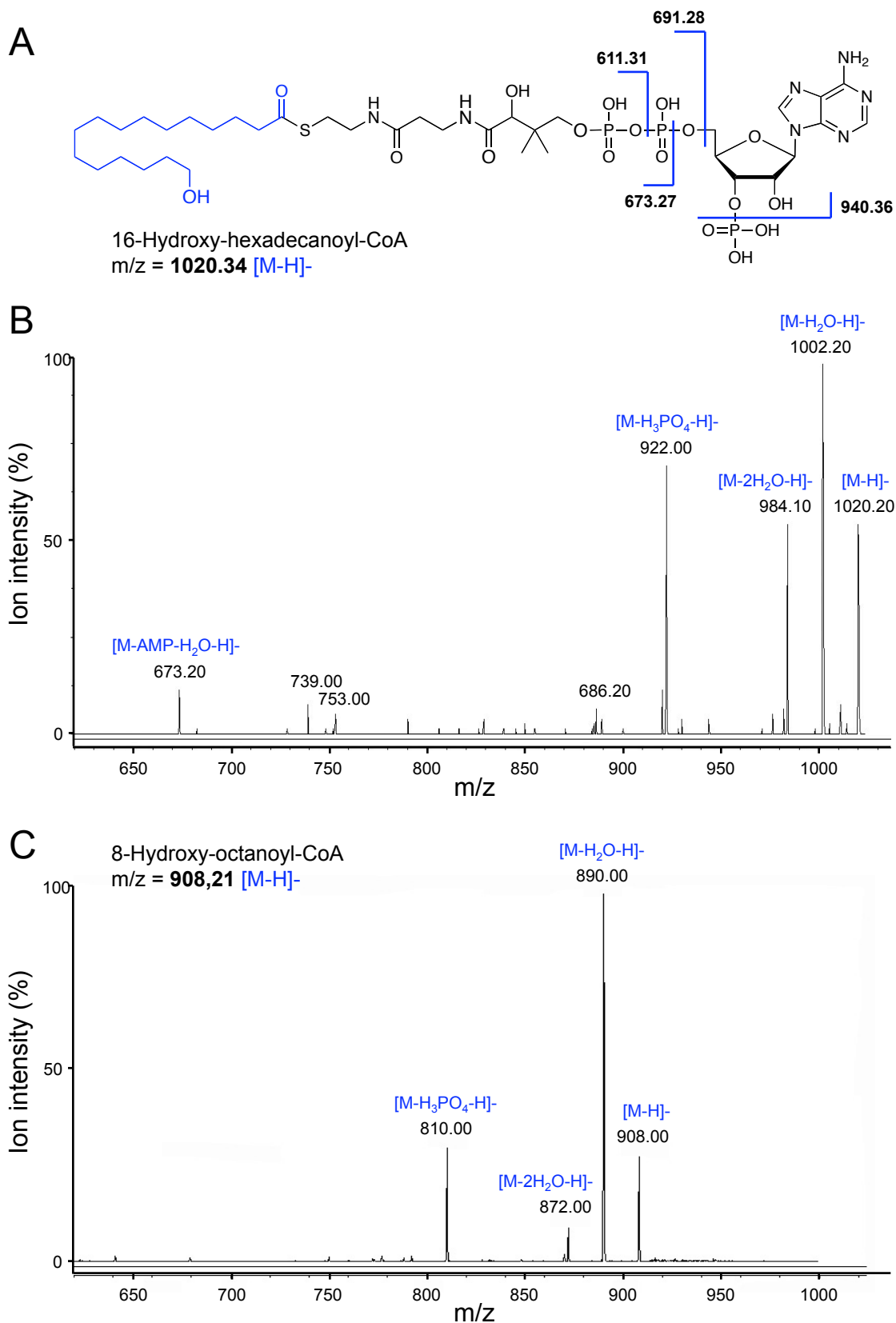


Supplemental Figure 1. Scanning electron micrographs of wild-type (Col-0) and *acos5* mutant anthers. Wild-type (Col-0) anthers and *acos5* anthers with adjacent stigmas are shown. Anther dehiscence occurred normally but no pollen grains could be found in the dehiscent anthers or on the stigma surfaces of mutant plants. Scale bar 100 μm .



Supplemental Figure 2. Mass spectrometric analysis of CoA-esters formed *in vitro* by ACOS5.

(A) Structure of 16-hydroxy-hexadecanoyl-CoA with the cleavage sites and m/z values off the major negative fragmentation ions.

(B) MS-MS spectrum of the singly charged 16OH-C16-CoA ion (m/z 1020,20).

(C) MS-MS spectrum of the singly charged 8OH-C8-CoA ion (m/z 908,00).

For experimental details see Supplemental Table 2 online.

Supplemental Figure 3.

A. Alignments used to generate Figure 1

At 4CL1	1	MAPQ-----	--EQAVSQVM	EKQSNNN--	----SDVIFR	SKLPD---IY
At 4CL2	1	MTTQDVI---	---VNDQ---	N-DQKQCS--	----NDVIFR	SRLPD---IY
At 4CL3	1	---MITAALH	EPQIHKPTDT	S-VVSDDVLP	HSPPTPRIFR	SKLPD---ID
At 4CL4	1	MVLQQQTHFL	TKKIDQE---	D-EEEEPS--	----HDFIFR	SKLPD---IF
Pp 4CL1	1	MEPVHA----	-----	-----EV--	----HDFIYR	SKLPD---ID
Pp 4CL2	1	MES-----	-----	-----EV--	----CDFIYR	SKLPD---ID
Pp 4CL3	1	-----	-----M	K-MKTAQA--	----EEFIYR	SKLPD---ID
Pp 4CL4	1	-----	-----M	E-AFKEKV--	-----	SKLPD---IY
Poptr 4CL1	1	-----	-----M	E-AKNDQA--	----QEFIFR	SKLPD---IH
Poptr 4CL2	1	-----	-----M	E-ANKDQV--	----QEFIFR	SKLPD---IY
Poptr 4CL3	1	MMSVATVEPP	KPELSPPQNQ	N-APSSHE--	----TDHIFR	SKLPD---IT
Poptr 4CL4	1	-----	-----M	D-TITKQK--	----EEFIFR	SKLPD---ID
Poptr 4CL5	1	-----	-----M	D-AIMNSQ--	----EEFIFR	SKLPD---IY
Os 4CL1	1	MGSMEQQQPE	-----SA-	A-PATEAS--	----PEIIFR	SKLQD---IA
Os 4CL2	1	---MITVAAP	EAQPQVAAA-	V-DEAPPE--	----AVTVFR	SKLPD---ID
Os 4CL5	1	MG-----	-----	-----SLP--	----EQFVFR	SRLPD---IA
Os 4CL3	1	MGSV-----	-----AA--	-----E--	----EVVVFR	SKLPD---IE
Os 4CL4	1	MGSM-----	-----AAA-	A-EAAQEE--	----ETVVFR	SKLPD---IE
Os ACOS9	1	MGDAAVPAMV	V-----	----EEEE--	----QEHVFR	SRFPP---VA
N.sylvestris	1	MGT-----R	-----AV-	E-SSQQQE--	----CEHIFR	SRYPP---VQ
Poptr ACOS13	1	MGTPI-----	-----	---PCSAQ--	----EEHIFR	SRHPA---VL
At ACOS5	1	-----	-----M	E-SQKQED--	----NEYIFR	SLYPS---VP
Pp ACOS6	1	MDPSGVDESI	STELIPSPVI	DGLTSPQE--	----QDHIFR	STLPLNPIVV
At 4CL1	34	IPNHLSLHDY	IFQNISEF--	--ATKPLIN	GPTGH-VYTY	SDVHVISRQI
At 4CL2	32	IPNHLPLHDY	IFENISEF--	--AAKPLIN	GPTGE-VYTY	ADVHVTSRKL
At 4CL3	44	IPNHLPLHTY	CFEKLSSV--	--SDKPLIV	GSTGK-SYTY	GETHLICRRV
At 4CL4	38	IPNHLPLTDY	VFQRFSGDGD	GDSSTTCIID	GATGR-ILTY	ADVQTNMRRV
Pp 4CL1	22	IPNHMPLADY	CLEKSSQW--	--PDKVCLID	GVTGR-EHRY	GEIELSSRRV
Pp 4CL2	19	IPNHMPLSDY	CLEKAAQW--	--PDKVCLID	GVTGR-EHTY	GEIELSTRRV
Pp 4CL3	22	IPNHMPLADY	CLEKAAQW--	--PENVCLID	GNTGR-KHTY	GEIEVSMRRV
Pp 4CL4	16	ISNHMPLTDY	CLEKVTQW--	--PDKVCLID	GNTGR-EYSY	GEMELTSRRV
Poptr 4CL1	22	IPNHLPLHTY	CFENLSRF--	--KDNPLIN	GPTGE-IHTY	AVELTSRKY
Poptr 4CL2	22	IPNHLPLHTY	CFEKLTSQF--	--KDNPLIN	GPTGD-IYTY	ADVELTSRKY
Poptr 4CL3	41	ISNHLPLHAY	CFENLSDF--	--SDRPLIS	GSTGK-TYSF	AETHLISRKY
Poptr 4CL4	22	IPKGLPLHSY	VFENFSKY--	--PSKPLIN	GANGD-VYTY	ADVELTARRA
Poptr 4CL5	22	IPKNLPLHSY	VLENLSKY--	--SSKPLIN	GANGD-VCTY	ADVELTARRV
Os 4CL1	33	ITNTLPLHRY	CFERLPEV--	--AARPCLID	GATGG-VLTY	ADVDRLSRRL
Os 4CL2	37	IPSHLPLHEY	CFARAAEL--	--PDAPCLIA	AATGR-TYTF	AETRLLCRRA
Os 4CL5	19	IPDHLPLHDY	VFERLADR--	--RDRACLID	GATGE-TLSF	GDVDALSRRV
Os 4CL3	21	IDNSMTLQEY	CFARMAEV--	--GARPCLID	GQTGE-SYTY	AEVESASRRA
Os 4CL4	28	IPSHLTLQAY	CFEKLPEV--	--AARPCLID	GQTGA-VYSY	GEVEELSRRV
Os ACOS9	29	VPDGVTVPEF	VLDGAEAY--	--ADRVALVE	AAAGGRSYTY	GEVARDTARF
N.sylvestris CL-1k	27	VPDNVTLPDF	VLHNVELY--	--TDKMAFVD	ATTGK-GYTY	GQVARDIRRF
Poptr ACOS13	24	VP-DITLPDF	VLQDAELY--	--ADKVAFVE	AATGK-TFTY	AEVVRDTRRF
At ACOS5	22	IPDKLTLPEF	VLQGVVEEY--	--TENVAFVE	AVTGM-AVTY	GDVVRDTKRL
Pp ACOS6	45	PPKGLTLHG	VLDNIEDY--	--LHRIALID	SSNGR-HYTY	GQVQLLTKNI

At 4CL1	79	AANF-HK--L	GVNQNDVVML	LLPNCPEFVL	SFLAASFRGA	TATAANPFFT
At 4CL2	77	AAGL-HN--L	GVKQHDVVM	LLPNSPEVVL	TFLAASFIGA	ITTSANPFFT
At 4CL3	89	ASGL-YK--L	GIRKGDVIMI	LLQNSAEFV	SFMGASMIGA	VSTTANPFYT
At 4CL4	87	AAGI-HR--L	GIRHGDVVML	LLPNSPEFAL	SFLAVAYLGA	VSTTANPFYT
Pp 4CL1	67	AAGL-DK--I	GVKQGDVIAL	LLPNCAEFVL	VFLGAAKRG	VVTTANPFYT
Pp 4CL2	64	AAGL-FK--I	GVKQGDVIAL	LLPNCAEFVQ	VFLGAAKMG	IVTTANPFYT
Pp 4CL3	67	AAGL-AN--I	GVKQGDVIAL	LLPNCAEFVQ	VFLGAAKRG	VITTTANPFYT
Pp 4CL4	61	AAGL-AK--I	GVEQGGVIAL	LLPNCAEFVQ	VFLGAAKRG	IVTTANPFYT
Poptr 4CL1	67	ASGL-NK--L	GIKQGDVILL	LLQNSPEFV	AFLGASIIGA	ISTTTANPFYT
Poptr 4CL2	67	ASGL-YK--L	GLQQGDVILL	LLQNSPEFV	AFLGASFIGA	ISSTANPFYT
Poptr 4CL3	86	AAGL-SN--L	GIRKGDVIMT	LLQNCPEFV	SFMGASMIGA	VTTTANPFYT
Poptr 4CL4	67	ASGL-NK--L	GIQQGDVIML	ILPSSPEFV	AFLGASHRGA	ITTTANPFST
Poptr 4CL5	67	ASGL-NK--I	GIQQGDVIML	FLPSSPEFV	AFLGASHRGA	IVTTANPFST
Os 4CL1	78	AAAL-RRAPL	GLRRGGVMS	LLRNSPEFV	SFFAASRVGA	AVTTANPMST
Os 4CL2	82	AAAL-HR--L	GVGHGDRVM	LLQNCVEFV	AFFAASFLGA	VTTANPFCT
Os 4CL5	64	AAGL-SS--I	GVCHGSTVML	LLPNSVEFV	AFLASSRLGA	VTTTANPLHT
Os 4CL3	66	AAGL-RR--M	GVGKGDVMS	LLRNCPEFV	SFLGAARLGA	ATTTANPFYT
Os 4CL4	73	AAGL-RR--L	GVGKGDVMS	LLRNCPEFV	TFLGAARLGA	ATTTANPFYT
Os ACOS9	75	ARAL-RS--V	GVRKGHVVV	ALPNLAVYP	VSLGIMSAGA	VFSGVNPRL
N.sylvestris CL-lk	72	AKAL-RS--L	GLRKGRRVV	VLPNVPEYAI	VALGIMAAGG	VFSGANPAAH
Poptr ACOS13	68	AKAL-RS--L	GLRKGRRVV	ALPNVAEYGI	VALGIMAAGG	VFSGANPTAH
At ACOS5	67	AKAL-TS--L	GLRKGQVMV	VLPNVAEYGI	IALGIMSAGG	VFSGANPTAL
Pp ACOS6	90	QAGLWNQ--F	GIRKGDVVIV	LLPNIAEYFI	FVLGIISIGA	IYSGSNPAAH

