Supporting Information

Table S1 Sources of *Morchella* strains

Strain name	Variety	Source	the ITS Sequencing Information
M6	M.*sextelata* M.Kuo	Hebei	TATTAAGAACACACAGACAGGGCTGCTATAGGGGCC GGCAGGGCTAGTAGCTTTACGTTGTTGAACGTCCTGT TTGGACCCGTTGGCAGCCCCCATCTAAACCCTCTGCG TACCTGTCCCCCCTTGCTTCCCCCGGCACCTCGCTGG GGGGAGGAACAACAACCAAAACTCTTTGTGAACAAA CAGACGTCAGAATTACAAAAACAAAAAAAAGTTAA AACTTTCAACAACGGATCTCTTGGTTCCCACATCGAT GAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCCCTGGTATTCCGGGGGGCATGCCTGTTC GAGCGTCATAAAAACCTCCTCCCCCTTCGGGTTTGAT TACTATCGTTGGGGGGTTTTGGCCTAATGGGATAGC GATTGGCAATTAGTTTCCCAATGTCCTAAATAGACGT AGACCCGCCTCCAGATGCGACAGCACCGAGGCCATC AACCGTGGAGTTATGGGATATATAGGCTTGCAGTAA AATGCTCACCTTTCTCCATACGCCGATGGCACACCGG TCGCAGTTGCGGGCGTAAATTGGAGTCCTCTTCAGG ACCCTCGTGGCCTAGCATCCACCATACATAATTTGAC CTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCA TATCATAAACCGGGAAGAGAAAAAAAAA
M36	M.*sextelata* M.Kuo	Hubei	TTTCCTCCGCTTATTGATATGCTTAAGTTCAGCGGGT ATCCCTACCTGATCCGAGGTCAAATTATGTATGGTGG ATGTTAGTCCACGAGGGTCCTGAAGAGGACTCCAAT TTACGCCCGCAACTGCGACCGGTGTGCCATCGGCGT ATGGAGAAAGGTGAGCATTTTACTGCAAGCCTATAT ATCCCATAACTCCACGGTTGATGGCCTCGGTGCTGTC GCATCTGGAGGCGGGTCTACGTCTATTTAGGACATT GGGAAACTAATTGCCAATCGCTATCCCATTAGGCCA AAACCCCCCAACGATAGTAATCAAACCCGAAGGGGG AGGAGGTTTTTATGACGCTCGAACAGGCATGCCCCC CGGAATACCAGGGGGCGCAATGTGCGTTCAAAGATT CGATGATTCACTGAATTCTGCAATTCACATTACTTAT CGCATTTCGCTGCGTTCTTCATCGATGTGGGAACCAA GAGATCCGTTGTTGAAAGTTTTAACTTTTTTTTGTTTT TGTAATTCTGACGTCTGTTTGTTCACAAAGAGTTTTG GTTGTTGTTCCTCCCCCCAGCGAGGTGCCGGGGGAA GCAAGGGGGGACAGGTACGCAGAGGGTTTAGATGG GGGCTGCCAACGGGTCCAAACAGGACGTTCAACAAC GTAAAGCTACTAGCCCTGCCGGCCCCTATAGCAGCC CTTTTCTGTGTGGTTCTTGGTAATGATCCTTCCGCAG GTTCACCTACGGAAG

