

TABLE S1. The primers used in this study

Application purpose	Primer name	Oligonucleotide sequence (5'→3')	Reference
PCR and sequence for <i>rpoB</i> of <i>Streptomyces</i> spp.	Strp-rpoB890F	CCCGAAGCGCTACGACCTCGC	This study
	Strp-rpoB1440R	GAGGCGAGCGAGCCGATCAGAC	
PCR and sequence for <i>rpoB</i> of <i>A. orientalis</i> and <i>S. erythraea</i>	Sp-rpob887F	GGAGAAGCGCTACGACCTGGCC	This study
	Sp-rpob1480R	CGTCTCGATGAAGCCGAACGGGTTGAC	
Real-time PCR for <i>hrdB</i> of <i>S. griseus</i>	SGR1701 hrdB F	GAAGGTCATCGAGGTCCAGAAG	1
	SGR1701 hrdB R	GTGGCGGAGCTTCGACATC	
Real-time PCR for <i>adpA</i> of <i>S. griseus</i>	adpA-77F	TTGCCGTGCTGCTGTTCA	2
	adpA-130R	AAACGGAGAGCGGGATGGA	
Real-time PCR for <i>metK</i> of <i>S. griseus</i>	metK-F2	CAACCTCGTGCGCAACAA	2
	metK-R2	CACAGGAAGCACCGTCGAA	
Real-time PCR for <i>strR</i> of <i>S. griseus</i>	SGR5931 strR F	AATTATCCGCCGTGACAATGG	1
	SGR5931 strR R	GGATGGGTCTCCAGGACAC	
Real-time PCR for <i>strB1</i> of <i>S. griseus</i>	strB1-F2	ACTACGAGAGCCAGGAGCAGAT	2
	strB1-R2	TGACTCCGAGCTTGGTCAACT	
Real-time PCR for <i>strD</i> of <i>S. griseus</i>	strD-F2	ACCCACACGTCTGCGAAAC	2
	strD-R2	TGGCCTCCAGCCCATAGA	
Real-time PCR for <i>strF</i> of <i>S. griseus</i>	StrF-F2	GACTACGACAAGGTGCACGACTA	2
	StrF-R2	AAGCGGATGTTCTCGATGGT	
Real-time PCR for SGR 281 of <i>S. griseus</i>	281-802F	CGCACGATCTGGAAGAACCT	2
	281-874R	GGTAGTAGAGGCGATCGACGTAGA	
Real-time PCR for SGR 443 of <i>S. griseus</i>	443-643F	GTGCAGTCCCGCGAGATG	2
	443-727R	GGTAGCGCCGTTTCGTTGTC	
Real-time PCR for SGR 593 of <i>S. griseus</i>	593-44F	GTTCTTGCCTGACCTGAATG	2
	593-101R	CGCGAGAGAAGCGGATCA	
Real-time PCR for SGR 604 of <i>S. griseus</i>	604-15F	GCCCTACTACGAACTGCGTCAT	2
	604-78R	GTAGACGTTGCCGACCAGGTT	

Real-time PCR for SGR 811 of <i>S. griseus</i>	811-F825 811-R899	CCTGCCCTACCTGATGTTTCC CAGTTCTGTTCGGTGAACCATTC	2
Real-time PCR for SGR 896 of <i>S. griseus</i>	896-F702 896-R770	GGAGTGCCGCGAGATCTTC TCGAGGACGGCGATGCTT	2
Real-time PCR for SGR 962 of <i>S. griseus</i>	962-551F 962-627R	TCCCCCTCAACATCTACGACTT GCGTTTCGCGGAGACGAT	2
Real-time PCR for SGR 2079 of <i>S. griseus</i>	2079-190F 2079-245R	GCCACACAGGCCCATCTC ACCAGGAAGGCCAGAAAA	2
Real-time PCR for SGR 2488 of <i>S. griseus</i>	2488-501F 2488-582R	GTCCGGCTCGATCGTCAAC GTGCTTGGCCGCGACGTA	2
Real-time PCR for SGR 2594 of <i>S. griseus</i>	2594-825F 2594-889R	CGTCTTCGGCATGGTCATG ATCTGCTCGACGGGTTC	2
Real-time PCR for SGR 3267 of <i>S. griseus</i>	3267-F945 3267-R1007	CGTCGTCACGCTCTGGAA TCCTCAGGACGGTCGAACAC	2
Real-time PCR for SGR 4413 of <i>S. griseus</i>	4413-140F 4413-199R	TCGCCGGGTACTTCTTCATC TGAGGCGCAGCCGTACGT	2
Real-time PCR for SGR 5295 of <i>S. griseus</i>	5295-F189 5295-R253	CAACGACTACCTGGGCATGA GCAGGGTGGAGGCGATCT	2
Real-time PCR for SGR 6072 of <i>S. griseus</i>	6072-F27 6072-R99	CACCGTCCTGGAGTACTTCGA GTCGGTGGCGAACAGCTT	2
Real-time PCR for SGR 6178 of <i>S. griseus</i>	6178-F372 6178-R424	CCGGGCTCCGGTGATC CGTCATCGCCCCTCAGATG	2
Real-time PCR for SGR 6367 of <i>S. griseus</i>	6367-F142 6367-R198	GCGTTCACGTCCGTTTCC GCTGCGGGCGACACA	2
Real-time PCR for SGR 6717 of <i>S. griseus</i>	6717-864F 6717-922R	CGCGCAGTTCATCATGGAA TCATCACGTA CTGGGCATCTC	2
Real-time PCR for SGR 6780 of <i>S. griseus</i>	6780-F381 6780-R457	CGGCGTCTCCGAGCAGAT CGTTGTGGTTGGCGATGAC	2

