HC-P.

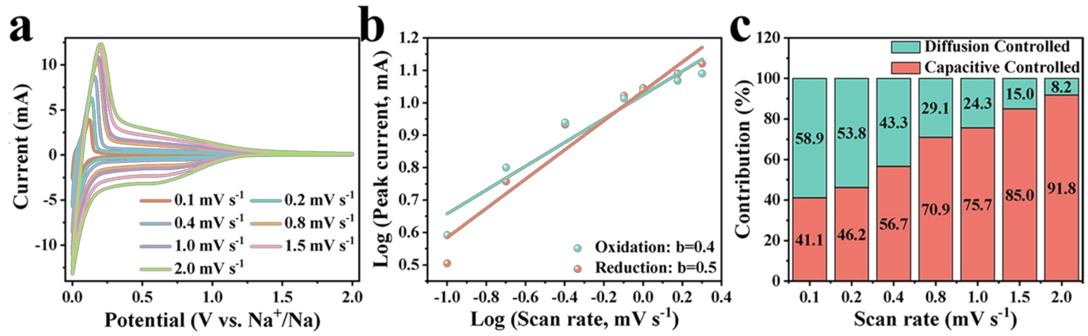

Fig. S8 (a) CV curves at different scan rates from 0.1 to 2.0 mV s^{-1} and (b) b-values of HC-A. (c) Capacitive contribution at different scan rates of HC-A.

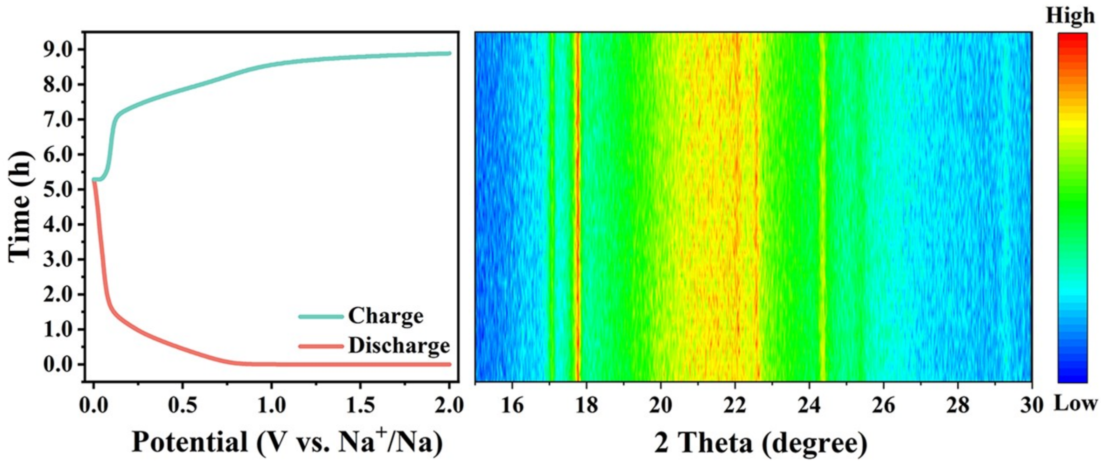

Fig. S9 The in-situ XRD curve of HC-P at 0.15 C.

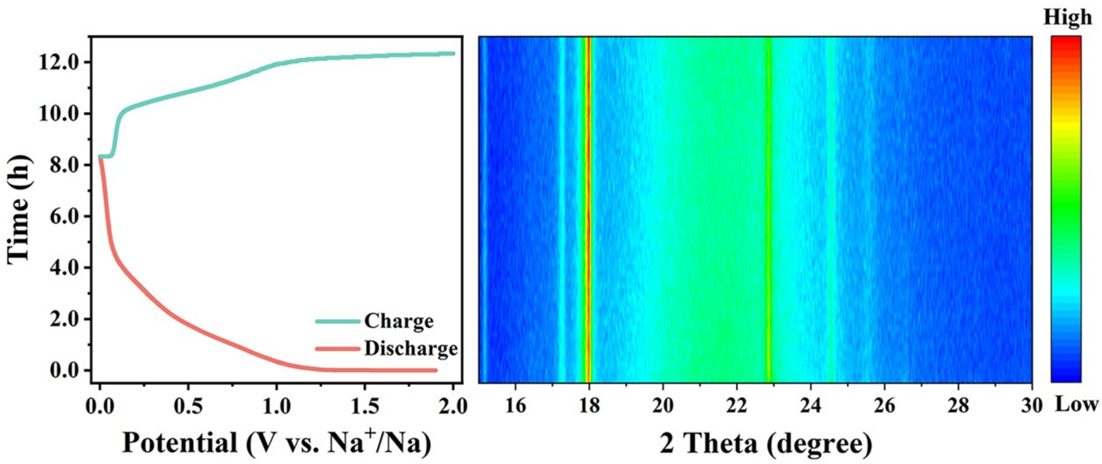

Fig. S10 The in-situ XRD curve of HC-A at 0.15 C.