M37	M.*sextelata* M.Kuo	Hubei	GTACCTGCGGAAGGATCATTACCAAGAACCACACAG AAAAGGGCTGCTATAGGGGCCGGCAGGGCTAGTAGC TTTACGTTGTTGAACGTCCTGTTTGGACCCGTTGGCA GCCCCCATCTAAACCCTCTGCGTACCTGTCCCCCCTT GCTTCCCCCGGCACCTCGCTGGGGGGAGGAACAACA ACCAAAACTCTTTGTGAACAAACAGACGTCAGAATT ACAAAAACAAAAAAAAGTTAAAACTTTCAACAACG GATCTCTTGGTTCCCACATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGAATTGCAGAATTCAGTG AATCATCGAATCTTTGAACGCACATTGCGCCCCCTGG TATTCCGGGGGGCATGCCTGTTCGAGCGTCATAAAA ACCTCCTCCCCCTTCGGGTTTGATTACTATCGTTGGG GGGTTTTGGCCTAATGGGATAGCGATTGGCAATTAG TTTCCCAATGTCCTAAATAGACGTAGACCCGCCTCCA GATGCGACAGCACCGAGGCCATCAACCGTGGAGTTA TGGGATATATAGGCTTGCAGTAAAATGCTCACCTTTC TCCATACGCCGATGGCACACCGGTCGCAGTTGCGGG CGTAAATTGGAGTCCTCTTCAGGACCCTCGTGGCCTA GCATCCACCATACATAATTTGACCTCGGATCAGGTA GGGATACCCGCTGAACTTAAGCATATCAATAAGGCG GAGGAA
M38	M.*sextelata* M.Kuo	Hubei	CTTTCGTAAAGGGTACCTGCGGAAGGATCATTACCA AGAACCACACAGAAAAGGGCTGCTATAGGGGCCGG CAGGGCTAGTAGCTTTACGTTGTTGAACGTCCTGTTT GGACCCGTTGGCAGCCCCCATCTAAACCCTCTGCGT ACCTGTCCCCCCTTGCTTCCCCCGGCACCTCGCTGGG GGGAGGAACAACAACCAAAACTCTTTGTGAACAAAC AGACGTCAGAATTACAAAAACAAAAAAAAGTTAAA ACTTTCAACAACGGATCTCTTGGTTCCCACATCGATG AAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACA TTGCGCCCCCTGGTATTCCGGGGGGCATGCCTGTTCG AGCGTCATAAAAACCTCCTCCCCCTTCGGGTTTGATT ACTATCGTTGGGGGGTTTTGGCCTAATGGGATAGCG ATTGGCAATTAGTTTCCCAATGTCCTAAATAGACGTA GACCCGCCTCCAGATGCGACAGCACCGAGGCCATCA ACCGTGGAGTTATGGGATATATAGGCTTGCAGTAAA ATGCTCACCTTTCTCCATACGCCGATGGCACACCGGT CGCAGTTGCGGGCGTAAATTGGAGTCCTCTTCAGGA CCCTCGTGGCCTAGCATCCACCATACATAATTTGACC TCGGATCAGGTAGGGATACCCGCTGAACTTAAGCAT ATCAATAGGCCGGAGGAAA
M39	M.*sextelata* M.Kuo	Hubei	GTACCTGCGGAAGGATCATTACCAAGAACCACACAG AAAAGGGCTGCTATAGGGGCCGGCAGGGCTAGTAGC TTTACGTTGTTGAACGTCCTGTTTGGACCCGTTGGCA GCCCCCATCTAAACCCTCTGCGTACCTGTCCCCCCTT GCTTCCCCCGGCACCTCGCTGGGGGGAGGAACAACA ACCAAAACTCTTTGTGAACAAACAGACGTCAGAATT ACAAAAACAAAAAAAAGTTAAAACTTTCAACAACG GATCTCTTGGTTCCCACATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGAATTGCAGAATTCAGTG AATCATCGAATCTTTGAACGCACATTGCGCCCCCTGG TATTCCGGGGGGCATGCCTGTTCGAGCGTCATAAAA ACCTCCTCCCCCTTCGGGTTTGATTACTATCGTTGGG