Real-time PCR for <i>hrdB</i> of <i>S. coelicolor</i>	hrdB-F918 hrdB-R980	GGGCAACCTCGGTCTGATC GAGAACTTGTAGCCCTTGGTGTAGT	3
Real-time PCR for SCO0124 of <i>S. coelicolor</i>	SCO0124-F1132 SCO0124-R1195	GAGGACCCGTCGGCATTG GGGTGAGGTAGGCCGTGAT	3
Real-time PCR for SCO0381 of <i>S. coelicolor</i>	SCO0381-F1280 SCO0381-R1351	GCCCGGACATCCGAAGAC CGCTGCGTCCGCTGATCT	3
Real-time PCR for SCO0489 of <i>S. coelicolor</i>	SCO0489-F3 SCO0489-R66	GAGACCAACCCCTTCGA CTGGCCCTCGTCGTTAC	3
Real-time PCR for SCO1207 of <i>S. coelicolor</i>	SCO1207-F495 SCO1207-R601	CACCGACCGGCACTCCAT CCGAGAAGTAGGCGTTCATCTC	3
Real-time PCR for SCO1268 of <i>S. coelicolor</i>	SCO1268-F544 SCO1268-R609	GTCGGACAGGCGGAGGAA GGGCAGGGAGACGAAACTG	3
Real-time PCR for SCO2785 of <i>S. coelicolor</i>	SCO2785-F819 SCO2785-R889	CCTGGCCCAGCAGTCCAT GGGCAGTCTTACGTAGTGCTT	3
Real-time PCR for SCO3215 of <i>S. coelicolor</i>	SCO3215-F303 SCO3215-R364	CGGACTGGTGC GCAAGGT CGCAGGTGAGGATGTTGAAGT	3
Real-time PCR for SCO5085 (<i>actII-ORF4</i>) of <i>S. coelicolor</i>	actII-ORF4-F17 actII-ORF4-R76	TGGGACGTGTCCATGTAATCA CCTTCGAGGATTTAAGCGGAAT	3
Real-time PCR for SCO5223 of <i>S. coelicolor</i>	SCO5223-F814 SCO5223-R866	CTCACCCCGGGCAGTGAA GCCTGGAGCAACCACATGA	3
Real-time PCR for SCO5800 of <i>S. coelicolor</i>	SCO5800-F1651 SCO5800-R1705	GACGAGCGCTTCGCCTACTA TGCCGATGAGACCGAACA	3
Real-time PCR for SCO5877 (<i>redD</i>) of <i>S. coelicolor</i>	redD-F201 redD-R265	CGGACCCAGCCTGTACAAC T CGATCGATACGGGTCCCAAT	3
Real-time PCR for SCO6283 of <i>S. coelicolor</i>	SCO6283-F312 SCO6283-R406	CACGAGCGAGGCCTTCCT CGAAGTTCTGCGGAACCA	3