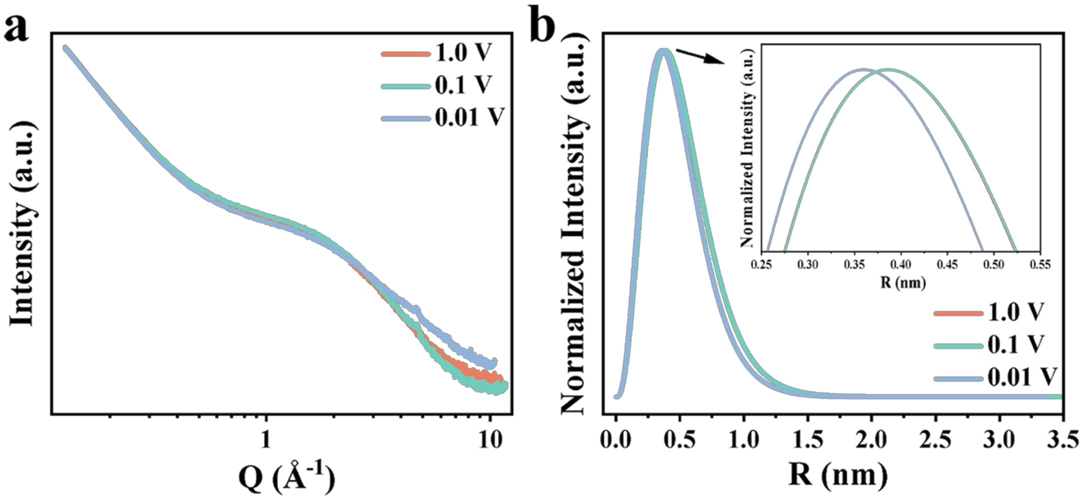

Fig. S11 (a) Ex-situ SAXS and (b) closed pore size distribution of HC-P at 1.0 V, 0.1 V and 0.01 V.

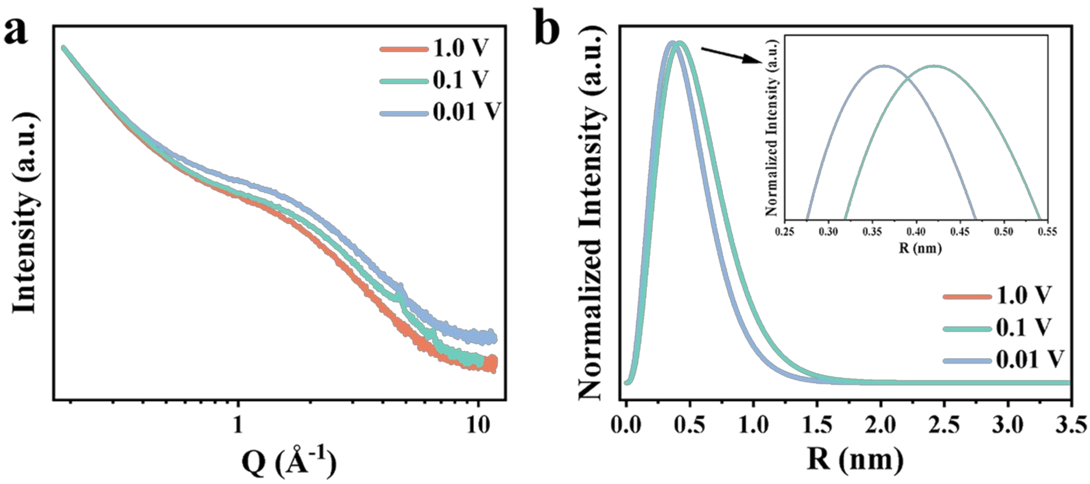

Fig. S12 (a) Ex-situ SAXS and (b) closed pore size distribution of HC-A at 1.0 V, 0.1 V and 0.01 V.

Table S1. Structure parameters of samples.

Samples	R_{SAXS} (Å)	d_{002} (nm)	L_a (nm)	L_c (nm)	FWHM (°)	A_D/A_G
HC-P	3.8	0.4	3.3	0.8	7.6	1.37
HC-A	3.6	0.4	3.2	0.7	7.4	1.31
HC-W	3.8	0.4	3.3	0.8	7.9	1.42

Table S2. Microcrystalline parameters of samples.