			GGGTTTTGGCCTAATGGGATAGCGATTGGCAATTAG TTTCCCAATGTCCTAAATAGACGTAGACCCGCCTCCA GATGCGACAGCACCGAGGCCATCAACCGTGGAGTTA TGGGATATATAGGCTTGCAGTAAAATGCTCACCTTTC TCCATACGCCGATGGCACACCGGTCGCAGTTGCGGG CGTAAATTGGAGTCCTCTTCAGGACCCTCGTGGCCTA GCATCCACCATACATAATTTGACCTCGGATCAGGTA GGGATACCCGCTGAACTTAAGCATATCAATAGCCGG AGGAAC
M4	M.*sextelata* M.Kuo	Shanxi	GAGGTTTCCGAAAACACCCTAATTTGGCTGCTATAC GGTCCGGGTGGATTATACCGTGTTGTTTGTGCAGCCC CCTGTTTTGACCGGTTGGGGCCCCCGCCTTTGCCCCC CGGGCACCTGCCCCCCGTAGATCCCCCCGGCACCTCT GTGGGGGGAGGAACAGATGAGTTGATCTTTGCAATC AATTGACCTTTCAATTAAGGATCTCTTGGTTCCTGCA TCTTTGAATAACGCATCGCATGGTTCCCACGAATGTG AATAACAAAATTCAGTGAATTATCCAGTCTTTTTGGC AATTGAGCCCCTTGGGCCTCTTCCTTCTATGATTGCT CGAATGGGTTGCTGCTCTCGACGCTGGGTTGTGGTCC GTTTACCCTTCCCCCCCTCTCGAGGCTGATACCCATC TTTGAAGGGTTGTCCCGAGTTGGATAATACTATCGTC TCGAGCTTTCGCACTGTGCTAGTTAGATTGATAGGCG TTGTGCAGATGTATTAAAAAATGTTTATCACAAAGCT GAGCAAATTTGAGGTAATGATGGCTCCCTAAAAATA TTTTCATTTTATTTTTTGAGAAAAATTTTTACCGTTGT GGGCGTGTATCGGGGCTACATCCATCCTCTCTATAAA TTCTGGTTGTTTCGACGGGCCCCCATGCTGAGCCGGG GGGGTGCTTTGCCCCTAGCCCCGCCGCGGTATCCCCA GAAAACGGTGGAAAAGTAATTCGTGGGTACAATGAA ATGCGATAAAAGGGATGCTTTATGGGGCGGCTGGTT TGCATTCTTACCTAGTTGCAAATTCGGCTTGTTCATT TGCCTCCAGTTAAACCTCGGCATTGTTTCTTGGTTTC TCCGACCTTCTTTTGGGGTGGCGGACGACCTAGATCT TTGGGAGCTAATAGACGTTATGACTTTAATAAGATA GATTTTTTCCTTCTTCACTCCTGTGTGATGTCGTAGTC ATATTGTAAACTGCTGTCGTGCACACATTCTTGCTCA AGTATCACCCGTAGACACCTAACATACAACATACAT GGTCCTCGACTGCTCGCATCAGGTCTGCCGTCGATTG CAAAGCATCCAGTCGACTCATAACG
M15	M.*importun a* M.Kuo, O'Donnell& T.J.Volk	Sichuan	ACGGCATCCCTACCTGATCCGAGGTCAATTGTGTATG GTGGATGCTAGGCCACGAGGGTCCTGAAAAAAGGGC TCCAATTTACGCCCGCAACTGCGACCGGTGTGCCATC GGCGTATGGAGAAAGGTGAGCATTTTACTGCAAGCC TATATATCCCATAACTCCACGGTTGATGGCCTCGGTG CTGTCGCATCTGGAGGCGGGTCTACGTCTATTTAGGA CATTGGGAAACTAATTGCCAATCGCTATCCCATTAG GCCAAAACCCCCCAACGATAGTAATCAAACCCGATG GGGGAGGAGGTTTTTATGACGCTCGAACAGGCATGC CCCCCGGAATACCAGGGGGCGCAATGTGCGTTCAAA GATTCGATGATTCACTGAATTCTGCAATTCACATTAC TTATCGCATTTCGCTGCGTTCTTCATCGATGTGGGAA CCAAGAGATCCGTTGTTGAAAGTTTTAACTTTTTTGT