At 4CL1	126	PAEIAKQAKA	SNTKLIITEA	RYVDKIKP--	-----	LQ-----
At 4CL2	124	PAEISKQAKA	SAAKLIVTQS	RYVDKIKN--	-----	LQ-----
At 4CL3	136	SQELYKQLKS	SGAKLIITHS	QYVDKLN--	-----	LG-----
At 4CL4	134	QPEIAKQAKA	SAAKMIITKK	CLVDKLTN--	-----	LK-----
Pp 4CL1	114	AAELEKQIEA	SGAGIVITQS	SYIEKLAG--	-----	LN-----
Pp 4CL2	111	SAELEKQTIA	SGAGIVVTHS	SYIEKLAG--	-----	LNVQVPTTSH
Pp 4CL3	114	SAELRKQILA	SGTTMVTQS	SYVEKLEG--	-----	LI-----
Pp 4CL4	108	STELAKQIIA	SGATVVVTQS	RYIEKLAG--	-----	LN-----
Poptr 4CL1	114	PAEVAKQATA	SKAKLIITQA	VYAEKVQEFV	K-----EN	VH-----
Poptr 4CL2	114	SAEIAKQATA	SKAKLIITHA	AYAELVQQFA	Q-----EN	DH-----
Poptr 4CL3	133	PGEIFKQFSA	SRAKLIITQS	QHVNKLKRDSD	CHENNQKPEE	D-----
Poptr 4CL4	114	PAELAKQAKA	SKAKLLITQA	CYYDKVKDYA	Q-----QN	D-----
Poptr 4CL5	114	PAELAKHAKA	SRAKLLITQA	CYYDKVKDFA	R-----ES	D-----
Os 4CL1	127	PHEIESQLAA	AGATVVITES	MAADKLPS--	-----	HS-----
Os 4CL2	129	PQEIHKQFKG	SGVKLILTQS	VYVDKLRQ--	-----	HE-----
Os 4CL5	111	PPEIAKQVAA	SGATVVVTEP	AFVAKVSG--	-----	LA-----
Os 4CL3	113	PHEVHRQAEA	AGARVIVTEA	CAVEKVREFA	A-----ER	G-----
Os 4CL4	120	PHEIHRQASA	AGARVIVTEA	CAVEKVRG--	-----	FA-----
Os ACOS9	122	AAEIKKQVED	SEAKLVVANE	VAFDKVKD--	-----	AG-----
N.sylvestris CL-lk	119	SSEIVKQVES	ADGKLIVSDL	PTYHKVKD--	-----	CG-----
Poptr ACOS13	115	ESELKKQAEA	ADAKLIVTND	LNYGKVKG--	-----	LG-----
At ACOS5	114	VSEIKKQVEA	SGARGIITDA	TNYEKVKS--	-----	LG-----
Pp ACOS6	138	ESEIQRQAEN	SGAKLVITDL	KTYKKVEA--	-----	LG-----

At 4CL1	156	-NDDGVVIVC	ID-DNESV--	-----P--IP	-----EGC	LR-FTE-LTQ
At 4CL2	154	-ND----GVL	IV-T-T----	----DSDAIP	-----ENC	LR-FSE-LTQ
At 4CL3	166	-EN----LTL	IT-T-D----	----EP--TP	-----ENC	LP-FST-LIT
At 4CL4	164	-ND----GVL	IV-C-L----	----DDDGDN	GVVSSSDGDC	VS-FTE-LTQ
Pp 4CL1	144	-VQ----IIT	VD-Q-H----	-----V	-----ANC	MH-ISV-LLN
Pp 4CL2	149	pVS----IIT	VD-Q-H----	-----V	-----DKC	MH-ISM-LLE
Pp 4CL3	144	-VQ----IVT	VD-Q-H----	-----V	-----DGC	LH-ISA-LLE
Pp 4CL4	138	-IQ----IIV	VD-Q-Y----	-----V	-----DGY	LH-VSA-LLE
Poptr 4CL1	149	-VK----IVT	VD-S-P----	-----P	-----ENY	LH-FSE-LTN
Poptr 4CL2	149	-VK----IMT	ID-S-L----	-----T	-----ENC	LH-FSE-LTS
Poptr 4CL3	174	-FI----VIT	ID-D-P----	-----P	-----ENC	LH-FNV-LVE
Poptr 4CL4	148	-VK----VMC	VD-S-A----	-----P	-----DVC	LH-FSE-LTQ
Poptr 4CL5	148	-VK----VMC	VD-S-A----	-----P	-----DGC	LH-FSE-LTQ
Os 4CL1	157	-HG----ALT	VV-L-I----	----DERR--	-----DGC	LH-FWD-DLM
Os 4CL2	159	-AFPRIDACT	VG-D-DTLTV	ITIDDDEATP	-----KAC	LP-FWDIAD
Os 4CL5	141	-GV----TVV	ATGG-G----	-----A	-----ERC	AS-FAG-LAA
Os 4CL3	147	-VP----VVT	VD-G-A----	-----F	-----DGC	VE-FRE-VLA
Os 4CL4	150	-ADRGIPVVA	VD-G-D----	-----F	-----DGC	VG-FGE-AML
Os ACOS9	152	-VP----VIG	VG-DRER---	-----M	-----PGA	IS-WDG-LLA
N.sylvestris CL-lk	149	-LP----VII	LG-E-EH---	-----V	-----EGT	IH-WDE-LLE
Poptr ACOS13	145	-LP----VIV	LG-E-VC---	-----I	-----STA	VN-WNE-LLD
At ACOS5	144	-LP----VIV	LG-E-EK---	-----I	-----EGA	VN-WKD-LLE
Pp ACOS6	168	-LP----VVV	MG-E-D----	-----V	-----SDG	SYCYLS-LFE

At 4CL1	186	STTEASEV-I	--D-----S	---VE-----	ISP-DDVVAL	PYSSGTTGLP
At 4CL2	180	SEE----PRV	-----D	SIPEK-----	ISP-EDVVAL	PFSSGTTGLP
At 4CL3	190	DDE----TNP	FQE-----T	---VD-----	IGG-DDAAAL	PFSSGTTGLP
At 4CL4	197	ADE----TEL	--L-----K	---PK-----	ISP-EDTVAM	PYSSGTTGLP
Pp 4CL1	165	ACE----DEC	--P-----Q	---VR-----	IHP-DDLVCL	PYSSGTTGLP
Pp 4CL2	171	PNE----AEC	--P-----Q	---VE-----	IHP-DDVVCL	PYSSGTTGLP
Pp 4CL3	165	ADE----AEC	--P-----Q	---VE-----	IHP-DDVVCL	PYSSGTTGLP
Pp 4CL4	159	ADE----AEC	--P-----E	---VD-----	IHP-DDVVCL	PYSSGTTGLP
Poptr 4CL1	170	SDE----DDI	--P-----A	---VE-----	INP-DDVVAL	PYSSGTTGLP
Poptr 4CL2	170	SDE----NEI	--P-----T	---VK-----	IKP-DDIMAL	PYSSGTTGLP
Poptr 4CL3	195	ANE----SEM	--P-----T	---VS-----	IHP-DDPVAL	PFSSGTTGLP
Poptr 4CL4	169	ADD----NDM	--P-----Q	---VD-----	IRP-DDVVAL	PYSSGTTGLP
Poptr 4CL5	169	ADE----NEV	--P-----Q	---VD-----	FSP-DDVVAL	PYSSGTTGLP
Os 4CL1	181	SEDEASPL--	--A-----G	---DEDDEKV	FDP-DDVVAL	PYSSGTTGLP
Os 4CL2	198	ADE----GSV	--P-----E	---VA-----	ISP-DDPVAL	PFSSGTTGLA
Os 4CL5	163	ADG----SAL	--P-----E	---VA-----	IDvaNDAVAL	PYSSGTTGLP
Os 4CL3	168	AEE----LDA	-----D	---AD-----	VHP-DDVVAL	PYSSGTTGLP
Os 4CL4	175	DASIEPL-DA	-----D	---EE-----	VHP-DDVVAL	PYSSGTTGLP
Os ACOS9	175	AADRTGAGVV	--P-----V	---DA-----	AQQ-SDLCAL	PYSSGTTGVS
N.sylvestris CL-lk	171	AAERAGSR-T	--DHITNHED	---EM-----	VQQ-NDLCAL	PFSSGTTGLS
Poptr ACOS13	167	AADRAGDTLA	Y-----	---EE-----	VLQ-SDLCAL	PFSSGTTGMS
At ACOS5	166	AGDKCGDT--	--D-----N	---EE-----	ILQ-TDLCAL	PFSSGTTGLQ
Pp ACOS6	190	ADG----SQA	--P-----T	---VD-----	ISE-HDVCAL	PYSSGTTGVS

At 4CL1	218	KGVMLTHKGL	VTSVAQQVDG	ENPNLYFH--	--SDDVILCV	LPMFHIYALN
At 4CL2	211	KGVMLTHKGL	VTSVAQQVDG	ENPNLYFN--	--RDDVILCV	LPMFHIYALN
At 4CL3	221	KGVLTHKSL	ITSVAQQVDG	DNPPLYLK--	--SNDVILCV	LPLFHIYSLN
At 4CL4	226	KGVMITHKGL	VTSIAQKVDG	ENPNLNFT--	--ANDVILCF	LPMFHIYALD
Pp 4CL1	194	KGVMLTHKSL	VSSVSQQVDG	EAPNFNIT--	--VEDTLMCV	LPMFHIYSLN
Pp 4CL2	200	KGVMLTHKSL	VSSVSQQVDG	DSPNFNIT--	--VEDTLMCV	LPMFHIYSLN
Pp 4CL3	194	KGVMLTHKGL	VSSVSQQVDG	EVPNFNIT--	--VEDTMMCV	LPMFHIYSLN
Pp 4CL4	188	KGVMLTHKSL	VTSVAQQVDG	EVPHFNIN--	--VEDTLMCV	LPMFHIYSLN
Poptr 4CL1	199	KGVMLTHKGL	VTSVAQQVDG	ENPNLYFH--	--EKDVILCV	LPLFHIYSLN
Poptr 4CL2	199	KGVMLTHKGL	VTSVAQQVDG	ENPNLYFH--	--ERDVILCV	LPLFHIYSLN
Poptr 4CL3	224	KGVLTHKSL	ITSVAQQVDG	EIPNLYLK--	--QDDVLCV	LPLFHIFSLN
Poptr 4CL4	198	KGVMLTHKGL	ITSVAQQVDG	DNPPLYFH--	--SEDVILCV	LPMFHIYALN
Poptr 4CL5	198	KGVMLTHKGL	ITSVAQQVDG	DNPPLYFH--	--SEDVILCV	LPMFHIYALN
Os 4CL1	217	KGVMLTHRSL	STSVAQQVDG	ENPNIGLH--	--AGDVILCA	LPMFHIYSLN
Os 4CL2	227	KGVLTHRSV	VSGVAHEVDG	ENPNLHMG--	--AGDVALCV	LPLFHIFSLN
Os 4CL5	193	KGVMSHRGL	VTSVAQLVDG	ENPNLHLR--	--EDDVLCV	LPMFHVYSLH
Os 4CL3	196	KGVMLTHRSL	ITSVAQQVDG	ENPNLYFS--	--KDDVILCL	LPLFHIYSLN
Os 4CL4	206	KGVMLTHRSL	VTSVAQQVDG	ENPNLYFR--	--REDVVLCL	LPLFHIYSLN
Os ACOS9	208	KGVMSHRNL	VSNLCSSMFA	VAPETA----	--GQVVTGL	MPFFHIYGIT
N.sylvestris CL-1k	209	KGVMLTHRNL	VANLCSTLFS	VSPEMV----	--GQVTTGL	IPFFHIYGIT
Poptr ACOS13	199	KGVMLTHRNL	VANLCSSLFS	VGPEMV----	--GQVATGL	IPFFHIYGIT
At ACOS5	197	KGVMLTHRNL	IANLCSTLFG	VrsEMI----	--GQIVTGL	IPFFHIYGIV
Pp ACOS6	219	KGVMITHRNI	VANLNQTLAD	IERAYRGGVI	PDESIVLGL	MPFFHIYGIC
At 4CL1	264	SIMLCGLRVG	AAILIMPKFE	INLLELIQR	CKVTVAPMVP	PIVLAIKSS
At 4CL2	257	SIMLCSLRVG	ATILIMPKFE	ITLLELIQR	CKVTVAMVVP	PIVLAIKSP
At 4CL3	267	SVLLNSLRSG	ATVLLMHKFE	IGALLDLIQR	HRVTIAALVP	PLVIALAKNP
At 4CL4	272	ALMLSAMRTG	AALLIVPRFE	LNLVMEIQR	YKVTVPVAP	PVVLAFIKSP
Pp 4CL1	240	SILLCGLRVG	ATLVIMPKFE	LPKLLDLIQR	HKVTMGPFVP	PIVLAIKNP
Pp 4CL2	246	SILLCGLRVG	ATLVIMPKFE	LSKMELIQK	HKVTMGPFVP	PIVLAIKNP
Pp 4CL3	240	SILLCGLRVG	AALVMSKFE	LPKLLDLIQR	YKVTVPFVP	PIVLAIKNP
Pp 4CL4	234	SILLCGLRAG	ATLVIMAKFE	LSKLEFIQK	YKVTMGPFVP	PIMLAIKNP
Poptr 4CL1	245	SVLLCGLRVG	SAILLMQKFE	IVTLMELVQK	YKVTIAPFVP	PVVLAVAKCP
Poptr 4CL2	245	SVFLCGLRAG	SAILVMQKFD	TVSLMDLVQK	YKVTIAPLVP	PICLAIKSP
Poptr 4CL3	270	SVLLCSLRAG	SAVLLMQKFE	IGSLELIQK	HNVSVAAVVP	PLVLALAKNP
Poptr 4CL4	244	SIMLCGLRVG	AAILIMPKFE	IGSLLGLIEK	YKVTIAPVVP	PVMVAIAKSP
Poptr 4CL5	244	SIMLCGLRVG	ASILIMPKFD	IGTLLGLIEK	YKVTIAPVVP	PVMLAIKSP
Os 4CL1	263	TIMMCGLRVG	AAIVVMRRFD	LAAMMDLVER	HRVTIAPLVP	PIVVAVAKSE
Os 4CL2	273	SVLLSRVRPA	PAVALMPRFE	MGAMLGAIER	WRVTVGAVVP	PLVVALAKNP
Os 4CL5	239	SILLCGMRAG	AAIVVMKRFD	TVKMLQLVER	HGVTIAPLVP	PIVVEMAKSD
Os 4CL3	242	SVLLAGLRAG	STIVIMRKFD	LGALVDLVRK	HNITIAPFVP	PIVVEIAKSP
Os 4CL4	252	SVLLAGLRAG	SAIVIMRKFD	LGALVDLTRR	HGVTVPFVP	PIVVEIAKSP
Os ACOS9	252	GICCATLRHK	GTVVMDRFD	LRTFLRALVD	HRVMFAPLVP	PVMLAMVKSP
N.sylvestris CL-1k	253	GICCATIRNK	GKVVLRRYE	LRAFLNALIT	HEVTFAPIVP	PIILALVKNP
Poptr ACOS13	243	GICCATLRNK	GKVVMGRFE	LRTFLNALIT	QEVSFAPIVP	PIILALVKNP
At ACOS5	241	GICCATMKNK	GKVVAMSRYD	LRIFLNALIA	HEVSFAPIVP	PIILNLVKNP
Pp ACOS6	269	GICCAAMRLK	GKVVMARYN	FQEFLDILLK	YEITFAPIVP	PILLQLVKKD

