

Fig. 5- figure supplement 1. Reconstructed metabolism pathways and core biological processes in the ancestral ochrophyte plastid.

This figure tabulates each of the ancestral ochrophyte HPPGs corresponding to 350 central plastid metabolism and other biological processes. The "origin" column shows the probable evolutionary source for each HPPG as defined by combined BLAST tophit and single-gene tree analysis. The origin of each ancestral HPPG is either assigned a "high confidence" value (in which the same origin was robustly supported both by single-gene tree and by BLAST tophit analysis) or a "low confidence" value (in the absence of robust and consistent support through both techniques; corresponding to the tree sister-group if one could be clearly assigned, or the BLAST tophit identity if not). A dash indicates the corresponding protein was not identified in the ancestral HPPG dataset due to either being plastid-encoded or alternative reasons; detailed explanations for the enzymes that are neither plastid-encoded nor detected in the ancestral HPPG dataset are provided in figure supplement 2.

Key		Origin		Confidence	
				High	Low
				<div></div>	<div></div>
				<div></div>	<div></div>
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				<div></div>	<div></div>
				<div></div>	<div></div>
Cluster	Enzyme	Origin	Cluster	Enzyme	Origin
1. Light harvesting					
2ka	Divergent li818-type	<div></div>	4. Fatty acid biosynthesis		
xhu	High light inducible protein	<div></div>	a) Fatty acid synthesis		
2kb	LhcA-type protein 1	<div></div>	xlv	Long-chain acyl-CoA transporter	<div></div>
2kd	LhcA-type protein 2	<div></div>	xjx	Long-chain acyl-CoA synthetase	<div></div>
2kc	LhcA-type protein 3	<div></div>	xpy	Acetyl-coA:carboxylase	<div></div>
2ke	LhcA-type protein 4	<div></div>	xlb	Malonyl-CoA:ACP transacylase	<div></div>
2jx	LhcF-type protein 1	<div></div>	xph	Beta-ketoacyl synthase	<div></div>
2jw	LhcF-type protein 2	<div></div>	abx	Beta-ketoacyl-ACP reductase	<div></div>
2jz	LhcF-type protein 3	<div></div>	xik	Enoyl: ACP reductase	<div></div>
2kf	LhcR-type protein 1	<div></div>	2ig	Long chain fatty acid elongase 1	<div></div>
abj	LhcR-type protein 2	<div></div>	2qi	Long chain fatty acid elongase 2	<div></div>
2kh	LhcR-type protein 3	<div></div>	2ge	Fatty acid desaturase 1	<div></div>
abk	LhcR-type protein 4	<div></div>	2iu	Fatty acid desaturase 2	<div></div>
2bg	Li818-type	<div></div>	2jh	Fatty acid desaturase 3	<div></div>
2. Photosynthesis					
-	PsbA,B,C,D,E,F,H,I,J,K,L,N,T,V,W,X,Y,Z	<div></div>	b) Glycerol metabolism		
xmo	PsbU	<div></div>	2ky	Glycerol-3-phosphate dehydrogenase	<div></div>
xhz	Psb27	<div></div>	2kn	Glyceraldehyde 3-phosphate dehydrogenase	<div></div>
2ax	PsbP	<div></div>	5. Tetrapyrrole biosynthesis		
2dx	Psb31	<div></div>	a) Common branch		
abn	Psb31	<div></div>	2ol	Glutamyl-tRNA synthetase	<div></div>
2gd	PsbP	<div></div>	aai	Glutamyl-tRNA reductase	<div></div>
2js	PsbM	<div></div>	xkn	Glutamate-1-semialdehyde 2,1-aminomutase (GSA)	<div></div>
xkb	PsbO	<div></div>	xin	Delta-aminolevulinic acid dehydratase	<div></div>