			TTTGTTATGATTCTGACGTCGGCTTGTTCACAAAGAG TTTTGGTTGTTGTTCCTCCCCCCAGCGGGTAGCCGGG GGAAGCAAGGCGGGACAGGTACGCAGAGGGTTTAG ATGGGGGCGGCTCCGGGTCCGGCCAGGACGTTCAAC AACGTAAAGCTACTAGCCCTGGTGGCCCCTCGGCTG CCCTTTTCTGTGTGGTTCTTGGTAATGATCCTTCCGC AGGTTCACCCTACGGAA
M24	M.*sextelata* M.Kuo	Qinghai	TAAATTTGGGTTTCCTAACCTTGATCCGAGGTCAAAT TATGTATTGGTGGATGCTAGGCCACGAGGGTCCTGA AGAGGACTCCAATTTACGCCCGCAACTGCGACCGGT GTGCCATCGGCGTATGGAGAAAGGTGAGCATTTTAC TGCAAGCCTATATATCCCATAACTCCACGGTTGATGG CCTCGGTGCTGTCGCATCTGGAGGCGGGTCTACGTCT ATTTAGGACATTGGGAAACTAATTGCCAATCGCTAT CCCATTAGGCCAAAACCCCCCAACGATAGTAATCAA ACCCATAAGGGGGAGGAGGTTTTTATGACGCTCGAA CAGGCATGCCCCCCGGAATTTTTTTTTTTTTTTTTT
M41	M.*sextelata* M.Kuo	hybridization	*M.sextelata* hybridization
M42	M.*sextelata* M.Kuo	hybridization	*M.sextelata* hybridization
M47	M.*sextelata* M.Kuo	hybridization	*M.sextelata* hybridization
M32	M.*septimelata* M.Kuo	Sichuan	CTCCTTCCGTAGGGGAACCTGCGGAAGGATCATTAC CAAGAACCACACAGAAAAGGGCAGCCGAGGGGCCA ACCAGGGCTAGTAGCTTTACGTTGTTGAACGTCCTGG AACGGACCCGGAGCCGCCCCCATCTAAACACTCTGC GTACCCATCCCACCTTGCTTCCCCCGGCCATCCGCTG GGGGGAGGAACAACAACCAAAACTCTTTGTGAAGA AACAGACGTCAGAATCATAACCAAAAAAAAGTTAA AACTTTCAACAACGGATCTCTTGGTTCCCACATCGAT GAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCTCTGGTATTCCGGGGGGCATGCCTGTTC GAGCGTCATAAAAACCTCCTCCCCCTTCGGGTTTGAT TACTATCGTTGGGGGGTATTGGCCTACTGGGAAAGC GATTTGGCAATTGCCTTCCCACTGTCCTAAATACACT TAGACCCGCCTCCAGATGCGACAGCACCGAGGCCAT CAACCGTGGAGTTATGGAATACCGTTCTCCACACGC CGATGGCAAACCGGTCGCAGTTGCGGGCGTAAATTG GAGCCCTCTTCAGGACCCTCGTGGCCTAGCATCCACC ATACATATTTTGACCTCGGATCAGGTAGGGATACCC GCTGAACTTAAGCATATCAATAAGCGGGAGGAA

M33	M.*septimelata* M.Kuo	Sichuan	CTTCCCGTAGGGGGACCTGCGGAAGGATCATTACCA AGAACCACACAGAAAAGGGCAGCCGAGGGGCCAAC CAGGGCTAGTAGCTTTACGTTGTTGAACGTCCTGGA ACGGACCCGGAGCCGCCCCCATCTAAACACTCTGCG TACCCATCCCACCTTGCTTCCCCCGGCCATCCGCTGG GGGGAGGAACAACAACCAAAACTCTTTGTGAAGAA ACAGACGTCAGAATCATAACCAAAAAAAAGTTAAA ACTTTCAACAACGGATCTCTTGGTTCCCACATCGATG AAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACA TTGCGCCCTCTGGTATTCCGGGGGGCATGCCTGTTCG AGCGTCATAAAAACCTCCTCCCCCTTCGGGTTTGATT ACTATCGTTGGGGGGTATTGGCCTACTGGGAAAGCG ATTTGGCAATTGCCTTCCCACTGTCCTAAATACACTT AGACCCGCCTCCAGATGCGACAGCACCGAGGCCATC AACCGTGGAGTTATGGAATACCGTTCTCCACACGCC GATGGCAAACCGGTCGCAGTTGCGGGCGTAAATTGG AGCCCTCTTCAGGACCCTCGTGGCCTAGCATCCACCA TACATATTTTGACCTCGGATCAGGTAGGGATACCCG CTGAACTTAAGCATATCAATAAGCGGAGGAA

Table S2 Mycelial growth rate of *Morchella* strains at different culture temperatures