Real-time PCR for SCO6430 of <i>S. coelicolor</i>	SCO6430-F458 SCO6430-R579	TGCAGTCCACCCAGATGTTT CCAGACGGTGACCACGTACA	3
Real-time PCR for SCO6766 of <i>S. coelicolor</i>	SCO6766-F35 SCO6766-R91	CTACATACCTGGCCGAACAGAAG CCACGATGAGCGGGAAC	3
Real-time PCR for SCO6826 of <i>S. coelicolor</i>	SCO6826-F772 SCO6826-R827	AGGGTCTGCCACGTGTTCA GGGTCGAGGATGACCTTCAG	3
Real-time PCR for SCO7670 of <i>S. coelicolor</i>	SCO7670-F278 SCO7670-R382	TCGGGCCCTACTGGAACAC CCACGACCGCGAGGTAGTT	3
Real-time PCR for SCO7684 of <i>S. coelicolor</i>	SCO7684-F629 SCO7684-R748	ACACCGAACACCGGTCCTT CGGGATGGACGTTGTACCA	3
Real-time PCR for <i>sigA</i> of <i>S. erythraea</i>	RT- <i>sigA</i> -F RT- <i>sigA</i> -R	CTACCTCAAGCAGATCGGCAAG GATCAGGTCCAGGAACGCCATG	4
Real-time PCR for <i>bldD</i> of <i>S. erythraea</i>	RT- <i>bldD</i> -F RT- <i>bldD</i> -R	GGCGTCGAGCAGAAGTCAGGCG CTCCAGGTTGATCACGACTTTG	4
Real-time PCR for SACE_0020 of <i>S. erythraea</i>	0020-F605 0020-R705	GCGTCTACCGCGCTACT GGGACGCACCAGCGTGAT	This study
Real-time PCR for SACE_1307 of <i>S. erythraea</i>	1307-F112 1307-R171	GAGGAGCTCACCGGTTTCC GGGCACGAACACCTTGATGT	This study
Real-time PCR for SACE_2345 of <i>S. erythraea</i>	2345-F426 2345-R479	CGGCACGGTGGAGTTCCT TTGGCCTCGATCCACTCGTA	This study
Real-time PCR for SACE_2622 of <i>S. erythraea</i>	2622-F336 2622-R391	GCTCGAACCCACCATTTCG GATGCAGGATGCGATCGAT	This study
Real-time PCR for SACE_2631 of <i>S. erythraea</i>	2631-F181 2631-R239	GATGCTCCGCGCTTCAAC CCGTCCATGCTCATCATCGA	This study
Real-time PCR for SACE_2703 of <i>S. erythraea</i>	2703-F166 2703-R225	GCGTTCGCCTGCTCTGAT GGGAACGCGCTGGAAGTACA	This study
Real-time PCR for SACE_2874 of <i>S. erythraea</i>	2874-F979 2874-R1057	CCGCTGCTCGTGGAGAAG GGAACGTGTTGCCGTGCAT	This study

Real-time PCR for SACE_3226 of <i>S. erythraea</i>	3226-F234 3226-R294	GGTGATCCCGAGTTCGT GTAGCCCCCAGGCAGAA	This study
Real-time PCR for SACE_3721 of <i>S. erythraea</i>	3721-F50 3721-R106	GCAGCATCGCCGAGTACTG CGCCGAGCTCCAGTTGA	This study
Real-time PCR for SACE_4130 of <i>S. erythraea</i>	4130-F1077 4130-R1197	GTTTCGCGACCAAGGAAGTTC TTCGAGTAGCCGCAGCAGTT	This study
Real-time PCR for SACE_4302 of <i>S. erythraea</i>	4302-F363 4302-R414	CGCGCTGGACATGTTTCATC CTTCGGCTTGCCGTATGG	This study
Real-time PCR for SACE_4471 of <i>S. erythraea</i>	4471-F382 4471-R463	CTGCTGCTGGACCAGATCCT GGTACCGCACGGACAACGT	This study
Real-time PCR for SACE_4577 of <i>S. erythraea</i>	4577-F40 4577-R161	GGCTACTGGGAAGAGGTCATCCT CCGACGTTTCATCTCGACGAT	This study
Real-time PCR for SACE_4647 of <i>S. erythraea</i>	4647-F334 4647-R427	GGCTACAGCAAGGTTTTCAAGAG CCACCATCGCACCGATCA	This study
Real-time PCR for SACE_5309 of <i>S. erythraea</i>	5309-F424 5309-R482	GACGTACTCGCGGACTTTCATC CCCAACATGTCCACGATCGT	This study

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3. **Tanaka Y, Hosaka T, Ochi K.** 2010. Rare earth elements activate the secondary metabolite-biosynthetic gene clusters in *Streptomyces coelicolor* A3(2). *J. Antibiot. (Tokyo)* **63**:477-481.
4. **Tanaka Y, Komatsu M, Okamoto S, Tokuyama S, Kaji A, Ikeda H, Ochi K.** 2009. Antibiotic overproduction by *rpsL* and *rsmG* mutants of various actinomycetes. *Appl. Environ. Microbiol.* **75**:4919-4922.