2jn	PsbQ	<div></div>	xjr	Porphobilinogen deaminase	<div></div>
2am	PsbW superfamily	<div></div>	2be	Uroporphyrin III synthase	<div></div>
abo	PsbW superfamily	<div></div>	2nc	Uroporphyrinogen decarboxylase 1	<div></div>
2fd	Psb29	<div></div>	xjh	Uroporphyrinogen decarboxylase 2	<div></div>
-	PetA,B,D,G,L,M,N	<div></div>	xkm	Uroporphyrinogen decarboxylase 3	<div></div>
xcc	petC	<div></div>	xgl	Coproporphyrinogen III oxidase 1	<div></div>
2ai	petJ/ cytochrome c6	<div></div>	xls	Coproporphyrinogen III oxidase 2	<div></div>
xmc	CPLD51 protein required for cyt b6 assembly	<div></div>	4gz	Protoporphyrinogen oxidase	<div></div>
-	PsaA,B,C,D,E,F,I,J,L,M	<div></div>	b) Chlorophyll branch		
xqz	PSI subunit 223993351	<div></div>	xnp	Magnesium chelatase subunit D	<div></div>
2dv	Ferredoxin 1	<div></div>	xks	Magnesium chelatase subunit H	<div></div>
xlg	Ferredoxin 2	<div></div>	-	Magnesium chelatase subunit I	<div></div>
xnv	Ferredoxin 3	<div></div>	xiw	Magnesium-PPIX methyltransferase	<div></div>
2lt	Ferredoxin rieske component	<div></div>	-	Magnesium-PPIX methylmonoester cyclase	<div></div>
xdk	Ferredoxin-NADP oxidoreductase 1	<div></div>	2kl	Protochlorophyllide reductase A	<div></div>
2do	Ferredoxin-NADP oxidoreductase 2	<div></div>	xmw	3,8-divinyl protochlorophyllide a 8-vinyl reductase	<div></div>
xln	Plastoquinol terminal oxidase	<div></div>	xke	Chlorophyll synthetase	<div></div>
xla	Photosystem II assembly factor Hcf136	<div></div>	c) Haem branch		
xqz	PsaO	<div></div>	xjs	Ferrochelatase	<div></div>
2bh	PGR5 protein	<div></div>	2kr	haem oxygenase 1	<div></div>
xpd	PGR5-like protein	<div></div>	2ks	haem oxygenase 2	<div></div>
-	atpA,B,D,E,F,G,H,I	<div></div>	xjj	haem transporter	<div></div>
xkk	atpC	<div></div>	d) Catabolism		
3. Central carbon metabolism					
a) CBB cycle					
-	Rubisco large subunit	<div></div>	6. Carotenoid biosynthesis		
-	Rubisco small subunit	<div></div>	2mc	Deoxyxylulose-5-phosphate synthase	<div></div>
2eg	Rubisco small subunit N-methyltransferase I	<div></div>	xif	1-deoxy-D-xylulose 5-phosphate reductoisomerase	<div></div>
xms	3-phosphoglycerate kinase	<div></div>	xlf	4-diphosphocytidyl-2C-methyl-D-erythritol synthase	<div></div>
2kn	Glyceraldehyde 3-phosphate dehydrogenase	<div></div>	xob	4-diphosphocytidyl-2C-methyl-D-erythritol kinase	<div></div>
xip	Triosephosphate isomerase	<div></div>	xos	2C-methyl-D-erythritol 2,4-cyclodiphosphate synthase	<div></div>
2mh	Fructose-bisphosphate aldolase	<div></div>	2bp	1-hydroxy-2-methyl-2-(E)-butenyl-4-diphosphate synthase	<div></div>
-	Sedoheptulose bisphosphatase	<div></div>	xjf	4-hydroxy-3-methylbut-2-enyl diphosphate reductase	<div></div>
xic	Fructose-1,6-bisphosphatase 1	<div></div>	xjd	Geranylgeranyl pyrophosphate synthase 1	<div></div>
2jl	Fructose-1,6-bisphosphatase 2	<div></div>	xaf	Geranylgeranyl pyrophosphate synthase 2	<div></div>
5aa	Fructose-1,6-bisphosphatase 3	<div></div>	-	Isopentenyl diphosphate isomerase	<div></div>
xji	Transketolase	<div></div>	2oz	Phytoene synthase	<div></div>
xkt	Ribose-5-phosphate isomerase	<div></div>	2cb	Phytoene desaturase 1	<div></div>