	5℃ (mm/d)	10℃ (mm/d)	15℃ (mm/d)	20℃ (mm/d)	25℃ (mm/d)	30℃ (mm/d)
M6	2.55±0.02^{e}	7.03±0.00^{d}	9.90±0.02^{c}	13.99±0.00^{b}	15.75±0.04^{a}	9.67±0.3^{c}
M36	1.62±0.06^{f}	6.57±0.04^{e}	10.06±0.05^{c}	14.09±0.06^{b}	15.47±0.03^{a}	9.15±0.10^{d}
M37	2.74±0.04^{e}	6.88±0.02^{d}	9.44±0.61^{c}	14.37±0.04^{b}	15.57±0.07^{a}	9.53±0.38^{c}
M38	2.30±0.18^{f}	6.88±0.00^{e}	10.05±0.09^{c}	14.28±0.01^{b}	15.24±0.01^{a}	9.37±0.19^{d}
M39	3.33±0.07^{f}	8.25±0.00^{d}	11.59±0.04^{c}	14.43±0.02^{b}	17.11±0.07^{a}	8.51±0.05^{d}
M4	2.71±0.00^{e}	7.46±0.01^{e}	10.42±0.12^{b}	14.34±0.01^{a}	14.75±0.29^{a}	9.08±0.04^{c}
M15	1.11±0.00^{d}	7.25±3.16^{b}	8.70±0.08^{b}	11.54±0.31^{a}	11.81±0.16^{a}	5.48±0.04^{c}
M24	2.11±0.04^{f}	6.65±0.20^{e}	9.22±0.01^{c}	13.48±0.12^{b}	14.61±0.03^{a}	8.27±0.00^{d}
M41	2.30±0.01^{f}	6.75±0.06^{e}	10.68±0.03^{c}	15.69±0.10^{b}	16.54±0.02^{a}	9.77±0.13^{d}
M42	3.06±0.07^{f}	7.81±0.01^{e}	11.16±0.09^{c}	16.11±0.02^{b}	17.03±0.14^{a}	10.37±0.10^{d}
M47	2.56±0.16^{e}	7.50±0.13^{d}	10.56±0.34^{c}	15.71±0.07^{b}	16.88±0.21^{a}	9.89±0.51^{c}
M32	2.33±0.27^{d}	6.15±0.00^{c}	8.15±0.09^{b}	11.92±0.03^{a}	12.02±0.02^{a}	7.73±0.13^{b}
M33	2.48±0.00^{e}	6.00±0.00^{d}	8.40±0.00^{c}	11.90±0.02^{a}	11.85±0.02^{a}	9.03±0.08^{b}

The data are presented as the mean ± variance (n=10). Different lowercase letters indicate a significant difference between different temperatures for the same strain ($p < 0.5$).

Table S3 Sequencing statistics of the M37 strain transcriptome

Samples	Total reads	Total bases	Q20%	Q30%	GC%	Mapped Reads
M5-1	44,828,066	6,645,127,797	98.32	94.7	50.79	23,476,458
M5-2	48,116,918	7,102,736,430	98.27	94.57	50.76	25,040,044
M5-3	45,750,644	6,729,814,218	98.41	94.97	50.59	20,729,616
M10-1	45,314,956	6,707,400,340	98.53	95.3	50.67	22,154,481

M10-2	43,648,004	6,482,107,252	98.07	93.96	50.84	20,584,398
M10-3	47,740,460	7,110,811,813	98.14	94.15	50.26	22,905,872
M15-1	48,034,850	7,135,131,931	98.17	94.22	50.72	22,321,794
M15-2	45,477,298	6,756,366,324	97.07	91.27	50.65	20,555,738
M15-3	35,566,786	5,277,149,098	98.26	94.55	50.48	14,927,380
M20-1	43,179,844	6,409,317,025	98.09	94.05	49.91	21,529,470
M20-2	46,093,102	6,787,522,818	98.5	95.18	49.45	18,248,259
M20-3	48,813,138	7,211,468,456	98.41	94.95	49.75	20,106,131
M25-1	45,883,604	6,824,936,640	98.13	94.11	49.38	23,818,178
M25-2	47,069,594	7,004,368,605	98	93.69	49.67	33,080,510
M25-3	45,254,254	6,704,874,156	98.34	94.76	49.72	34,845,775
M30-1	46,633,778	6,915,881,579	98.3	94.64	49.92	29,062,170
M30-2	31,142,856	4,328,994,544	98.31	94.85	49.77	18,097,113
M30-3	46,526,824	6,880,456,766	98.46	95.09	49.74	24,640,605