At 4CL1	314	ETEKYDLS--	SIR--VVKSG	AAPLGKELED	AVNAKFPNAK	LGQGYGMTEA
At 4CL2	307	ETEKYDLS--	SVR--MVKSG	AAPLGKELED	AISAKFPNAK	LGQGYGMTEA
At 4CL3	317	TVNSYDLS--	SVR--FVLSG	AAPLGKELQD	SLRRRLPQAI	LGQGYGMTEA
At 4CL4	322	ETERYDLS--	SVR--IMLSG	AATLKKELED	AVRLKFPNAI	FGQGYGMTEA
Pp 4CL1	290	IVENYDLS--	SMR--MVMSG	AAPLGRELED	AFRARLPNAV	LGQGYGMTEA
Pp 4CL2	296	IVENYDLS--	SIK--MVMSG	AAPLGKELED	AFRARLPNAV	LGQGYGMTEA
Pp 4CL3	290	IVDNYDLS--	SIR--MVMSG	AAPLGKELED	AFRARLPNAV	LGQGYGMTEA
Pp 4CL4	284	IVENYDLS--	SIK--MIMSG	AAPLGKELED	AFRARLPNAI	LGQGYGMTEA
Poptr 4CL1	295	VVDKYDLS--	SIR--TVMSG	AAPMGKELED	TVRAKLPNAK	LGQGYGMTEA
Poptr 4CL2	295	VVDQYDLS--	SIR--TVLSG	AAPLGKELED	TVRAKLPNAK	LGQGYGMTEA
Poptr 4CL3	320	MVANFDLS--	SIR--VVLSG	AAPLGKELEE	ALRSRVPQAI	LGQGYGMTEA
Poptr 4CL4	294	DLDKHDLS--	SLR--MLKSG	GSPLGKELED	TVRARFPQAR	LGQGYGMTEA
Poptr 4CL5	294	DFDKHDLS--	SLR--MIKSG	GAPLGKELED	TVRAKFPQAR	LGQGYGMTEA
Os 4CL1	313	AAAARDLS--	SVR--MVLSG	AAPMGKDIED	AFMAKLPNAV	LGQGYGMTEA
Os 4CL2	323	FVERHDLS--	SIR--IVLSG	AAPLGKELED	ALRARLPQAI	FGQGYGMTEA
Os 4CL5	289	ALDRHDLS--	SIR--MVISG	AAPMGKELQD	IVHAKLPNAV	LGQGYGMTEA
Os 4CL3	292	RVTAECLA--	SIR--MVMSG	AAPMGKDLQD	AFMAKIPNAV	LGQGYGMTEA
Os 4CL4	302	RVTADDLA--	SIR--MVMSG	AAPMGKDLQD	AFMAKIPNAV	LGQGYGMTEA
Os ACOS9	302	VADEFDLSL	ALK--SVMTA	AAPLAPDLLA	AFQRKFPGVQ	VEEAYGLTEH
N.sylvestris CL-lk	303	IVDEFDLSKL	KLR--SIMTA	AAPLAPEILN	EFEKKFPDVQ	VQEAYGMTEH
Poptr ACOS13	293	IVEEFDLSKL	KLK--AIMTA	AAPLAPELLT	AFENKFPGVQ	VQEAYGLTEH
At ACOS5	291	IVDEFDLS--	KLKLSVMTA	AAPLAPELLT	AFEAKFPNVQ	VQEAYGLTEH
Pp ACOS6	319	LGENFDRSKL	KLK--SILTA	AAPLGIELQR	AFEAKFPGVE	VQQAAYGLTEY
At 4CL1	360	GPVLAMSLGF	AKEPF-PV-K	SGACGTVVRN	AEMKIVDPDT	GDSL SRNQPG
At 4CL2	353	GPVLAMSLGF	AKEPF-PV-K	SGACGTVVRN	AEMKILDPDT	GDSL PRNKPG
At 4CL3	363	GPVLSMSLGF	AKEPI-PT-K	SGSCGTVVRN	AELKVVHLET	RLSLGYNQPG
At 4CL4	368	GTVAK-SLAF	AKNPF-KT-K	SGACGTVIRN	AEMKVVDTET	GISL PRNKSG
Pp 4CL1	336	GPVLAMCLAF	AKTPF-SV-K	PGSCGTVVRN	AEVKIVDTET	GMSLPYNQPG
Pp 4CL2	342	GPVLAMCLAF	AKSPF-PV-K	PGSCGTVVRN	AEVKIVDTET	GMSLPYNQPG
Pp 4CL3	336	GPVLAMCLAF	AKTPF-PV-K	PGSCGTVVRN	AEVKIVDTET	GMSLPYNQPG
Pp 4CL4	330	GPVLAMSLAF	AKTPF-PV-K	PGSCGTVVRN	AEVKIIDTET	GMSLSYNQPG
Poptr 4CL1	341	GPVLSMCLAF	AKEPF-EI-K	SGACGTVVRN	AEMKIVDPDT	GRSL PRNQSG
Poptr 4CL2	341	GPVIAMCLAF	AKEPF-EI-K	SGACGTVVRN	AEMKIVDPET	GESQPRNKTG
Poptr 4CL3	366	GPVLSMCLAF	SKQPL-PT-K	SGSCGTVVRN	AELKVIDPET	GSSLGRNQPG
Poptr 4CL4	340	GPVLAMCLAF	AKEPF-DI-K	PGACGTVVRN	AEMKIVDPET	GSSL PRNLPG
Poptr 4CL5	340	GPVLAMCLAF	AKEPF-DI-K	PGACGTVVRN	AEMKIVDPET	GASL PRNQPG
Os 4CL1	359	GPVLSMCLAF	AKEPF-KV-K	SGACGTVVRN	AELKIIDPDT	GKSLGRNLRG
Os 4CL2	369	GPVLSMCPAF	AKEPT-PA-K	SGSCGTVVRN	AELKVVDPDT	GFSLGRNLPG
Os 4CL5	335	GPVLSMCMF	AKEPT-PV-K	SGACGTVVRN	AELKIVDPDT	GLSL PRNQPG
Os 4CL3	338	GPVLAMCLAF	AKEPF-KV-K	SGSCGTVVRN	AELKIVDPDT	GTSLGRNQSG
Os 4CL4	348	GPVLAMCLAF	AKEPF-EV-K	SGSCGTVVRN	AELKIVDPDT	GATLGRNQSG
Os ACOS9	350	SCITL-THAA	GD-GHGHVAK	KSSVGFILPN	LEVKFVDPDT	GRSL PANTPG
N.sylvestris CL-lk	351	SCITL-SHSD	Q-----HTAK	RNSVGFILPN	LEVKFVDPDT	GRSL PKNKPG
Poptr ACOS13	341	SCITL-THGD	PSKGHG-IAK	KNSVGFLLPN	LEIKFINPEN	GQSL PENTPG
At ACOS5	339	SCITL-THGD	PEKGQG-IAK	RNSVGFILPN	LEVKFIDPDT	GRSL PKNTSG
Pp ACOS6	367	SCVTV-SHCS	PIHGRGPS-K	PGSVGFILPG	LEVKFVDPNT	GLSL PANTPG

At 4CL1	408	EICIRGHQIM	KGYLNNPAAT	AETIDKDGWL	HTGDIGLIDD	DDELFIIVDRL
At 4CL2	401	EICIRGNQIM	KGYLNDPLAT	ASTIDKDGWL	HTGDVGFIDD	DDELFIIVDRL
At 4CL3	411	EICIRGQQIM	KEYLNDPEAT	SATIDEEGWL	HTGDIGYVDE	DDEIFIIVDRL
At 4CL4	415	EICVRGHQLM	KGYLNDPEAT	ARTIDKDGWL	HTGDIGFVDD	DDEIFIIVDRL
Pp 4CL1	384	EICIRGPQIM	KGYLKNPEAT	ANTIDKDGFL	HTGDVAFIDE	DEEMFIIVDRV
Pp 4CL2	390	EICIRGPQIM	KGYLNNPEAT	ANTIDKDGFL	HTGDVAFIDE	DEEMFIIVDRV
Pp 4CL3	384	EICIRGPQIM	KGYLNNPEAT	ANTIDKDGFL	HTGDVAFIDE	DEEMFIIVDRV
Pp 4CL4	378	EICIRGPQIM	KGYLNNPEAT	AYTIDEDGFL	HTGDVAFIDE	DEEMFIIVDRV
Poptr 4CL1	389	EICIRGSQIM	KGYLNDPEAT	ERTVDNDGWL	HTGDIGYIDG	DDELFIIVDRL
Poptr 4CL2	389	EICIRGCQIM	KGYLNDPEAT	ERTIDKDGWL	HTGDIGYIDE	D-ELFIIVDRL
Poptr 4CL3	414	EICIRGSQIM	KGYLNDAEAT	ANIIDVEGWL	HTGDIGYVDD	DDEIFIIVDRL
Poptr 4CL4	388	EICIRGDQIM	KGYLNDPEAT	SRTIDNDGWL	HTGDIGFIDD	DDELFIIVDRL
Poptr 4CL5	388	EICIRGDQIM	KGYLNDPEAT	SRTIDKEGWL	HTGDIGYIDD	DDELFIIVDRL
Os 4CL1	407	EICIRGQQIM	KGYLNNPEAT	KNTIDAEGWL	HTGDIGYVDD	DDEIFIIVDRL
Os 4CL2	417	EICIRGPQIM	KGYLNDPEAT	AATIDVEGWL	HTGNIGYVDD	DDEVFIIVDRV
Os 4CL5	383	EICIRGKQIM	KGYLNNPEAT	EKTIDKDGWL	HTGDIGFVDD	DDEIFIIVDRL
Os 4CL3	386	EICIRGEQIM	KGYLNDPEAT	KNTIDEDGWL	HTGDIGFVDD	DDEIFIIVDRL
Os 4CL4	396	EICIRGEQIM	KGYLNDPEST	KNTIDKGGWL	HTGDIGYVDD	DDEIFIIVDRL
Os ACOS9	398	ELCVRSQSV	QGYKKEET	ERTVDGKGL	HTGDVGYIDG	DGDVFIIVDRI
N.sylvestris CL-1k	395	EICVKSQCV	KGYKNEFET	CLTIDKDGWL	QTGDIGYIDD	DGDIFLVDRI
Poptr ACOS13	389	EICVRSQCV	QGYNNKEET	ARTIDADGWL	HTGDIGYIDN	DGDIFIVDRI
At ACOS5	387	ELCVRSQCV	QGYFMKEET	DKTIDEQGL	HTGDIGYIDD	DGDIFIVDRI
Pp ACOS6	415	EIFVRGEST	KGYFKNPAAT	AATIDFEGWL	HTGDIGYIDN	