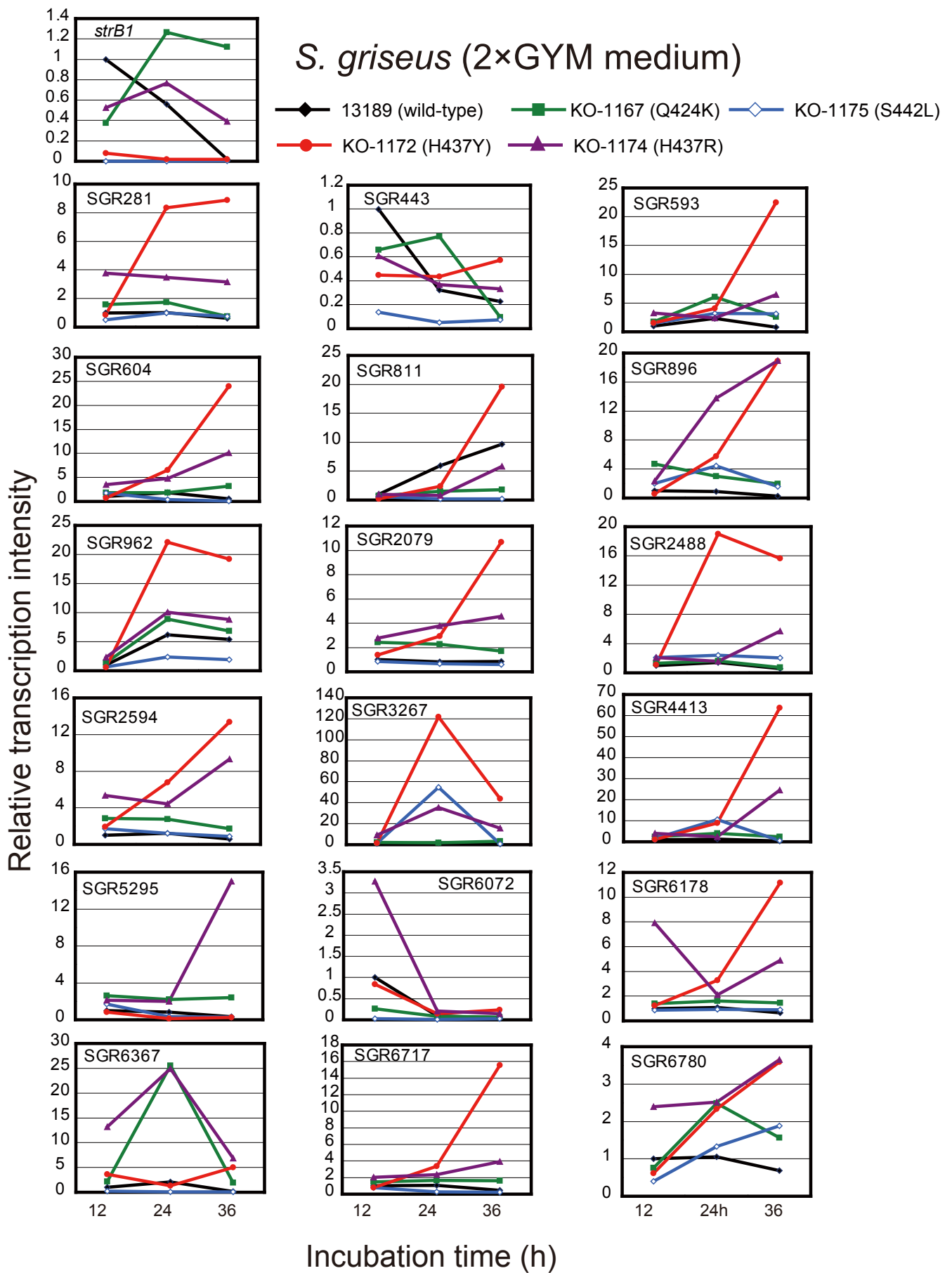


Fig. S1. Profile of changes in expression of secondary metabolite-biosynthetic genes of the *S. griseus* *rpoB* mutants grown in 2×GYM medium

The expression level detected in the wild-type strain IFO13189 at 12 h was taken as unity (= 1). See legend to Fig. 2 for details.