Band	Samples	Raman shift (cm^{-1})	Corresponding structure
G	HC-P	1581.7	Vibration of the graphite crystal
	HC-A	1590.0	
	HC-W	1586.9	
D(D1)	HC-P	1351.9	Disordered graphite lattice
	HC-A	1351.8	
	HC-W	1350.8	
D2	HC-P	1613.7	Layer-stacking arrangement of carbon atoms in graphene
	HC-A	1604.3	
	HC-W	1616.1	
D3	HC-P	1486.3	Amorphous carbon
	HC-A	1480.6	
	HC-W	1490.0	
D4	HC-P	1236.9	Disordered structure of sp^2-sp^3
	HC-A	1250.1	
	HC-W	1232.5	

Table S3. Comparison of the electrochemical performance with typical biomass-derived HC reported previously.

Precursors	**Reversible capacity**	**Initial coulombic efficiency**	**Rate capacity**	**Capacity retention**	**References**
Sunflower seed shells	287 mAh g^{-1} at 25 mA g^{-1}	76%	135 mAh g^{-1} at 372 mA g^{-1}	85% after 500 cycles at 372 mA g^{-1}	[1]
Aegle marmelos shell	224 mAh g^{-1} at 10 mA g^{-1}	76%	78 mAh g^{-1} at 1 A g^{-1}	66% after 2500 cycles at 1000 mA g^{-1}	[2]
Peanut shell	204 mAh g^{-1} at 30 mA g^{-1}	54%	99 mAh g^{-1} at 300 mA g^{-1}	81% after 100 cycles at 300 mA g^{-1}	[3]
Corncob	272 mAh g^{-1} at 30 mA g^{-1}	67%	35 mAh g^{-1} at 2 A g^{-1}	79% after 100 cycles at 30 mA g^{-1}	[4]
Spartina alterniflora loisel	142 mAh g^{-1} at 50 mA g^{-1}	42%	150 mAh g^{-1} at 500 mA g^{-1}	42% after 1000 cycles at 200 mA g^{-1}	[5]
Green peas pod	293 mAh g^{-1} at 30 mA g^{-1}	74%	142 mAh g^{-1} at 300 mA g^{-1}	74% after 100 cycles at 30 mA g^{-1}	[6]

Sugarcane bagasse	300 mAh g^{-1} at 25 mA g^{-1}	57%	115 mAh g^{-1} at 1 A g^{-1}	67% after 300 cycles at 100 mA g^{-1}	7
Macadamia nutshell	118 mAh g^{-1} at 100 mA g^{-1}	54%	200 mAh g^{-1} at 200 mA g^{-1}	65% after 100 cycles at 20 mA g^{-1}	8
Rice husks	251 mAh g^{-1} at 25 mA g^{-1}	67%	111 mAh g^{-1} at 500 mA g^{-1}	85% after 500 cycles at 100 mA g^{-1}	9
Vine shoots	270 mAh g^{-1} at 30 mA g^{-1}	71%	110 mAh g^{-1} at 100 mA g^{-1}	97% after 315 cycles at 100 mA g^{-1}	10
Natural balsa	248 mAh g^{-1} at 100 mA g^{-1}	32%	100 mAh g^{-1} at 2 A g^{-1}	95% after 500 cycles at 2 A g^{-1}	11
Pomegranate peel	359 mAh g^{-1} at 30 mA g^{-1}	52%	84 mAh g^{-1} at 600 mA g^{-1}	68% after 200 cycles at 150 mA g^{-1}	12
Platanus flosses	260 mAh g^{-1} at 100 mA g^{-1}	80%	107 mAh g^{-1} at 2 A g^{-1}	80% after 1000 cycles at 500 mA g^{-1}	13
Waste hemp hurd	262 mAh g^{-1} at 30	73%	79 mAh g^{-1} at 1 A	96% after 300 cycles	14

	mA g^{-1}		g^{-1}	at 2 A g^{-1}	
Coffee ground	225 mAh g^{-1} at 50 mA g^{-1}	62%	119 mAh g^{-1} at 2500 mA g^{-1}	92% after 250 cycles at 50 mA g^{-1}	15
Almond shell	317 mAh g^{-1} at 37 mA g^{-1}	86%	267 mAh g^{-1} at 3720 mA g^{-1}	91% after 600 cycles at 372 mA g^{-1}	This work

Table S4. Closed pore sizes of samples.

Samples	1.0 V (Å)	0.1 V (Å)	0.01 V(Å)
HC-P	3.9	3.9	3.6
HC-A	4.2	4.2	3.6
HC-W	4.0	4.0	3.6

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