2jj	D-ribulose-5-phosphate 3-epimerase	<div></div>	xjy	Phytoene desaturase 2	<div></div>
acq	Phosphoribulokinase 1	<div></div>	xhm	Zeta-carotene isomerase	<div></div>
xfl	Phosphoribulokinase 2	<div></div>	2kz	Zeta-carotene desaturase	<div></div>
b) Glycolysis/ gluconeogenesis					
3bo	Phosphoglycerate mutase 1	<div></div>	2dc	Beta-carotene isomerase	<div></div>
2je	Phosphoglycerate mutase 2	<div></div>	2kx	Lycopene beta cyclase	<div></div>
2ko	Enolase	<div></div>	xeq	Violaxanthin de-epoxidase	<div></div>
xlr	Pyruvate kinase	<div></div>	xjg	Zeaxanthin epoxidase	<div></div>
2dd	Pyruvate dehydrogenase	<div></div>	7. Iron-sulphur cluster biosynthesis		
xmt	Dihydrolipoamide dehydrogenase	<div></div>	-	SufB	<div></div>
xan	Dihydrolipoamide acetyltransferase	<div></div>	-	SufC	<div></div>
2hk	Pyruvate carboxylase	<div></div>	2hx	FeS assembly protein SufD	<div></div>
xlj	Pyruvate phosphate dikinase	<div></div>	xjm	Cysteine desulphurase NFS1	<div></div>
2is	Pyrophosphate-dependent phosphofructo-1-kinase	<div></div>	xki	sulphite reductase (ferredoxin) 1	<div></div>
xnl	Phosphoglucosmutase	<div></div>	xra	sulphite reductase (ferredoxin) 2	<div></div>
xdv	Beta-glucan synthase	<div></div>	xlo	Fe-S cluster biosynthesis protein ISA1	<div></div>
4ay	Glucan 1,3-beta-glucosidase	<div></div>	xgg	Mitochondrial Fe-S cluster biosynthesis protein ISA2	<div></div>
xru	Hexose and triose phosphate transporter	<div></div>	2dy	NifU protein 1	<div></div>
			2oq	NifU protein 2	<div></div>
8. Riboflavin biosynthesis					
2oe	4-dihydroxy-2-butanone 4-phosphate synthase	<div></div>	9. Glutamate/ glutamine/ aspartate/ lysine biosynthesis		
2oe	GTP cyclohydrolase	<div></div>	a) Glutamine branch		
4hc	Riboflavin synthase	<div></div>	2bx	Pyruvate transporter	<div></div>
9. Glutamate/ glutamine/ aspartate/ lysine biosynthesis					
a) Glutamine branch					
2ct	Bicarbonate transporter	<div></div>	2ct	Bicarbonate transporter	<div></div>
2hk	Pyruvate carboxylase	<div></div>	2hk	Pyruvate carboxylase	<div></div>
2mi	Aspartate aminotransferase	<div></div>	2mi	Aspartate aminotransferase	<div></div>
2jb	Glutamine synthetase	<div></div>	2jb	Glutamine synthetase	<div></div>
xso	Kynurenine aminotransferase	<div></div>	xso	Kynurenine aminotransferase	<div></div>
2jk	Glutamate synthase	<div></div>	2jk	Glutamate synthase	<div></div>
b) Aspartate branch					
xlk	Aspartate kinase	<div></div>	10. Aromatic amino acid biosynthesis		
2cy	Aspartate-semialdehyde dehydrogenase 1	<div></div>	a) Chorismate branch		
xgf	Aspartate semialdehyde dehydrogenase 2	<div></div>	xmk	DAHP synthetase	<div></div>
2br	Dihydropicolinate synthase	<div></div>	-	3-dehydroquinate synthase	<div></div>
4ba	Homoserine dehydrogenase	<div></div>	xjv	3-dehydroquinate reductase/ Shikimate dehydroge	<div></div>
xis	Dihydrodipicolinate reductase	<div></div>	-	Shikimate kinase	<div></div>
xlw	Diaminopimelate aminotransferase	<div></div>	xiq	EPSP synthase	<div></div>
xoi	Diaminopimelate epimerase	<div></div>	xsl	Chorismate synthase	<div></div>