S. griseus (R4 medium)

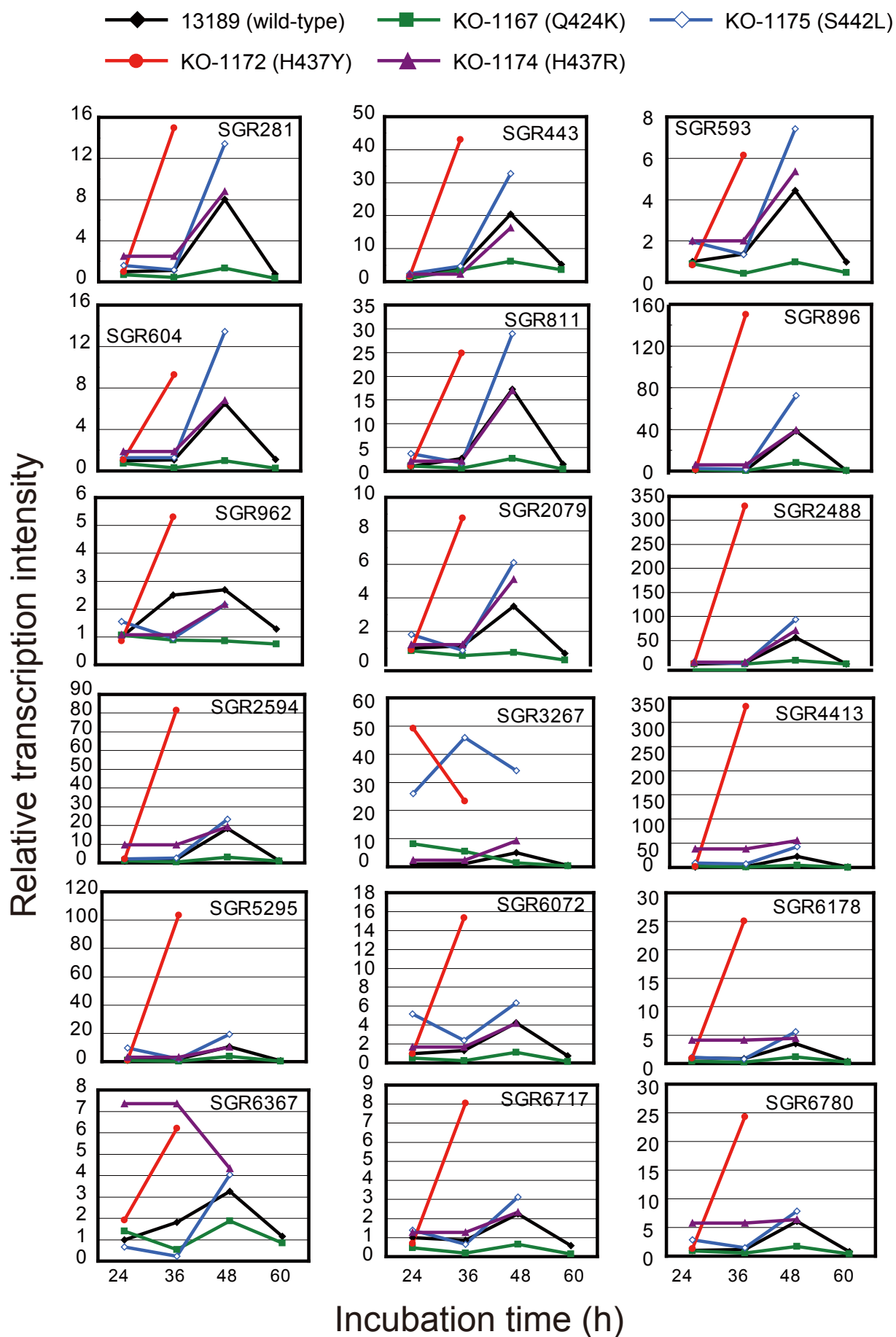


Fig. S2. Profile of changes in expression of secondary metabolite-biosynthetic genes of the *S. griseus* *rpoB* mutants grown in R4 medium

The expression level detected in the wild-type strain IFO13189 at 24 h was taken as unity (= 1). The data for the strain KO-1172 (H437Y) grown in R4 medium for 48 and 60 h are absent because this strain caused extensive autolysis at the late growth phase in R4 medium. See legend to Fig. 2 for details.