B. Alignments used to generate Supplemental Figure 4 online

At 4CL1	M	AP-----Q-	-E-----QA	V-----SQVM	EK-----
At 4CL2	M	TT-----	-----QD	VI-----VN	DQ---N----
At 4CL3	M	ITAA-----	-----	----LHEPQI	HKPTDTS--V
At 4CL4	M	VL-----	-----QQ	QTHFLTCKID	QE---D----
Pp 4CL1	M	EPV-----	-----	-----HA	EV-----
Pp 4CL2	M	ES-----	-----	-----	EV-----
Pp 4CL3	M	K-----	-----	-----MKTA	QA-----
Pp 4CL4	M	E-----	-----	-----AFKE	KV-----
Poptr 4CL1	M	E-----	-----	-----AKND	QA-----
Poptr 4CL2	M	E-----	-----	-----ANKD	QV-----
Poptr 4CL3	M	MSVA-----	-----	----TVEPPK	PELSPPQ---
Poptr 4CL4	M	D-----	-----	-----TITK	QK-----
Poptr 4CL5	M	D-----	-----	-----AIMN	SQ-----
Os 4CL1	M	GSME-----	-----	----QQQ-	-P--ESA---
Os 4CL2	M	ITVA-----	-----	----APEAQ-	-P--QVA---
Ns 4CL-1k	M	GT-----	---RAV---	E-----SSQQ	QE-----
Poptr ACOS	M	GTP-----	-----	-----IPCS	AQ-----
At ACOS5	M	E-----	-----	-----SQKQ	ED-----
Pp ACOS6	M	DPSGVDESIS	TE---LIP--	SPVIDGLTSP	QE-----
Gh ACS1	M	AGN-NFVIEV	EK-----	----GKDAS	DG-----
Gh ACS2	M	AEERNYIIKV	EE-----	----GKAAT	DE-----
At LACS4	M	SQQKKYIFQV	EE-----	----GKEGS	DG-----
At LACS5	M	TSQKRFIFEV	EA-----	----AKEAT	DG-----
At LACS3	M	ATG-RYIVEV	EK-----	----GKQGV	DGG-----
At LACS2	M	SLAADNVLV	EE-----	----GRPAT	AE-----

At 4CL1	-----Q	SNNNN-----	-----	-----	-----SDVIF	RSKLPDIYI-
At 4CL2	-----D	QKQCS-----	-----	-----	-----NDVIF	RSRLPDIYI-
At 4CL3	VSDD----	VL PHSPP-----	-----	-----	-----TPRIF	RSKLPDIDI-
At 4CL4	-----E	EEEPS-----	-----	-----	-----HDFIF	RSKLPDIFI-
Pp 4CL1	-----	-----	-----	-----	-----HDFIY	RSKLPDIDI-
Pp 4CL2	-----	-----	-----	-----	-----CDFIY	RSKLPDIDI-
Pp 4CL3	-----	-----	-----	-----	-----EEFIY	RSKLPDIDI-
Pp 4CL4	-----	-----	-----	-----	-----	-SKLPDIYI-
Poptr 4CL1	-----	-----	-----	-----	-----QEFIF	RSKLPDIHI-
Poptr 4CL2	-----	-----	-----	-----	-----QEFIF	RSKLPDIYI-
Poptr 4CL3	-NQN-----	A PSSHE-----	-----	-----	-----TDHIF	RSKLPDITI-
Poptr 4CL4	-----	-----	-----	-----	-----EEFIF	RSKLPDIDI-
Poptr 4CL5	-----	-----	-----	-----	-----EEFIF	RSKLPDIYI-
Os 4CL1	-A-----	P ATEAS-----	-----	-----	-----PEIIF	RSKLQDIAI-
Os 4CL2	AAVD-----	EAPPE-----	-----	-----	-----AVTVF	RSKLPDIDI-
Ns 4CL-1k	-----	-----	-----	-----	-----CEHIF	RSRYPPVQV-
Poptr ACOS	-----	-----	-----	-----	-----EEHIF	RSRHPAVLV-
At ACOS5	-----	-----	-----	-----	-----NEYIF	RSLYPSVPI-
Pp ACOS6	-----	-----	-----	-----	-----QDHIF	RSTLPLNPV
Gh ACS1	-----	-----	-----	-----	--QPSIGPVY	RSSFAANGFP
Gh ACS2	-----	-----	-----	-----	--RPSIGPVY	RSCFAENGFP
At LACS4	-----	-----	-----	-----	--RPSVGPVY	RSIFAKDGF
At LACS5	-----	-----	-----	-----	--NPSVGPVY	RSTFAQNGFP
At LACS3	-----	-----	-----	-----	--SPSVGPVY	RSIYAKDGF
At LACS2	-----	-----	-----	-----	--HPSAGPVY	RCKYAKDGLL

At 4CL1	--PNHLSLHD	YI-FQNISEF	-----	ATKPC	LINGPTGHVY	TYSDVHVISR	QI--AANF--
At 4CL2	--PNHLPLHD	YI-FENISEF	-----	AAKPC	LINGPTGEVY	TYADVHVTSR	KL--AAGL--
At 4CL3	--PNHLPLHT	YC-FEKLSSV	-----	SDKPC	LIVGSTGKSY	TYGETHLICR	RV--ASGL--
At 4CL4	--PNHLPLTD	YV-FQRFSGD	GDG-DSSTC	IIDGATGRIL	TYADVQTNMR	RI--AAGI--	
Pp 4CL1	--PNHMPLAD	YC-LEKSSQW	-----	PDKVC	LIDGVTGREH	RYGEIELSSR	RV--AAGL--
Pp 4CL2	--PNHMPLSD	YC-LEKAAQW	-----	PDKVC	LIDGVTGREH	TYGEIELSTR	RV--AAGL--
Pp 4CL3	--PNHMPLAD	YC-LEKAAQW	-----	PENVC	LIDGNTGRKH	TYGEIEVSMR	RV--AAGL--
Pp 4CL4	--SNHMPLTD	YC-LEKVTQW	-----	PDKVC	LIDGNTGREY	SYGEMELTSR	RV--AAGL--
Poptr 4CL1	--PNHLPLHT	YC-FENLSRF	-----	KDNPC	LINGPTGEIH	TYAEVELTSR	KV--ASGL--
Poptr 4CL2	--PNHLPLHT	YC-FEKLSQL	-----	KDNPC	LINGPTGDIY	TYADVELTSR	KV--ASGL--
Poptr 4CL3	--SNHLPLHA	YC-FENLSDF	-----	SDRPC	LISGSTGKTY	SFAETHLISR	KV--AAGL--
Poptr 4CL4	--PKGLPLHS	YV-FENFSKY	-----	PSKPC	LINGANGDVY	TYADVELTAR	RA--ASGL--
Poptr 4CL5	--PKNLPLHS	YV-LENLSKY	-----	SSKPC	LINGANGDVC	TYADVELTAR	RV--ASGL--
Os 4CL1	--TNTLPLHR	YC-FERLPEV	-----	AARPC	LIDGATGGVL	TYADVDRLSR	RL--AAALRR
Os 4CL2	--PSHLPLHE	YC-FARAAEL	-----	PDAPC	LIAAATGRTY	TFAETRLLCR	RA--AAAL--
Ns 4CL-1k	--PDNVTLPD	FV-LHNVELY	-----	TDKMA	FVDATTGKGY	TYGQVARDIR	RF--AKAL--
Poptr ACOS	--P-DITLPD	FV-LQDAELY	-----	ADKVA	FVEAATGKTF	TYAEVVRDTR	RF--AKAL--
At ACOS5	--PDKLTLPE	FV-LQGVEEY	-----	TENVA	FVEAVTGKAV	TYGDVVRDTK	RL--AKAL--
Pp ACOS6	VPPKGLTLHG	YV-LDNIEDY	-----	LHRIA	LIDSSNGRHY	TYGQVQLLTK	NI--QAGLW-
Gh ACS1	APIPGMESCW	DIFRMSVEKY	PDNRM LGRRQ	IVDGKAGKYV	WQTYREVYDI	VIKVGNSIR-	
Gh ACS2	APIPGMESCW	DIFRMSVEKY	PNHMLGHRQ	IVDGKAGKYV	WQTYKQVYDI	VMKVGNSIR-	
At LACS4	DPIEGMDSCW	DVFRMSVEKY	PNNPMLGRRE	IVDGKPGKYV	WQTYQEVYDI	VMKLGNSLR-	
At LACS5	NPIDGIQSCW	DIFRTAVEKY	PNNRM LGRRR	ISNGKAGKYV	WKTYKEVYDI	VIKLGNSLR-	
At LACS3	EPPDDLVS AW	DIFRLSVEKS	PNNPMLGRRE	IVDGKAGKYV	WQTYKEVHNV	VIKLGNSIR-	
At LACS2	DLPTDIDSPW	QFFSEAVKKY	PNEQMLGQRV	TTDSKVGPYT	WITYKEAHDA	AIRIGSAIR-	

At 4CL1	H-KLGVNQND	VVMLLLPNCP	EFVLSFLAAS	FRGATATAAN	PFFTPAEIAK	QAKASNTKLI
At 4CL2	H-NLGVKQHD	VVMILLPNSP	EVVLTFLAAS	FIGAITTSAN	PFFTPAEISK	QAKASAAKLI
At 4CL3	Y-KLGIRKGD	VIMILLQNSA	EFVFSFMGAS	MIGAVSTTAN	PFYTSQELYK	QLKSSGAKLI
At 4CL4	H-RLGIRHGD	VVMLLLPNSP	EFALSFLAVA	YLGAVSTTAN	PFYTQPEIAK	QAKASAAKMI
Pp 4CL1	D-KIGVKQGD	VIALLLPNCA	EFVLVFLGAA	KRGAVVTTAN	PFYTAAELEK	QIEASGAGIV
Pp 4CL2	F-KIGVKQGD	VIALLLPNCA	EFVQVFLGAA	KMGAIVTTAN	PFYTSAELEK	QTIASGAGIV
Pp 4CL3	A-NIGVKQGD	VIALLLPNCA	EFVQVFLGAA	KRGAVITTAN	PFYTSAELRK	QILASGTTMV
Pp 4CL4	A-KIGVEQGG	VIALLLPNCA	EFVQVFLGAA	KRGAIVTTAN	PFYTSTELAK	QIIASGATVV
Poptr 4CL1	N-KLGIKQGD	VILLLLQNSP	EFVFAFLGAS	IIGAISTTAN	PFYTPAEVAK	QATASKAKLI
Poptr 4CL2	Y-KLGLQQGD	VILLLLQNSP	EFVFAFLGAS	FIGAISSTAN	PFYTSAEIAK	QATASKAKLI
Poptr 4CL3	S-NLGIKKGD	VIMTLLQNCP	EFVFSFMGAS	MIGAVTTTVN	PFYTPGEIFK	QFSASRAKLI
Poptr 4CL4	N-KLGIQQGD	VIMLILPSSP	EFVLAFLGAS	HRGAITTAAN	PFSTPAELAK	QAKASKAKLL
Poptr 4CL5	N-KIGIQQGD	VIMLFLPSSP	EFVLAFLGAS	HRGAIVTAAN	PFSTPAELAK	HAKASRAKLL
Os 4CL1	A-PLGLRRGG	VVMSLLRNSP	EFVLSFFAAS	RVGAAVTTAN	PMSTPHEIES	QLAAAGATVV
Os 4CL2	H-RLGVGHGD	RVMVLLQNCV	EFAVAFFAAS	FLGAVTTAAN	PFCTPQEIHK	QFKGSGVKLI
Ns 4CL-1k	R-SLGLRKGR	VVVVLPNVP	EYAIVALGIM	AAGGVFSGAN	PAAHSSEIVK	QVESADGKLI
Poptr ACOS	R-SLGLRKGH	VVVVALPNVA	EYGIVALGIM	AAGGVFSGAN	PTAHESELKK	QAEAADAKLI
At ACOS5	T-SLGLRKQD	VMVVLPNVA	EYGIIALGIM	SAGGVFSGAN	PTALVSEIKK	QVEASGARGI
Pp ACOS6	N-QFGIRKGD	VVIVLLPNIA	EYFIFVLGII	SIGAIYSGSN	PAAHESEIQR	QAENSGAKLV
Gh ACS1	--SCDVVEGG	KCGIYGANCP	EWIISMEACN	AHGLYCVPLY	DTLGAGAVEF	IICHAESIA
Gh ACS2	--SCGVEEKG	KCGIYGANCP	EWIMTMEACN	AHGLSCVPLY	DTLGADAVEF	IICHAEVSLA
At LACS4	--SVGVKDEA	KCGIYGANSP	EWIISMEACN	AHGLYCVPLY	DTLGADAVEF	IISHSEVSIV
At LACS5	--SCGIKEGE	KCGIYGINCC	EWIISMEACN	AHGLYCVPLY	DTLGAGAVEF	IISHAEVSIA
At LACS3	--TIGVGKGD	KCGIYGANSP	EWIISMEACN	AHGLYCVPLY	DTLGAGAIEF	IICHAEVSLA
At LACS2	--SRGVDPGH	CCGIYGANCP	EWIIMEACM	SQGITYVPLY	DSLGVNAVEF	IINHAEVSLV