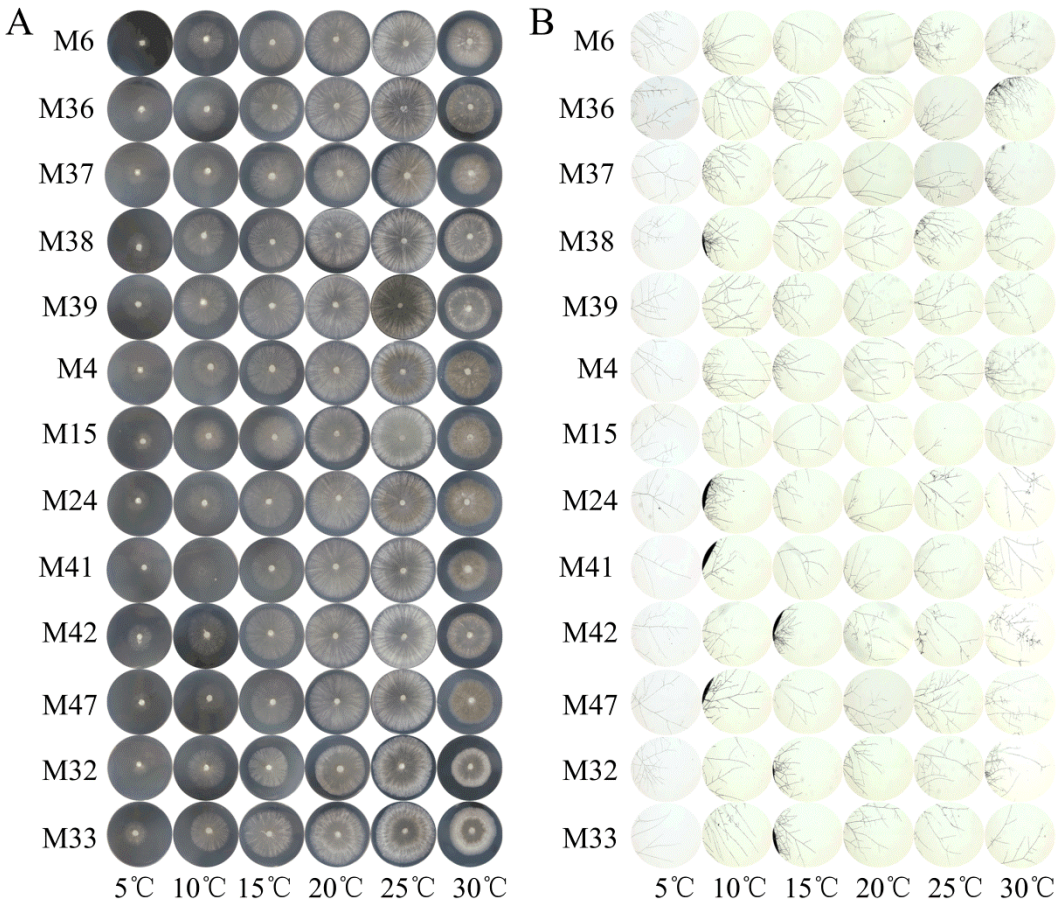


Fig. S1 Morphological features of *Morchella* mycelia (A) and mycelial branches (B) in solid media at different culture temperatures.

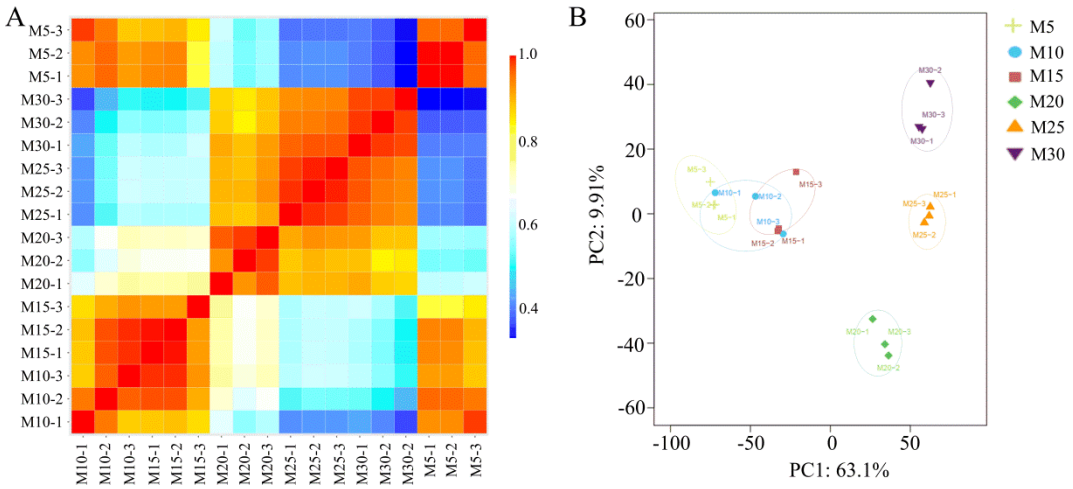


Fig. S2 Cluster analysis (A) and PCA (B) of intergroup differences at various culture temperatures.