S. coelicolor A3(2) (GYM medium)

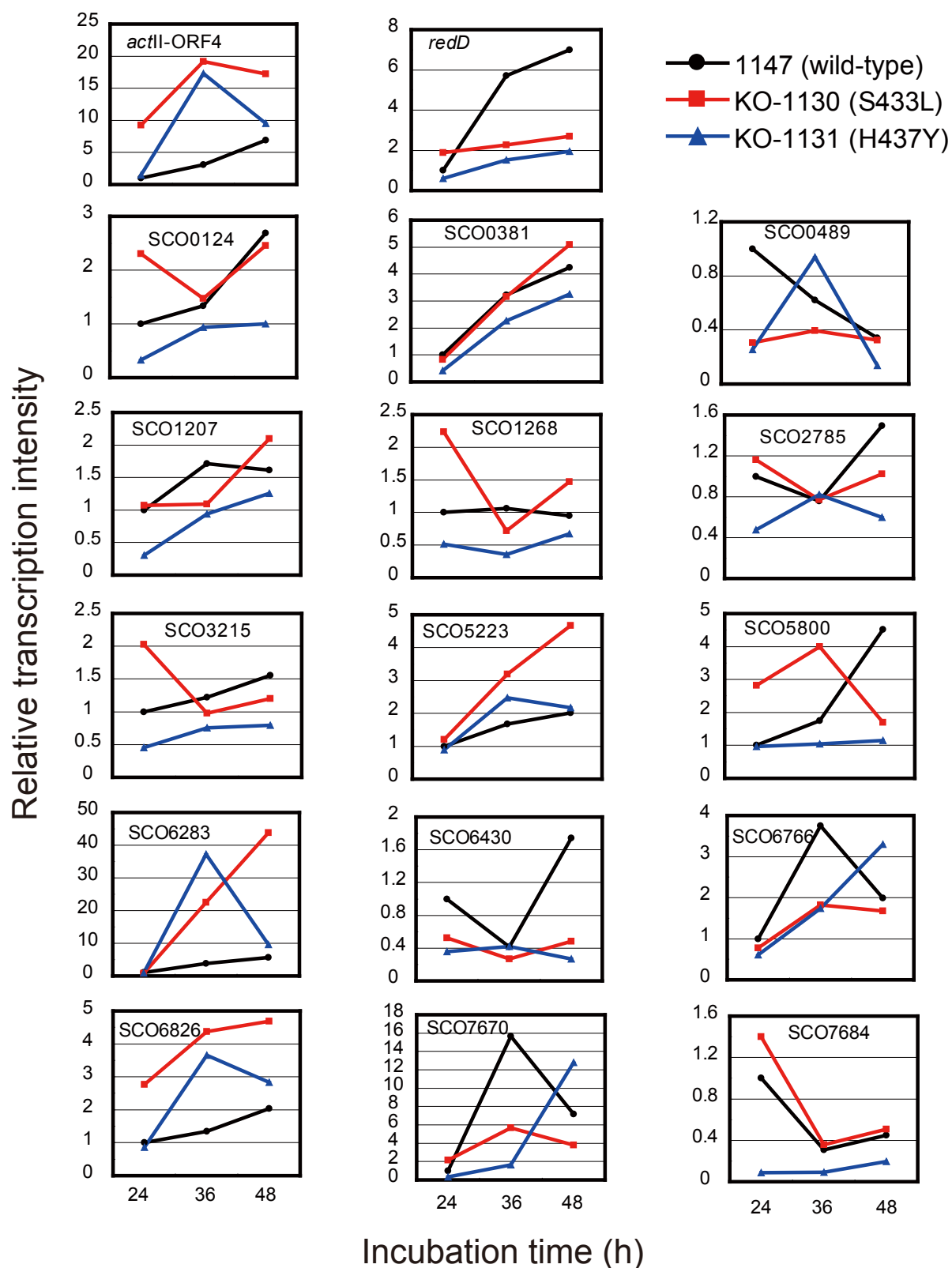


Fig. S3. Profile of changes in expression of secondary metabolite-biosynthetic genes of the *S. coelicolor rpoB* mutants grown in GYM medium

The expression level detected in the wild-type strain 1147 at 24 h was taken as unity (= 1). See legend to Fig. 2 for details.