At 4CL1	ITEARYVDKI	KP-----	-----LQ---	-----N-DD	-----	--GVIVCI-
At 4CL2	VTQSRYVDKI	KN-----	-----LQ---	-----N-D-	-----	--GVLIVTT-
At 4CL3	ITHSQYVDKL	KN-----	-----LG---	-----E-N-	-----	-LTLITTD--
At 4CL4	ITKKCLVDKL	TN-----	-----LK---	-----N-D-	-----	--GVLIVCL-
Pp 4CL1	ITQSSYIEKL	AG-----	-----LN---	-----V-Q-	-----	---IITVDQH
Pp 4CL2	VTHSSYIEKL	AG-----	-----LNVQV	PTTSHPV-S-	-----	---IITVDQH
Pp 4CL3	VTQSSYVEKL	EG-----	-----LI---	-----V-Q-	-----	---IVTVDQH
Pp 4CL4	VTQSRYIEKL	AG-----	-----LN---	-----I-Q-	-----	---IIVVDQY
Poptr 4CL1	ITQAVYAEKV	QE-----	-----FVK---	-----ENVH	-----V	-K-IVTVDSP
Poptr 4CL2	ITHAAYAELV	QQ-----	-----FAQ---	-----ENDH	-----V	-K-IMTIDSL
Poptr 4CL3	ITQSQHVNKL	RD-----	-----SDCH	ENNQKPEED-	-----F	-I-VITIDDP
Poptr 4CL4	ITQACYVDKV	KD-----	-----YAQ---	-----QND-	-----V	-K-VMCVDSA
Poptr 4CL5	ITQACYVDKV	KD-----	-----FAR---	-----ESD-	-----V	-K-VMCVDSA
Os 4CL1	ITESMAADKL	PS-----	-----HS---	-----H-G-	-----	---ALTVVLI
Os 4CL2	LTQSVYVDKL	RQ-----	-----HEAFPR	IDACTVGDDT	-----	-LTVITI---
Ns 4CL-1k	VSDLPTYHKV	KD-----	-----CG---	-----L-P-	-----	---VILGEE
Poptr ACOS	VTNDLNYGKV	KG-----	-----LG---	-----L-P-	-----	---VIVLGEV
At ACOS5	ITDATNYEKV	KS-----	-----LG---	-----L-P-	-----	---VIVLGEV
Pp ACOS6	ITDLKTYKKV	EA-----	-----LG---	-----L-P-	-----	---VVVMGED
Gh ACS1	FVEEKKINEL	FK-----	-----	-----TFPA	-----STEH	LKTIVSFG--
Gh ACS2	FVEEKKIAEL	FK-----	-----	-----TFPN	-----STKY	LRTIISFG--
At LACS4	FVEEKKISEL	FK-----	-----	-----TCPN	-----STEY	MKTVVSFG--
At LACS5	FVEEKKIPEL	FK-----	-----	-----TCPN	-----STKY	MKTVVSFG--
At LACS3	FAEENKISEL	LK-----	-----	-----TAPK	-----STKY	LKYIVSFG--
At LACS2	FVQEKTVSSI	LS-----	-----	-----CQKG	-----CSSN	LKTIVSFG--

At 4CL1	-----DDNES	VPIP-----	---E---GCL	RFTE-LTQST	TEASEVI----	D-----
At 4CL2	-----DSDA-	--IP-----	---E---NCL	RFSE-LTQSE	EPRVDSIP--	-----
At 4CL3	---E-----	-PTP-----	---E---NCL	PFST-LITDD	ETN-----	PFQ----E--
At 4CL4	-----DDDGD	NGVVSSSD--	---D---GCV	SFTE-LTQAD	ETE---L---	L-----
Pp 4CL1	-----	---V-----	---A---NCM	HISV-LLNAC	EDE---C---	P-----
Pp 4CL2	-----	---V-----	---D---KCM	HISM-LLEPN	EAE---C---	P-----
Pp 4CL3	-----	---V-----	---D---GCL	HISA-LLEAD	EAE---C---	P-----
Pp 4CL4	-----	---V-----	---D---GYL	HVSA-LLEAD	EAE---C---	P-----
Poptr 4CL1	-----	---P-----	---E---NYL	HFSE-LTNSD	EDD---I---	P-----
Poptr 4CL2	-----	---T-----	---E---NCL	HFSE-LTSSD	ENE---I---	P-----
Poptr 4CL3	-----	---P-----	---E---NCL	HFNV-LVEAN	ESE---M---	P-----
Poptr 4CL4	-----	---P-----	---D---VCL	HFSE-LTQAD	DND---M---	P-----
Poptr 4CL5	-----	---P-----	---D---GCL	HFSE-LTQAD	ENE---V---	P-----
Os 4CL1	-----	DERR-----	---D---GCL	HFWD-DLMSE	DEASPLAGDE	DDEKV-----
Os 4CL2	-----	DDD EATPKA----	-----CL	PFWDLIADAD	EGS---V---	P-----
Ns 4CL-1k	H-----	---V-----	---E---GTI	HWDE-LLEAA	ERAGSRT---	DHITNHED--
Poptr ACOS	C-----	---I-----	---S---TAV	NWNE-LLDAA	DRAGDTLAY-	-----
At ACOS5	K-----	---I-----	---E---GAV	NWKD-LLEAG	DKCGDT----	D-----
Pp ACOS6	-----	---V-----	---SD--GSY	CYLS-LFEAD	GSQ---A---	P-----
Gh ACS1	-----	--KVTPEQKA	EAEKHGLKIY	PWEEFLQLGE	NKNYGLP---	-----
Gh ACS2	-----	--KVTPEQKA	EAEKQGLAIF	TWEEFLQLGE	NKQYDLP---	-----
At LACS4	-----	--GVSREQKE	EAETFGLVIY	AWDEFLKLGE	GKQYDLP---	-----
At LACS5	-----	--GVKPEQKE	EAEKLGVLVIH	SWDEFLKLGE	GKQYELP---	-----
At LACS3	-----	--EVTNNQRV	EAERHRLTIY	SWDQFLKLGE	GKHYELP---	-----
At LACS2	-----	--EVSSTQKE	EAKNQCVSLF	SWNEFSLMGN	LDEANLP---	-----

At 4CL1	-----	-----S	VEISPDDVVA	LPYSSGTTGL	PKGVMLTHKG	LVTSAQQVD
At 4CL2	-----	-----	EKISPEDVVA	LPFSSGTTGL	PKGVMLTHKG	LVTSAQQVD
At 4CL3	-----	-----T	VDIGGDDAAA	LPFSSGTTGL	PKGVLTHKS	LITSVAQQVD
At 4CL4	-----	-----K	PKISPEDTVA	MPYSSGTTGL	PKGVMITHKG	LVTSAIQKVD
Pp 4CL1	-----	-----Q	VRIHPDDLVC	LPYSSGTTGL	PKGVMLTHKS	LVSSVSQQVD
Pp 4CL2	-----	-----Q	VEIHPDDVVC	LPYSSGTTGL	PKGVMLTHKS	LVSSVSQQVD
Pp 4CL3	-----	-----Q	VEIHPDDVVC	LPYSSGTTGL	PKGVMLTHKG	LVSSVSQQVD
Pp 4CL4	-----	-----E	VDIHPDDVVC	LPYSSGTTGL	PKGVMLTHKS	LVTSAQQVD
Poptr 4CL1	-----	-----A	VEINPDDVVA	LPYSSGTTGL	PKGVMLTHKG	LVTSAQQVD
Poptr 4CL2	-----	-----T	VKIKPDDIMA	LPYSSGTTGL	PKGVMLTHKG	LVTSAQQVD
Poptr 4CL3	-----	-----T	VSIHPDDPVA	LPFSSGTTGL	PKGVLTHKS	LITSVAQQVD
Poptr 4CL4	-----	-----Q	VDIRPDDVVA	LPYSSGTTGL	PKGVMLTHKG	LITSVAQQVD
Poptr 4CL5	-----	-----Q	VDFSPDDVVA	LPYSSGTTGL	PKGVMLTHKG	LITSVAQQVD
Os 4CL1	-----	-----	--FDPDDVVA	LPYSSGTTGL	PKGVMLTHRS	LSTSVAQQVD
Os 4CL2	-----	-----E	VAISPDDPVA	LPFSSGTTGL	AKGVVLTHRS	VVSGVAHEVD
Ns 4CL-1k	-----	-----	EMVQQNDLCA	LPFSSGTTGL	SKGVMLTHRN	LVANLCSTLF
Poptr ACOS	-----	-----	EEVLQSDLCA	LPFSSGTTGM	SKGVMLTHRN	LVANLCSSLF
At ACOS5	-----	-----N	EEILQTDLCA	LPFSSGTTGL	QKGVMLTHRN	LIANLCSTLF
Pp ACOS6	-----	-----T	VDISEHDVCA	LPYSSGTTGV	SKGVMITHRN	IVANLNQTLA
Gh ACS1	-----	-----	-VKKKTDICT	IMYTSGTTGD	PKGVFISNDS	IVTLIAGVKR
Gh ACS2	-----	-----	-IKKKTIDICT	IMYTSGTTGD	PKGVLISNES	IITLLAAVDC
At LACS4	-----	-----	-IKKKSIDICT	IMYTSGTTGD	PKGVMISNES	IVTLIAGVIR
At LACS5	-----	-----	-IKKPSIDICT	IMYTSGTTGD	PKGVMISNES	IVTITGVMH
At LACS3	-----	-----	-EKRRSDVCT	IMYTSGTTGD	PKGVLITNES	IIHLLEGVKK
At LACS2	-----	-----	-RKRKTDICT	IMYTSGTTGE	PKGVLINNA	ISVQVLSIDK

At 4CL1	-----	GENPNLYF--	-----	HSDD	VILCVLPMFH	IYALNSIMLC	GLRVGAAILI
At 4CL2	-----	GENPNLYF--	-----	NRDD	VILCVLPMFH	IYALNSIMLC	SLRVGATILI
At 4CL3	-----	GDNPPLYL--	-----	KSND	VILCVLPLFH	IYSLNSVLLN	SLRSGATVLL
At 4CL4	-----	GENPNLNF--	-----	TAND	VILCFLPMFH	IYALDALMLS	AMRTGAALLI
Pp 4CL1	-----	GEAPNFNI--	-----	TVED	TLMCVLPMPH	IYSLNSILLC	GLRVGATLVI
Pp 4CL2	-----	GDSPNFNI--	-----	TVED	TLMCVLPMPH	IYSLNSILLC	GLRVGATLVI
Pp 4CL3	-----	GEVPNFNI--	-----	TVED	TMMCVLPMPH	IYSLNSILLC	GLRVGAALVV
Pp 4CL4	-----	GEVPHFNI--	-----	NVED	TLMCVLPMPH	IYSLNSILLC	GLRAGATLVI
Poptr 4CL1	-----	GENPNLYF--	-----	HEKD	VILCVLPLFH	IYSLNSVLLC	GLRVGSAILL
Poptr 4CL2	-----	GENPNLYF--	-----	HERD	VILCVLPLFH	IYSLNSVFLC	GLRAGSAILV
Poptr 4CL3	-----	GEIPPLYL--	-----	KQDD	VVLCVLPPLFH	IFSLNSVLLC	SLRAGSAVLL
Poptr 4CL4	-----	GDNPPLYF--	-----	HSED	VILCVLPMFH	IYALNSIMLC	GLRVGAAILI
Poptr 4CL5	-----	GDNPPLYF--	-----	HSED	VILCVLPMFH	IYALNSIMLC	GLRVGASILI
Os 4CL1	-----	GENPNIGL--	-----	HAGD	VILCALPMFH	IYSLNTIMMC	GLRVGAAIIV
Os 4CL2	-----	GENPNLHM--	-----	GAGD	VALCVLPLFH	IFSLNSVLLS	RVRPAPAVAL
Ns 4CL-1k	-----	SVSPE-----	M----	VGQV	TTLGLIPFFH	IYGITGICCA	TIRNKGKVVV
Poptr ACOS	-----	SVGPE-----	M----	VGQV	ATLGLIPFFH	IYGITGICCA	TLRNKGKVVV
At ACOS5	-----	GVRSE-----	M----	IGQI	VTLGLIPFFH	IYGIVGICCA	TMKNKGKVVV
Pp ACOS6	DIE-----	RAYRGGVI---	P----	DDES	VVLGLMPFFH	IYGICGICCA	AMRLKGKVVV
Gh ACS1	LLG-----	SVNEQLTM--	-----	KD	VYISYLPLAH	IFDR--VIEE	LFISHGASIG
Gh ACS2	LLG-----	RVNEELTM--	-----	ND	VYISYLPLAH	IFDR--VIEE	LFISHGASIG
At LACS4	LLK-----	SANEALTV--	-----	KD	VYLSYLPLAH	IFDR--VIEE	CFIQHGAAG
At LACS5	FLG-----	NVNASLSE--	-----	KD	VYISYLPLAH	VFDR--AIEE	CIIQVGGSIG
At LACS3	LLK-----	TIDEELTS--	-----	KD	VYLSYLPLAH	IFDR--VIEE	LCIYEASIG
At LACS2	MLE-----	VTDRSCDT--	-----	SD	VFFSYLPLAH	CYDQ--VMEI	YFLSRGSSVG