xkz	Diaminopimelate decarboxylase	<div></div>	b) Phenylalanine/Tyrosine branch		
10. Aromatic amino acid biosynthesis					
a) Chorismate branch					
xmk	DAHP synthetase	<div></div>	9af	Chorismate mutase	<div></div>
-	3-dehydroquinate synthase	<div></div>	2mi	Aspartate aminotransferase	<div></div>
xjv	3-dehydroquinate reductase/ Shikimate dehydroge	<div></div>	xso	Kynurenine/ phenylpyruvate aminotransferase	<div></div>
-	Shikimate kinase	<div></div>	xsg	Prephenate dehydrogenase	<div></div>
xiq	EPSP synthase	<div></div>	c) Tryptophan branch		
xsl	Chorismate synthase	<div></div>	xhr	Anthraniolate synthase	<div></div>
b) Phenylalanine/Tyrosine branch					
9af	Chorismate mutase	<div></div>	xld	Anthraniolate phosphoribosyltransferase	<div></div>
2mi	Aspartate aminotransferase	<div></div>	2gg	Phosphoribosylanthranilate isomerase/ indole 3-gly	<div></div>
xso	Kynurenine/ phenylpyruvate aminotransferase	<div></div>	abs	Tryptophan synthase alpha	<div></div>
xsg	Prephenate dehydrogenase	<div></div>	xfu	Tryptophan synthase beta	<div></div>
11. Branched chain amino acid biosynthesis					
a) Valine/ Isoleucine branch					
-	Acetolactate synthase	<div></div>	11. Branched chain amino acid biosynthesis		
xmy	Keto-acid reductoisomerase	<div></div>	a) Valine/ Isoleucine branch		
xkg	Dihydroxy-acid dehydratase	<div></div>	-	Acetolactate synthase	<div></div>
xiz	Branched-chain amino acid aminotransferase II	<div></div>	xmy	Keto-acid reductoisomerase	<div></div>
b) Leucine branch					
-	Isopropylmalate synthase	<div></div>	xkg	Dihydroxy-acid dehydratase	<div></div>
xmm	3-isopropylmalate isomerase	<div></div>	xiz	Branched-chain amino acid aminotransferase II	<div></div>
xkq	3-isopropylmalate dehydrogenase	<div></div>	12. Serine and cysteine biosynthesis		
xiz	Branched-chain amino acid aminotransferase II	<div></div>	a) Serine branch		
12. Serine and cysteine biosynthesis					
a) Serine branch					
xhx	Serine hydroxymethyltransferase	<div></div>	b) Cysteine branch		
xly	ATP sulphurylase (sulphate adenyllyltransferase)	<div></div>	xly	ATP sulphurylase (sulphate adenyllyltransferase)	<div></div>
-	Adenosine sulphate kinase	<div></div>	-	Adenosine sulphate kinase	<div></div>
xiv	Phosphoadenosine phosphosulphate reductase 1/	<div></div>	xiv	Phosphoadenosine phosphosulphate reductase 1/	<div></div>
xkd	Phosphoadenosine phosphosulphate reductase 2	<div></div>	xkd	Phosphoadenosine phosphosulphate reductase 2	<div></div>
xki	sulphite reductase (ferredoxin) 1	<div></div>	xki	sulphite reductase (ferredoxin) 1	<div></div>
xra	sulphite reductase (ferredoxin) 2	<div></div>	xra	sulphite reductase (ferredoxin) 2	<div></div>
xct	Cysteine synthase	<div></div>	xct	Cysteine synthase	<div></div>
xgx	Serine O-acetyltransferase	<div></div>	xgx	Serine O-acetyltransferase	<div></div>
13. Aminoacyl tRNA synthetases					
xhe	Alanyl-tRNA synthetase	<div></div>	13. Aminoacyl tRNA synthetases		
2mg	CysteinyI-tRNA synthetase 1	<div></div>	a) Serine branch		
2cw	CysteinyI-tRNA synthetase 2	<div></div>	b) Cysteine branch		
2np	Aspartyl-tRNA synthetase	<div></div>	xhe	Alanyl-tRNA synthetase	<div></div>