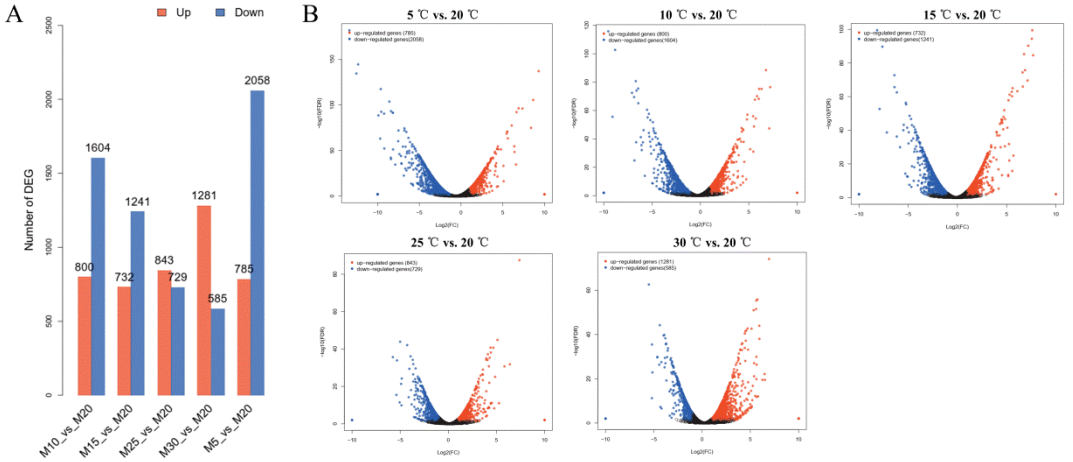


Fig. S3 Numbers of differentially expressed genes (DEGs) in different treatment groups (vs. 5 ℃ or 20 ℃). (A) Column chart of DEGs for each treatment group. (B) Volcano maps of upregulated and downregulated genes in different treatment groups. The red squares are upregulated genes, the blue squares are downregulated genes, and the gray areas are genes with not significant difference in expression; |log2 FC| ≥ 1, $p < 0.05$.

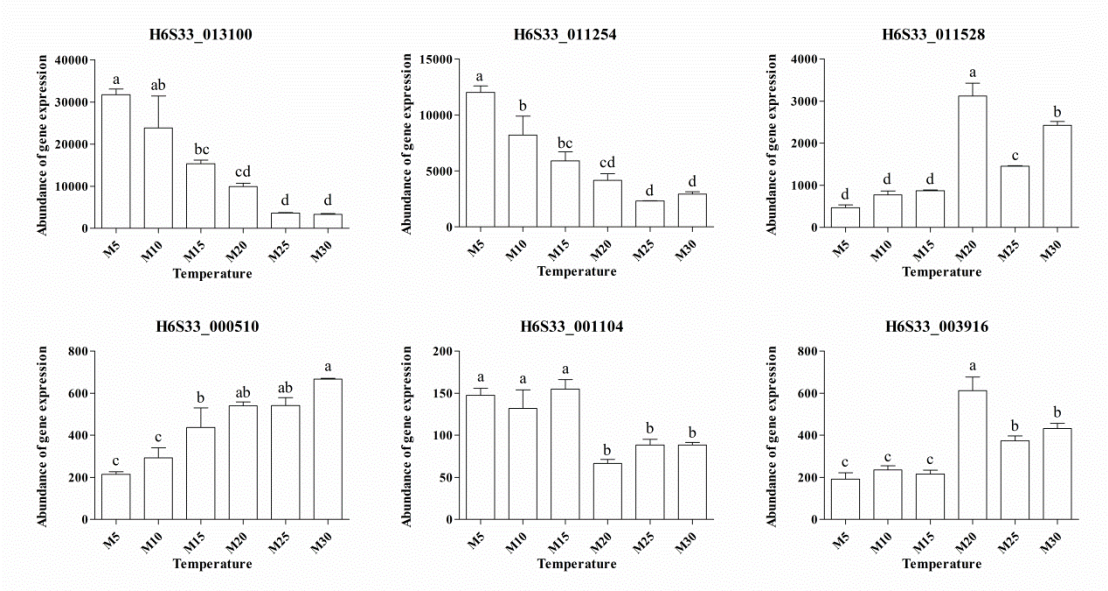


Fig. S4 Analysis of the ubiquitin-proteasome system gene expression in *Morchella* mycelia under different temperature treatments. Different lowercase letters indicate a significant difference between different temperatures ($p < 0.5$).