At 4CL1	MPKFEINLLL	ELIQRCKVTV	APMVPPIVLA	IAK-----	-----	-----
At 4CL2	MPKFEITLLL	EQIQRCKVTV	AMVPPIVLA	IAK-----	-----	-----
At 4CL3	MHKFEIGALL	DLIQRHRVTI	AALVPPLVIA	LAK-----	-----	-----
At 4CL4	VPRFELNLVM	ELIQRYKVTV	VPVAPPVVLA	FIK-----	-----	-----
Pp 4CL1	MPKFELPKLL	DLIQRHKVTV	GPFVPPIVLA	IAK-----	-----	-----
Pp 4CL2	MPKFELSKML	ELIQKHKVTV	GPFVPPIVLA	IAK-----	-----	-----
Pp 4CL3	MSKFELPKLL	DLIQRYKVTV	GPFVPPIVLA	IAK-----	-----	-----
Pp 4CL4	MAKFELSKLL	EFIQKYKVTV	GPFVPPIMLA	IAK-----	-----	-----
Poptr 4CL1	MQKFEIVTLM	ELVQKYKVTV	APFVPPVVLA	VAK-----	-----	-----
Poptr 4CL2	MQKFDTVSLM	DLVQKYKVTV	APLVPPICLA	IAK-----	-----	-----
Poptr 4CL3	MQKFEIGSLL	ELIQKHNVSV	AAVPPPLVLA	LAK-----	-----	-----
Poptr 4CL4	MPKFEIGSLL	GLIEKYKSVI	APVPPVMVA	IAK-----	-----	-----
Poptr 4CL5	MPKFDIGTLL	GLIEKYKSVI	APVPPVMLA	IAK-----	-----	-----
Os 4CL1	MRRFDLAAMM	DLVERHRVTI	APLVPPIVVA	VAK-----	-----	-----
Os 4CL2	MPRFEMGAML	GAIERWRVTI	GAVVPPLVVA	LAK-----	-----	-----
Ns 4CL-1k	LRRYELRAFL	NALITHEVTF	APIVPPPIILA	LVK-----	-----	-----
Poptr ACOS	MGRFELRTFL	NALITQEVSF	APIVPPPIILA	LVK-----	-----	-----
At ACOS5	MSRYDLRIFL	NALIAHEVSF	APIVPPPIILN	LVK-----	-----	-----
Pp ACOS6	MARYNFQEFL	DILLKYEITF	APIVPPILLQ	LVK-----	-----	-----
Gh ACS1	FWRGDVKLLV	EDIGELKPSI	FCAVPRVLDL	IYSGLLQKIS	AGGLLKKKMF	DLAYTYKYNN
Gh ACS2	FWRGDVKLLV	EDIGELKPSV	FCAVPRVLDL	IYSGLLQKIS	EGGLLKKTLF	NVAYSFKFYN
At LACS4	FWRGDVKLLI	EDLAELKPTI	FCAVPRVLDL	VYSGLLQKLS	DGGFLKKFIF	DSAFSYKFGY
At LACS5	FWRGDVKLLI	EDLDELKPSI	FCAVPRVLDL	VYTGLQKLS	GGGFVKKKVF	DVAFSYKFGN
At LACS3	FWRGDVKILI	EDIAALKPTV	FCAVPRVLER	IYTGLQKLS	DGGFVKKKLF	NFAFKYKHKN
At LACS2	YWRGDIRYLM	DDVQALKPTV	FCGVPRVYDK	LYAGIMQKIS	ASGLIRKKLF	DFAYNYKLG

At 4CL1	-----	SSETEKYDLS	S-----	I	RVVKSGAAPL	GKELEDAVNA	KFPNAKLGQG
At 4CL2	-----	SPETEKYDLS	S-----	V	RMVKSGAAPL	GKELEDAISA	KFPNAKLGQG
At 4CL3	-----	NPTVNSYDLS	S-----	V	RFVLSGAAPL	GKELQDSLRR	RLPQAILGQG
At 4CL4	-----	SPETERYDLS	S-----	V	RIMLSGAATL	KKELEDAVRL	KFPNAIFGQG
Pp 4CL1	-----	NPIVENYDLS	S-----	M	RMVMSGAAPL	GRELEDAFRA	RLPNAVLGQG
Pp 4CL2	-----	NPIVENYDLS	S-----	I	KMVMSGAAPL	GKELEDAFRA	RLPNAVLGQG
Pp 4CL3	-----	NPIVDNYDLS	S-----	I	RMVMSGAAPL	GKELEDAFRA	RLPNAVLGQG
Pp 4CL4	-----	NPIVENYDLS	S-----	I	KMIMSGAAPL	GKELEDAFRA	RLPNAILGQG
Poptr 4CL1	-----	CPVVDKYDLS	S-----	I	RTVMSGAAPM	GKELEDTVRA	KLPNAKLGQG
Poptr 4CL2	-----	SPVVDQYDLS	S-----	I	RTVLSGAAPL	GKELEDTVRA	KLPNAKLGQG
Poptr 4CL3	-----	NPMVANFDLS	S-----	I	RVVLSGAAPL	GKELEEALRS	RVPQAILGQG
Poptr 4CL4	-----	SPDLDKHDLS	S-----	L	RMLKSGGSPL	GKELEDTVRA	RFPQARLGQG
Poptr 4CL5	-----	SPDFDKHDLS	S-----	L	RMIKSGGAPL	GKELEDTVRA	KFPQARLGQG
Os 4CL1	-----	SEAAAARDLS	S-----	V	RMVLSGAAPM	GKDIEDAFMA	KLPGAVLGQG
Os 4CL2	-----	NPFVERHDLS	S-----	I	RIVLSGAAPL	GKELEDALRA	RLPQAILGQG
Ns 4CL-1k	-----	NPIVDEFDLS	KL-----	KL	RSIMTAAAPL	APEILNEFEK	KFPDVQVQEA
Poptr ACOS	-----	NPIVEEFDLS	KL-----	KL	KAIMTAAAPL	APELLTAFEN	KFPGVQVQEA
At ACOS5	-----	NPIVDEFDLS	KL-----	KL	QSVMTAAAPL	APELLTAFEA	KFPNVQVQEA
Pp ACOS6	-----	KDLGENFDRS	KL-----	KL	KSILTAAAPL	GIELQRAFEA	KFPQVEVQQA
Gh ACS1	MKKGRKHGEA	SPICDKIVFS	KVKQGLGGNV	RLILSGAAPL	STHVEEFLR-	VVACCHVLQG	
Gh ACS2	MRNGSKHAEA	SPFSDRIVFS	QVKERLGGNL	RIILSGAAPL	SSHVEEFLR-	VVACCHVMQG	
At LACS4	MKKGQSHVEA	SPLFDKLVFS	KVKQGLGGNV	RIILSGAAPL	ASHVESFLR-	VVACCHVLQG	
At LACS5	MKKGQSHVAA	SPFCDKLVFN	KVKQGLGGNV	RIILSGAAPL	ASHIESFLR-	VVACCNVLQG	
At LACS3	MEKGQPHEQA	SPIADKIVFK	KVKEGLGGNV	RLILSGAAPL	AAHIESFLR-	VVACAHVLQG	
At LACS2	MRKGFSEQEA	SPRLDRLMFD	KIKEALGGRA	HMLLSGAAPL	PRHVEEFLR-	IIPASNLSQG	

At 4CL1	YGMTEAGPVL	AMSLGFAKEP	F-PVKSGACG	TVVRNAEMKI	VDPDTGDSLS	RNQ---PGEI
At 4CL2	YGMTEAGPVL	AMSLGFAKEP	F-PVKSGACG	TVVRNAEMKI	LDPDTGDSLPL	RNK---PGEI
At 4CL3	YGMTEAGPVL	SMSLGFAKEP	I-PTKSGSCG	TVVRNAELKV	VHLETRLSLG	YNQ---PGEI
At 4CL4	YGMTESGTV-	AKSLAFKPNP	F-KTKSGACG	TVIRNAEMKV	VDTETGISLP	RNK---SGEI
Pp 4CL1	YGMTEAGPVL	AMCLAFAKTP	F-SVKPGSCG	TVVRNAEVKI	VDTETGMSLP	YNQ---PGEI
Pp 4CL2	YGMTEAGPVL	AMCLAFKSP	F-PVKPGSCG	TVVRNAEVKI	VDTETGMSLP	YNQ---PGEI
Pp 4CL3	YGMTEAGPVL	AMCLAFKTP	F-PVKPGSCG	TVVRNAEVKI	VDTETGMSLP	YNQ---PGEI
Pp 4CL4	YGMTEAGPVL	AMSLAFKTP	F-PVKPGSCG	TVVRNAEVKI	IDTETGMSLS	YNQ---PGEI
Poptr 4CL1	YGMTEAGPVL	SMCLAFKTP	F-EIKSGACG	TVVRNAEMKI	VDPDTGRSLP	RNQ---SGEI
Poptr 4CL2	YGMTEAGPVI	AMCLAFKTP	F-EIKSGACG	TVVRNAEMKI	VDPETGESQP	RNK---TGEI
Poptr 4CL3	YGMTEAGPVL	SMCLAFSKQP	L-PTKSGSCG	TVVRNAELKV	IDPETGSSLG	RNQ---PGEI
Poptr 4CL4	YGMTEAGPVL	AMCLAFKTP	F-DIKPGACG	TVVRNAEMKI	VDPETGSSLP	RNL---PGEI
Poptr 4CL5	YGMTEAGPVL	AMCLAFKTP	F-DIKPGACG	TVVRNAEMKI	VDPETGASLP	RNQ---PGEI
Os 4CL1	YGMTEAGPVL	SMCLAFKTP	F-KVKSGACG	TVVRNAELKI	IDPDTGKSLG	RNL---RGEI
Os 4CL2	YGMTEAGPVL	SMCPAFKTP	T-PAKSGSCG	TVVRNAELKV	VDPDTGFSLG	RNL---PGEI
Ns 4CL-1k	YGMTEHSCI-	TLSHSDQH--	--TAKRNSVG	FILPNLEVVF	VDPDTGRSLP	KNK---PGEI
Poptr ACOS	YGLTEHSCI-	TLTHGDPSKG	HGIAKKNSVG	FLLPNLEIKF	INPENGQSLP	ENT---PGEI
At ACOS5	YGLTEHSCI-	TLTHGDPEKG	QGIAKRNSVG	FILPNLEVVF	IDPDTGRSLP	KNT---SGEL
Pp ACOS6	YGLTEYSCV-	TVSHCSPIHG	RGPSKPGSVG	FILPGLEVVF	VDPNTGLSLP	ANT---PGEI
Gh ACS1	YGLTESCAG-	----SFVSLP	NELSMLGTVG	PPVPNIDVRL	ESVPEMNYDA	LAS-TPRGEI
Gh ACS2	YGLTETCAG-	----TFVSLP	HELSMLGTVG	PPVPNVDVRL	ESVPEMGYDA	LAS-TPRGEI
At LACS4	YGLTESCAG-	----TFVSLP	DELGMLGTVG	PPVPNVDIRL	ESVPEMEYDA	LAS-TARGEI
At LACS5	YGLTESCAG-	----TFATFP	DELDMLGTVG	PPVPNVDIRL	ESVPEMNYDA	LGS-TPRGEI
At LACS3	YGLTESCGG-	----TFVSIP	NELSMLGTVG	PPVPNVDIRL	ESVPEMGYDA	LAS-NPRGEI
At LACS2	YGLTESCGG-	----SFTTLA	GVFSMVGTVG	VPMPTVEARL	VSVPEMGYDA	FSADVPRGEI