2ol	Glutamyl-tRNA synthetase	<div></div>	2mg	CysteinyI-tRNA synthetase 1	<div></div>
2mr	Phenylalanyl-tRNA synthetase 1	<div></div>	2cw	CysteinyI-tRNA synthetase 2	<div></div>
2lx	Phenylalanyl-tRNA synthetase 2	<div></div>	2np	Aspartyl-tRNA synthetase	<div></div>
2ja	Glycyl-tRNA synthetase	<div></div>	2ol	Glutamyl-tRNA synthetase	<div></div>
xmg	Histidyl-tRNA synthetase	<div></div>	2mr	Phenylalanyl-tRNA synthetase 1	<div></div>
2qe	Isoleucyl-tRNA synthetase	<div></div>	2lx	Phenylalanyl-tRNA synthetase 2	<div></div>
9aa	Lysyl-tRNA synthetase	<div></div>	2ja	Glycyl-tRNA synthetase	<div></div>
2kq	Leucyl-tRNA synthetase	<div></div>	xmg	Histidyl-tRNA synthetase	<div></div>
xdl	Methionyl-tRNA synthetase	<div></div>	2qe	Isoleucyl-tRNA synthetase	<div></div>
xqu	Asparaginyl-tRNA synthetase	<div></div>	9aa	Lysyl-tRNA synthetase	<div></div>
xsa	Prolyl-tRNA synthetase	<div></div>	2kq	Leucyl-tRNA synthetase	<div></div>
xho	Glutamyl-tRNA synthetase	<div></div>	xdl	Methionyl-tRNA synthetase	<div></div>
9ac	Arginyl-tRNA synthetase	<div></div>	xqu	Asparaginyl-tRNA synthetase	<div></div>
xhf	Seryl-tRNA synthetase	<div></div>	xsa	Prolyl-tRNA synthetase	<div></div>
xiu	Threonyl-tRNA synthetase	<div></div>	xho	Glutamyl-tRNA synthetase	<div></div>
xky	Valyl-tRNA synthetase	<div></div>	9ac	Arginyl-tRNA synthetase	<div></div>
xhg	Tryptophanyl-tRNA synthetase	<div></div>	xhf	Seryl-tRNA synthetase	<div></div>
xfs	Tyrosyl-tRNA synthetase	<div></div>	xiu	Threonyl-tRNA synthetase	<div></div>
14. Nucleotide synthesis and import					
2cs	Adenylate kinase	<div></div>	14. Nucleotide synthesis and import		
xnf	Guanylate kinase	<div></div>	a) Serine branch		
2ow	UMP-CMP kinase	<div></div>	b) Cysteine branch		
2hu	Nucleotide triposphate transporter 1	<div></div>	xnf	Guanylate kinase	<div></div>
15. Ribosome					
rps2-14, rps16-20					
rpl1-6, rpl11-16, rpl18-24, rpl27, rpl29, rpl31-36					
xjb	rps1A	<div></div>	a) Serine branch		
xih	rps1B	<div></div>	b) Cysteine branch		
-	rps15	<div></div>	xjb	rps1A	<div></div>
2mt	rpl9	<div></div>	xih	rps1B	<div></div>
xix	rpl10	<div></div>	-	rps15	<div></div>
xhv	rpl17	<div></div>	2mt	rpl9	<div></div>
xju	rpl28	<div></div>	xix	rpl10	<div></div>
xmh	rps30A	<div></div>	xhv	rpl17	<div></div>
xid	rps21	<div></div>	xju	rpl28	<div></div>
16. Translation initiation					
xjt	Translation initiation factor 1	<div></div>	16. Translation initiation		
xjc	Translation initiation factor 2	<div></div>	a) Serine branch		
4ac	Translation initiation factor 3	<div></div>	b) Cysteine branch		
-	Translation elongation factor EF-Tu	<div></div>	xjt	Translation initiation factor 1	<div></div>
-	Translation elongation factor EF-Ts	<div></div>	xjc	Translation initiation factor 2	<div></div>
xqr	Translation elongation factor P	<div></div>	4ac	Translation initiation factor 3	<div></div>
xjl	Translation elongation factor G	<div></div>	-	Translation elongation factor EF-Tu	<div></div>
2qq	Ribosome release factor	<div></div>	-	Translation elongation factor EF-Ts	<div></div>
xqf	Ribosome recycling factor	<div></div>	xqr	Translation elongation factor P	<div></div>