S. erythraea (2×GYM medium)

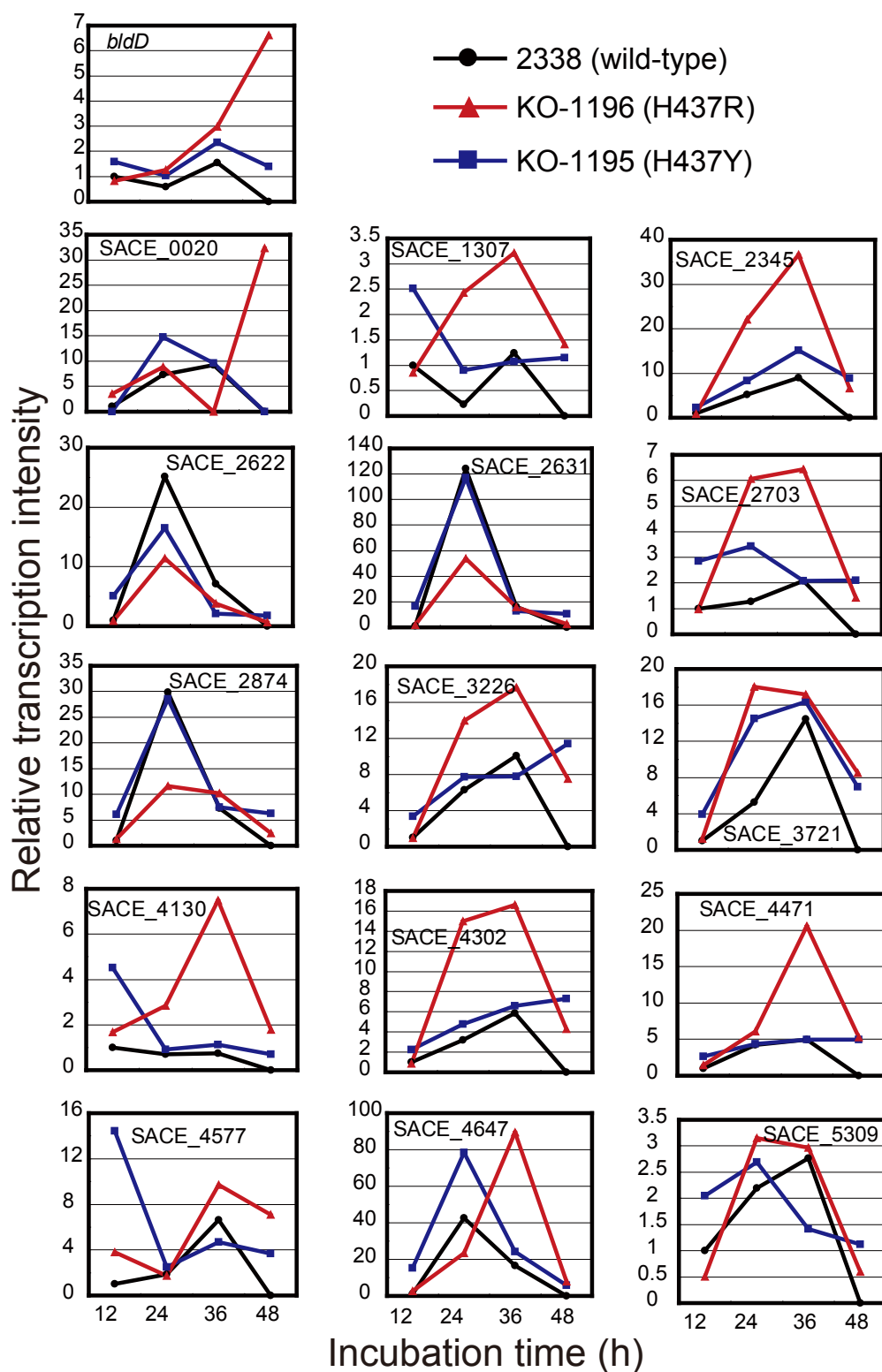
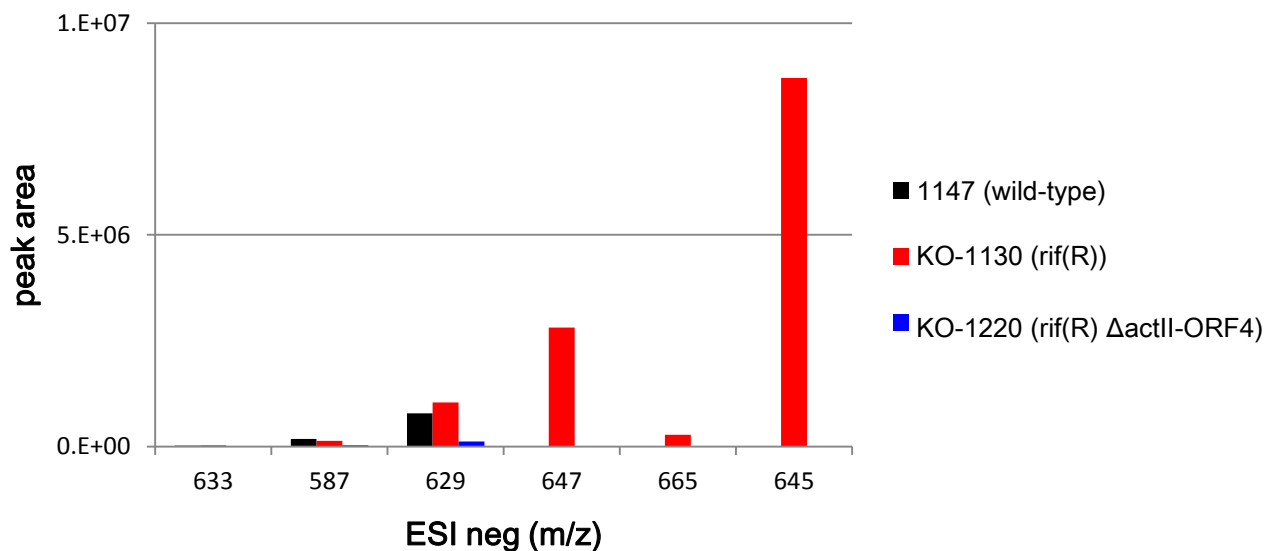


Fig. S4. Profile of changes in expression of secondary metabolite-biosynthetic genes of *S. erythraea* *rpoB* mutants grown in 2×GYM medium

The expression level detected in the wild-type strain NRRL2338 at 12 h was taken as unity (= 1). See legend to Fig. 2 for details.