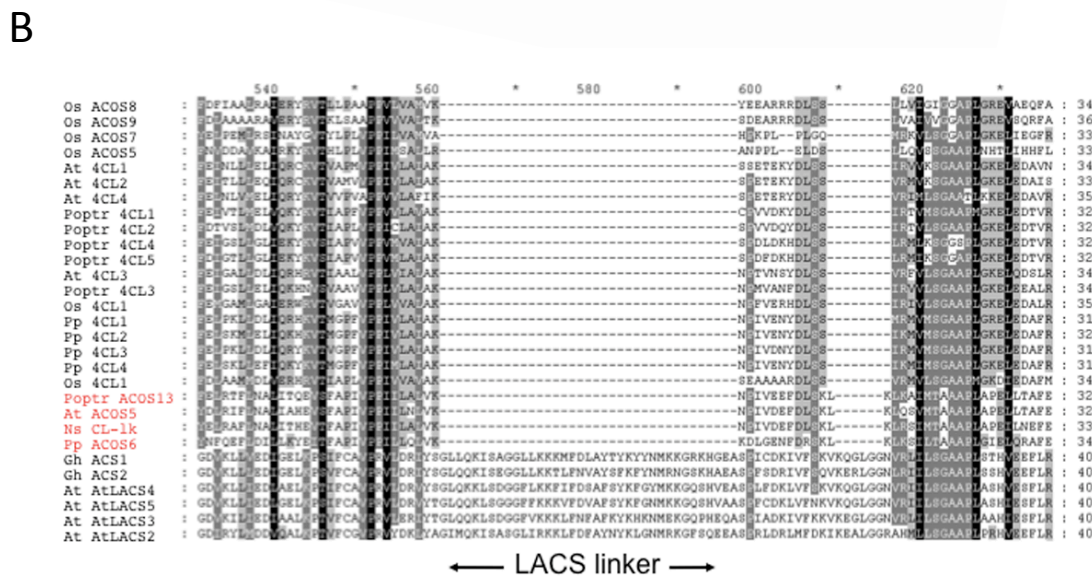
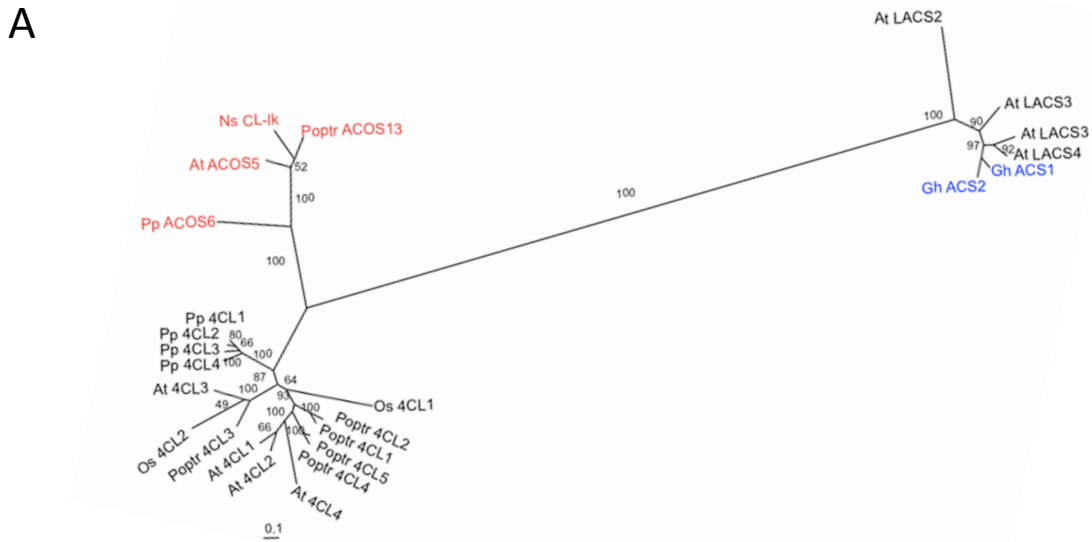
At 4CL1	CIRGHQIMK-	-----	--GYLNNPAA	TAETID----	KDGLHTGDI	GLIDDDDEL
At 4CL2	CIRGNQIMK-	-----	--GYLNDPLA	TASTID----	KDGLHTGDV	GFIDDDDEL
At 4CL3	CIRGQQIMK-	-----	--EYLNDPEA	TSATID----	EEGWLHTGDI	GYVDEDEIF
At 4CL4	CVRGHQLMK-	-----	--GYLNDPEA	TARTID----	KDGLHTGDI	GFVDDDEIF
Pp 4CL1	CIRGPQIMK-	-----	--GYLKNPEA	TANTID----	KDGFLHTGDV	AFIDEDEEMF
Pp 4CL2	CIRGPQIMK-	-----	--GYLNNPEA	TANTID----	KDGFLHTGDV	AFIDEDEEMF
Pp 4CL3	CIRGPQIMK-	-----	--GYLNNPEA	TANTID----	KDGFLHTGDV	AFIDEDEEMF
Pp 4CL4	CIRGPQIMK-	-----	--GYLNNPEA	TAYTID----	EDGFLHTGDV	AFIDEDEEMF
Poptr 4CL1	CIRGSQIMK-	-----	--GYLNDPEA	TERTVD----	NDGWLHTGDI	GYIDGDDEL
Poptr 4CL2	CIRGCQIMK-	-----	--GYLNDPEA	TERTID----	KDGLHTGDI	GYIDED-ELF
Poptr 4CL3	CIRGSQIMK-	-----	--GYLNDPEA	TANIID----	VEGWLHTGDI	GYVDDDEIF
Poptr 4CL4	CIRGDQIMK-	-----	--GYLNDPEA	TSRTID----	NDGWLHTGDI	GFIDDDDEL
Poptr 4CL5	CIRGDQIMK-	-----	--GYLNDPEA	TSRTID----	KEGWLHTGDI	GYIDDDDEL
Os 4CL1	CIRGQQIMK-	-----	--GYLNNPEA	TKNTID----	AEGWLHTGDI	GYVDDDEIF
Os 4CL2	CIRGPQIMK-	-----	--GYLNDPEA	TAATID----	VEGWLHTGNI	GYVDDDEVF
Ns 4CL-1k	CVKSQCVMK-	-----	--GYKNEFE	TCLTID----	KDGLQTGDI	GYIDDDGDIF
Poptr ACOS	CVRSQCVMQ-	-----	--GYNNKEE	TARTID----	ADGWLHTGDI	GYIDNDGDIF
At ACOS5	CVRSQCVMQ-	-----	--GYFMNKEE	TDKTID----	EQGWLHTGDI	GYIDDDGDIF
Pp ACOS6	FVRGESTMK-	-----	--GYFKNPAA	TAATID----	FEGWLHTGDI	GYIDNDGDVF
Gh ACS1	CIKNTLFS-	-----	--GYKREDL	TREVL----	-DGWFHTGDI	GEWQPNGSMK
Gh ACS2	CLKGTTLFS-	-----	--GYFKREDL	TKEVMI----	-DGWFHTGDI	GEWQPNGSMK
At LACS4	CIRGKTLFS-	-----	--GYKREDL	TKEVLI----	-DGWLHTGDV	GEWQPDGSMK
At LACS5	CIRGKTLFS-	-----	--GYKREDL	TKEVFI----	-DGWLHTGDV	GEWQPNGSMK
At LACS3	CIRGKTLFS-	-----	--GYKREDL	TQEVFI----	-DGWLHTGDV	GEWQPDGAMK
At LACS2	CLRGNSMFS-	-----	--GYHKRQDL	TDQVLI----	-DGWFHTGDI	GEWQEDGSMK

At 4CL1	IVDRLKELIK	YKGFQ-----	----VAPAE	EALLIGHPDI	TDVAVVA----	-----
At 4CL2	IVDRLKELIK	YKGFQ-----	----VAPAE	ESLLIGHPEI	NDVAVVA----	-----
At 4CL3	IVDRLKEVIK	FKGFQ-----	----VPPAE	ESLLINHHSI	ADAAVVP----	-----
At 4CL4	IVDRLKELIK	FKGYQ-----	----VAPAE	EALLISHPSI	DDAAVVA----	-----
Pp 4CL1	IVDRVKEIIK	FKGFQ-----	----VPPAE	EALLSHKEI	QDAAVVS----	-----
Pp 4CL2	IVDRVKEIIK	FKGFQ-----	----VPPAE	EALLSNEEI	QHAAVVS----	-----
Pp 4CL3	IVDRVKEIIK	FKGFQ-----	----VPPAE	EALLFSHPLI	QDAAVVS----	-----
Pp 4CL4	IVDRVKEIIK	YKGFQ-----	----VPPAE	EAVLLSHQQI	QDAAVVS----	-----
Poptr 4CL1	IVDRLKELIK	YKGFQ-----	----VAPAE	EAMLIAHPDI	SDCAVVP----	-----
Poptr 4CL2	IVDRLKELIK	YKGFQ-----	----VAPAE	EAMLIAHPNI	SDAAVVP----	-----
Poptr 4CL3	IVDRVKEIIK	FKGFQASCSM	LYGQVPPAE	EALLVNHPDI	ADAAVVP----	-----
Poptr 4CL4	IVDRLKELIK	YKGFQ-----	----VAPAE	EALLQAHTGI	SDAAVVG----	-----
Poptr 4CL5	IVDRLKELIK	YKGFQ-----	----VAPAE	EALLLAHPEI	SDAAVVG----	-----
Os 4CL1	IVDRLKEIIK	YRGFQ-----	----VAPAE	EALLNTHPSI	ADAAVVG----	-----
Os 4CL2	IVDRVKELIK	FKGFQ-----	----VPPAE	ESLLIAHPSI	RDAAVVP----	-----
Ns 4CL-1k	LVDRIKELIK	YKGFQ-----	----VAPAE	EGILLTHPSV	EDAAVVG----	-----
Poptr ACOS	IVDRIKELIK	YKGFQ-----	----VAPAE	EAILLTHPSV	EDAAVVP----	-----
At ACOS5	IVDRIKELIK	YKGFQ-----	----VAPAE	EAILLTHPSV	EDVAVVP----	-----
Pp ACOS6	IVERMKELIK	YKGFQ-----	----VPPAE	EAVLISHPAV	ADAAVIP----	-----
Gh ACS1	IIDRKKNIFK	LSQGE-----	---YVAENL	ENIYGLVSAI	DSIWIYGNF	ESFLVAVVNP
Gh ACS2	VIDRKKNIFK	LSQGE-----	---YVAENL	ENVYGCVSDI	ESIWVYGNF	ESYLVAVVNP
At LACS4	IIDRKKNIFK	LSQGE-----	---YVAENI	ENIYGEVQAV	DSVWVYGNF	ESFLIAIANP
At LACS5	IIDRKKNIFK	LAQGE-----	---YVAENL	ENVYSQVEVI	ESIWVYGNF	ESFLVAIANP
At LACS3	IIDRKKNIFK	LSQGE-----	---YVAENL	ENIYSHVAAI	ESIWVYGNF	ESYLVAVVCP
At LACS2	IIDRKKNIFK	LSQGE-----	---YVAENL	ENTYSRCPLI	AQIWVYGNF	ESFLVGVVVP

At 4CL1	-----	-----	-----	-----	-----	-----
At 4CL2	-----	MKEEDAGEVP	VAFVVRSKDS	NISEDEIKQF	VSKQVVFYKR	INKVFFTDSI
At 4CL3	-----	QNDEVAGEVP	VAFVVRNNGN	DITEEDVKEY	VAKQVVFYKR	LHKVFFVASI
At 4CL4	-----	MKDEVADEVP	VAFVARSQGS	QLTEDDVKSY	VNKQVVHYKR	IKMVFFIEVI
Pp 4CL1	-----	RKDDVAGEVP	VAFVVRATSS	TITEDEVKDY	IAKQVVFYKK	IHNVFFVDSV
Pp 4CL2	-----	RKDDVAGEVP	VAFVVRQAGS	TISEEEVKDY	VAKQVVFYKK	IHNVFFVDSI
Pp 4CL3	-----	RKDDIAGEVP	VAFVVRTPSS	IISEEEVKAY	IADQVVFYKK	IHSVFFVDSI
Pp 4CL4	-----	RKDEVAGEVP	VAVVVRSPGC	TITEDEVKDH	VAKRVVFYKK	IHDVFFADSI
Poptr 4CL1	-----	MKDEAAGEVP	IAFVVRANGS	KITEDEIKQY	ISKQVVFYKR	ISRVFFTEAI
Poptr 4CL2	-----	MKDEAAGEVP	VAFVVRNNGS	KITEDEIKQY	ISKQVIFYKR	IGRVFFTEAI
Poptr 4CL3	-----	QKDEVAGEVP	VAFVVRNDL	DLNEEAVKDY	IAKQVVFYKK	LHKVFFVHSI
Poptr 4CL4	-----	MKDENSGEIP	VAFVIKSENS	QVTGEEIMQY	ISKQVIYYKK	IKRVFFVEAI
Poptr 4CL5	-----	MKDEDAGEVP	VAFVVKSEKS	QATEDEIKQY	ISKQVIFYKR	IKRVFFIEAI
Os 4CL1	-----	LKF---GEIP	VAFVAKTEGS	ELSEDDVKQF	VAKEVIYYKK	IREVFFVDKI
Os 4CL2	-----	QKDDVAGEVP	VAFVVRAADS	DITEESIKEF	ISKQVVFYKR	LHKVHFIHAI
Ns 4CL-1k	-----	LPDEEAGEIP	VAVVVLNSKA	KESEEDIINY	IASTVAQYKR	VRVVQFVDSI
Poptr ACOS	-----	LPDEEAGEIP	AACVVMSKSA	KESEEDIMEF	VASNVAHYKK	VRVVQFVDSI
At ACOS5	-----	LPDEEAGEIP	AACVVINPKA	TEKEEDILNF	VAANVAHYKK	VRAVHFVDSI
Pp ACOS6	-----	IPDEEAGEIP	GACVVLKPCD	FISPSEIQAF	VASKVSTYKQ	VRHVEFLASI
Gh ACS1	NKEALESWAA	DNNVS-GDFE	SLCKNPKAKE	FILGELAKTG	KEKCLKGFEI	IKAVHLDP-M
Gh ACS2	NKQALERWAA	DNGVS-GDFE	TICKDPKAKE	YILGELTRTG	KEKQLKGFEF	IKAVHLDH-V
At LACS4	NQHILERWAA	ENGVS-GDYD	ALCQNEKAKE	FILGELVKMA	KEKKMKGFEI	IKAIHLDP-V
At LACS5	AQQTILERWAV	ENGVN-GDFN	SICQNAKAKA	FILGELVKTA	KENKCLKGFEI	IKDVHLEP-V
At LACS3	SKIQIEHWAK	EHKVS-GDFE	SICRNQKTKE	FVLGEFNRVA	KDKCLKGFEL	IKGVHLDT-V
At LACS2	DRKAIEDWAK	LNYSQPNDFE	SLCQNLKAQK	YFLDELNSTA	KQYQLKGFEM	LKAIHLEP-N

At 4CL1	-----	-----	-----	-----	-----
At 4CL2	PKAPSGKILR	KDLRARLANG	LMN-----	-----	---
At 4CL3	PKSPSGKILR	KDLKAKLC--	-----	-----	---
At 4CL4	PKAVSGKILR	KDLRAKLETM	CSK-----	-----	---
Pp 4CL1	PKSPSGKILR	KDLRNKV---	-----	-----	---
Pp 4CL2	PESPSGKILR	KDLRNKV---	-----	-----	---
Pp 4CL3	PKSASGKILR	KDLRNKV---	-----	-----	---
Pp 4CL4	PKSAYGKILR	KDITLKF---	-----	-----	---
Poptr 4CL1	PKAPSGKILR	KDLRARLATG	DFLIKQFQHDT	YMQKQQ----	---
Poptr 4CL2	PKAPSGKILR	KDLRARVSAG	DLPCTSDS--	-----	---
Poptr 4CL3	PKSAAGKILR	KDLRAKLATA	TTMS-----	-----	---
Poptr 4CL4	PKAPSGKILR	KNLRERLAGG	LQK-----	-----	---
Poptr 4CL5	PKAPSGKILR	KNLRETLPGI	-----	-----	---
Os 4CL1	PKAPSGKILR	KELRKQLQHL	QQEALTN---	-----	---
Os 4CL2	PKSASGKILR	RELRAKLAAC	-----	-----	---
Ns 4CL-1k	PKSPSGKILR	RLIKDKMLER	LKNA-----	-----	---
Poptr ACOS	PKSPSGKIMR	RLLEKMGTT	SKAS-----	-----	---
At ACOS5	PKSLSGKIMR	RLLRDKILSI	NKK-----	-----	---
Pp ACOS6	PKSSSGKILR	RVLKEQIVKD	RNATKSDGQL	K-----	---
Gh ACS1	PFDMERDLLT	PTYKKKRPQL	LKYYQSVIDE	MYKSANKPNA	---
Gh ACS2	PFDMDRDLT	PTFKKKRPQL	LKYYQSVIDD	MYNSINKPNA	---
At LACS4	PFDMERDLLT	PTFKKKRPQL	LKYYQSVIDE	MYKTINAKFA	SRG
At LACS5	AFDMERDLLT	PTYKKKRPQL	LKYYQNVIIH	MYKTTKESLA	SGQ
At LACS3	PFDMERDLIT	PSYKMKRPQL	LKYYQKEIDE	MYKKNREVQL	RV-
At LACS2	PFDIERDLIT	PTFKLKRPL	LQHYKGIVDQ	LYSEAKRSM	---

Supplemental Figure 3. Alignment of amino acid sequences used to generate the phylogenetic trees shown in Figure 1 (A) and Supplemental Figure 4A (B). Protein names with species identifiers are given at the left. Dashes indicate gaps introduced to optimize the alignment. At, *Arabidopsis thaliana*; Os, *Oryza sativa* Poptr, *Populus trichocarpa*; Pp, *Physcomitrella patens*.



Supplemental Figure 4. Relationship of ACOS5 and clade A acyl-CoA synthetase proteins to cotton ACS1 and ACS2 proteins

(A) Phylogenetic analysis of 4CLs, clade A acyl-CoA synthetases (in red) including ACOS5, and LACS proteins (cotton Gh ACS1 and Gh ACS2 acyl-CoA synthetases in blue). The protein sequences used to generate this phylogeny are given in Supplemental Dataset 1 online

(B) Alignment of 4CLs, clade A acyl-CoA synthetases (in red) and LACS proteins, and cotton ACS1 and ACS2 acyl-CoA synthetases. Gh ACS1 and Gh ACS2 contain the linker region characteristic of LACS proteins, as defined by Shockey et al. (2002). Gh ACS1 and Gh ACS2 sequences from Wang and Li (2008); LACS sequences from Shockey et al. (2002); all other sequences from de Azevedo Souza et al. (2008). Numbers indicate bootstrap values out of 1000 replicates.

Supplemental Table 1. Genes used for phylogenetic reconstruction shown in Figure 1

Gene name	Reference gene model ¹	Clade	Annotation Reference
Arabidopsis			
4CL1	At1g51680	4CL class I	Elhting et al., 1999
4CL2	At3g21240	4CL class I	Elhting et al., 1999
4CL3	At1g65060	4CL class II	Elhting et al., 1999
At4L4	At3g21230	4CL class I	Hamberger et al., 2004
ACOS5	At1g62940	ACOS A	de Azevedo Souza et al., 2008
Rice			
4CL1	Os08g14760	4CL class I	Hamberger et al., 2007
4CL2	Os02g46970	4CL class II	Hamberger et al., 2007
4CL3	Os02g08100	4CL class I	Hamberger et al., 2007
4CL4	Os06g44620	4CL class I	Hamberger et al., 2007
4CL5	Os08g34790	4CL class I	Hamberger et al., 2007
ACOS9	Os04g24530	ACOS A	de Azevedo Souza et al., 2008
Physcomitrella			
4CL1	fgenesh1_pg.scaffold_185000.l.045	4CL Physco	de Azevedo Souza et al., 2008
4CL2	e_gw1.167.67.1	4CL Physco	de Azevedo Souza et al., 2008
4CL3	estExt_fgenesh1_pm.C_200030	4CL Physco	de Azevedo Souza et al., 2008
4CL4	estExt_fgenesh2_pg.C_710053	4CL Physco	de Azevedo Souza et al., 2008
ACOS6	fgenesh1_pg.scaffold_96000119	ACOS A	de Azevedo Souza et al., 2008
Poplar			
4CL1	estExt_fgenesh4_pg.C_1210004	4CL class I	Tsai et al, 2006; Hamberger et al., 2007
4CL2	gw1.XVIII.2818.1	4CL class I	Tsai et al, 2006; Hamberger et al., 2007
4CL3	grail3.0100002702	4CL class II	Tsai et al, 2006; Hamberger et al., 2007
4CL4	grail3.0099003002	4CL class I	Tsai et al, 2006; Hamberger et al., 2007
4CL5	fgenesh4_pg.C_LG_III001773	4CL class I	Tsai et al, 2006; Hamberger et al., 2007
ASOC13	eugene3.00010460	ACOS A	de Azevedo Souza et al., 2008
Tobacco			
CL-lk	AY163489	ACOS A	Varbanova et al., 2003

¹Sources of gene models: Arabidopsis, The Arabidopsis Information Resource (TAIR, <http://www.arabidopsis.org/>); rice, The Rice Genome Annotation Project rice genome browser (<http://rice.plantbiology.msu.edu/>); *Physcomitrella*, JGI *Physcomitrella patens* ssp *patens* v.1.1 genome browser (http://genome.jgi-psf.org/Phypa1_1/Phypa1_1.home.html); poplar, JGI *Populus trichocarpa* v.1.1 genome browser (http://genome.jgi-psf.org/Poptr1_1/Poptr1_1.home.html); tobacco, GeneBank Accession number as given (<http://www.ncbi.nlm.nih.gov>).

Supplemental Table 2. Molecular masses of CoA-ester products formed *in vitro* from different fatty acids by ACOS5. For product analysis, the reaction mix contained 2 μg of recombinant enzyme, 0.5 mM fatty acid, 1 mM ATP, 1 mM MgCl_2 , 1 mM CoA, 30 mM NH_4HCO_3 , and 0.05 % Triton X-100. After an incubation period of 1 to 3 h, the samples were diluted 1:50 with 50 % methanol and directly infused *via* a nano ESI source into an ion trap mass spectrometer (HCT ultra, Bruker Daltonics, Bremen) operating in negative ion mode. Mass spectra were obtained by scanning from m/z 400 to 1200. Putative product peaks were further characterized by MS-MS analysis resulting in fragments characteristic of CoA or phosphoadenosine-containing compounds, thereby confirming formation of the corresponding fatty acyl-CoA esters. Product analysis was carried out for the substrates oleic acid (C18:1), 16-hydroxy hexadecanoic acid (16OH-C16), and 8-hydroxy octanoic acid (8OH-C8).

Molecular species	C18:1		16OH-C16		8OH-C8	
	Mass (calc.)	Mass (obs.)	Mass (calc.)	Mass (obs.)	Mass (calc.)	Mass (obs.)
Fatty acid	282.26		272.24		160.11	
Fatty acyl-CoA [M]	1031.36		1021.34		909.21	
<i>MS spectrum:</i>						
[M+Na-2H]-	1052.33	1052.50	1042.31	1042.20	930.19	930.00
[M-H]-	1030.35	1030.69	1020.33	1020.20	908.21	908.00
[M-2H] ²⁻	514.67	514.80	209.66	209.50	453.60	453.50
<i>MS-MS spectrum:</i>						
[M-H ₂ O-H]-	1012.34	1012.20	1002.32	1002.20	890.20	890.00
[M-2H ₂ O-H]-	994.33	ND	984.31	984.10	872.19	872.00
[M-HPO ₃ -H]-	950.39	950.40	940.37	ND	828.24	ND
[M-H ₃ PO ₄ -H]-	932.38	932.40	922.36	922.00	810.23	810.20
[M-AMP-H]-	701.30	701.20	691.28	ND	579.15	579.00
[M-AMP-H ₂ O-H]-	683.29	683.20	673.27	673.20	561.15	561.00
[M-ADP-H]-	621.33	621.20	611.31	611.20	499.19	ND
[ADP-H]-	426.02	426.00	426.02	426.00	426.02	425.80
[ADP-H ₂ O-H]-	408.01	407.80	408.01	408.00	408.01	407.80
[AMP-H]-	346.06	ND	346.06	346.07	346.06	346.07

Supplemental Table 3. Co-expression of *CYP703A2* and *MS2* with *ACOS5*

r^2 value ¹	AGI code	Protein function or annotation	Insertion line or mutant phenotype
0.98	At1g01280	Cytochrome P450 protein CYP703A2	Partially male sterile ²
0.97	At3g11980	Male sterility protein MS2	Partially male sterile ³

¹Co-expression analysis carried out using <http://prime.psc.riken.jp/> Correlated Gene Search: Tissue and development v.1; 237 data points from developmental series. r^2 values are Pearson coefficient values.

² Morant et al. (2007)

³ Aarts et al. (1997)

Supplemental Table 4. Primer sequences used for PCR and RNA probe generation

Semi-quantitative RT-PCR		
Gene	Primer name	Sequence (5' → 3')
At1g62940	RT-CLL4F	CCTAATGTCCAAGTCCAAGAGGC
	RT-CLL4R	CTTCCTCGTCCGGTAACGGC
Genotyping		
Gene	Primer name	Sequence (5' → 3')
At1g62940	CLL4F	TTTGGTACCGTTTAAAAATGGAGTCAAAAG
	EcoR1 reverse	AAAGAATTCCATTGCGGTATCTCCGCA
	dspn1	CTTATTTTCAGTAAGAGTGTGGGGTTTTG
Complementation construct		
Gene	Primer name	Sequence (5' → 3')
At1g62940	ACLL5F	GATTGGTTAAGTTCATACGTTC
	ACLL5R	GCATGAGAAAGCAGCGTG
Generation of ACOS5:GUS constructs		
Gene	Primer name	Sequence (5' → 3')
At1g62940	Pfw1-62940	TGCAATGTAATCTTCAATCCTG
	Prv2-62940	GCTTTTTTACATAGCCATTAG
	Pfw3-62940	GTAATATCTTGTGAAATCACAAC
	Prv1-62940	TATCTTCTTGCTTTTGACTCTC
	Pfw2-62940	TAACATATATAAAATAAAGGTTTTAA
	Prv1-62940	TATCTTCTTGCTTTTGACTCTC
Generation of ACOS5:YFP construct		
Gene	Primer name	Sequence (5' → 3')
	attb1fw-62940	CGATGGAGAGTCAAAAGCAAGAA
	attb2rv-62940	CCTACTTCTTGTTGATGCTGAG-3
RNA probe generation for <i>in situ</i> hybridization		
Gene	Primer name	Sequence (5' → 3')
At1g62940	CLL4 cDNA F	ATGGAGAGTCAAAAGCAAGAAGATTAA
	CLL4 cDNA F-T7	GATAATACGACTCACTATAGGATGGAGAGTCAAAAGCAAGAAGATTAA
	CLL4 cDNA R-T7	GATAATACGACTCACTATAGGCATTGTGCGGTATGTGCGCATTTGTCTCC
	CLL4 cDNA R	CATTGTCCGGTATGTGCGCATTTGTCTCC