A



B

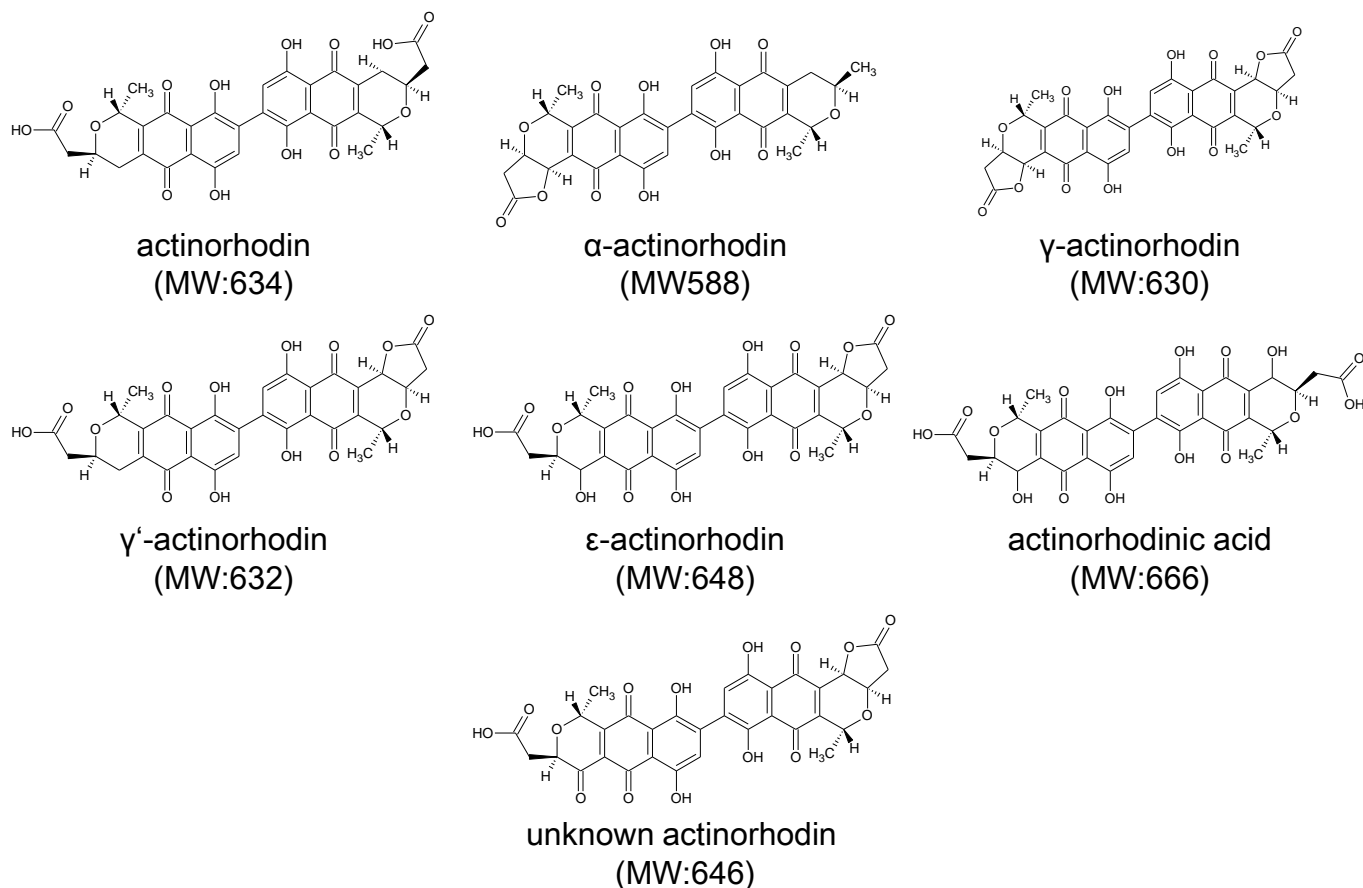


Fig. S5. Actinorhodin-related metabolites produced by the *S. coelicolor* *rpoB* mutant KO-1130 and effects of introducing the Δ actII-ORF4 mutation

(A) UPLC/MS analysis of metabolites produced by *rpoB* mutants. The wild-type strain 1147 and *rpoB* mutant strains KO-1130 (rif(R)) and KO-1220 (rif(R) Δ actII-ORF4) were grown for 4 days as described in the legend to Fig. 3. A double volume of acetonitrile was added to the culture broth and mixed well. The mixture was then centrifuged at $15000 \times g$ for 1 min, and the supernatant was analyzed directly by UPLC/MS.

The analytical conditions were as follows: device, Waters ACQUITY UPLC H-Class; column, Waters ACQUITY UPLC BEH C18, (2.1 × 150 mm); column temperature, 40° C; gradient elution, solvent A (0.1% HCOOH in acetonitrile), solvent B (0.1% HCOOH in deionized water); gradient profile: 0 – 10 min, 10% – 95% A, 90% – 5% B; 10 – 13 min, 95% A, 5% B; 13 – 14 min, 95% – 10% A, 5% – 90% B; flow rate, 0.2 mL/min; detection, m/z 587, 629, 633, 645, 647, 665 using a Waters SQ detector mass spectrometer; ionization mode, ESI negative, capillary voltage, 3.0 kV; source temperature, 120° C; desolvation temperature, 350° C; desolvation gas flow, 600 L/h; cone gas flow, 50 L/h; cone voltage; 60 V.

(B) Chemical structures of actinorhodin and related compounds. The metabolites with m/z of 633, 587, 629, 647, and 665 in (A) were assigned as actinorhodin, α -actinorhodin, γ -actinorhodin, ε -actinorhodin, and actinorhodinic acid, respectively. The possible structure of the metabolite with m/z of 645 is shown as unknown actinorhodin.