

Chloroplast and Cyanobacterial Genomes, Genes and RNAs: a Compilation

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The organization and expression of plastid genomes are among the most extensively studied fields in plant molecular biology. Restriction endonuclease cleavage site maps have been constructed for the plastid genomes of many plant species. Genes for the rRNAs, for most of the tRNAs and for several proteins have been located on these physical maps. Furthermore, the nucleotide sequences of many of these genes, and/or the corresponding RNAs, have been determined.

This article, which is an up-date of the information found in Bohnert et al., 1982 and Crouse et al., 1984, compiles the information on plastid genomes, genes and RNAs which has appeared in the literature. Some highlights of the data, along with the literature citations, are presented in table-form. In addition, related information on cyanobacteria is included. Table 1 lists the plastid genomes for which physical maps have been constructed, and indicates the genes which have been mapped. Sequenced genes for rRNAs, tRNAs and proteins are compiled in Tables 2, 3 and 4, respectively. Gene

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nomenclature follows the set of guidelines agreed upon by the majority of workers in the field of chloroplast molecular biology (see Hallick and Bottomley, 1983). Many general reviews have been written on this or related topics:

Buetow et al., 1982	Groot, 1984
Wallace, 1982	Stutz, 1984
Weil and Parthier, 1982	Hallick et al., 1984
Bogorad et al., 1983	Hallick, 1985
Hagemann and Metzloff, 1983	Palmer, 1985
Whitfield and Bottomley, 1983	

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TABLE I. Physical mapping data on chloroplast DNA from various plant species and mapping of genes or specific regions

Plant source (common name)	Type of repeat	Organization into segments ^b (kbp)				Total size (kbp)	Genes ^c or regions mapped	Reference*
<i>Atriplex triangularis</i>	I (R)	24.1	ND	24.1	ND	152	23SrDNA 16SrDNA <i>rbcL</i> <i>psbA</i>	Palmer 1982
<i>Atropa belladonna</i>	I (R)	ND	ND	ND	ND	160	23SrDNA 16SrDNA 5SrDNA 4.5SrDNA	Fluhr and Edelman 1981a
<i>Brassica napus</i> (winter rape)	I (R)					150		Vedel et al. 1982 Vedel and Mathieu 1983
<i>Brassica</i> ssp.	I (R)	ND	ND	ND	ND	ca. 150	23SrDNA 16SrDNA <i>rbcL</i> <i>psbA</i>	Palmer et al. 1983a
<i>Chlamydomonas reinhardtii</i>	I (R)	21	76	21	77	195	23SrDNA 16SrDNA 7SrDNA 5SrDNA 3SrDNA 17 <i>trns</i>	Rochaix 1978, 1981 Rochaix and Malnoe 1978 Malnoe and Rochaix 1978 Malnoe et al. 1979

TABLE I. Continued

Plant source (common name)	Type ^a of repeat	Organization into segments ^b (kbp)				Total size (kbp)	Genes ^c or regions mapped	Reference [*]
							<i>rbcL</i> <i>rnfA</i> <i>rpl2</i> <i>rps4</i> , 11, 13, 19 <i>psbA</i> .D <i>rpoB</i> .C' <i>ars1</i> <i>oriA</i> ,B	Watson and Surzycki 1982, 1983 Erickson et al. 1984a,b Lemieux et al. 1984a,b Rochaix et al. 1984 Valler et al. 1984 Waddell et al. 1984 Wang et al. 1984 Bergmann et al. 1985
<i>Chlorella ellipsoidea</i>	I(R,E)	23	29.5	23	98.5	ca. 175	23SrDNA 16SrDNA 5SrDNA	Yamada 1983
<i>Cicer arietinum</i>	No (E)					120		Chu and Tewari 1982
<i>Cucumis sativa</i> (cucumber)	I (R)	14+	24	14+	ca. 104	155	23SrDNA 16SrDNA <i>rbcL</i> <i>psbA</i>	Palmer 1982 Palmer and Thompson 1982
<i>Cyanophora paradoxa</i>	I(R,E)	11	17.5	11	87	127	23SrDNA 16SrDNA 29 <i>trns</i> <i>rbcL</i> ,S <i>atpB</i> <i>ppcB</i> [*]	Bohnert and Löffelhardt, 1982 Heinhorst and Shively 1983 Kuntz et al. 1984a Lemaux and Grossman 1984 Wasmann and McIntosh, pers. comm.
<i>Euglena gracilis</i> Z.	T(R,E)	5.7	5.7	5.7	122	140	23SrDNA 16SrDNA 5SrDNA 23 <i>trns</i> <i>rbcL</i> <i>rnfA</i> <i>rps7</i> , 12 <i>psbA</i> <i>oriA</i>	Gray and Hallick 1977, 1978, 1979 Jenni and Stutz 1978, 1979 Rawson et al. 1978 Keller et al. 1980, 1982 Orozco et al. 1980a,b, 1982a Jenni et al. 1981 Rutti et al. 1981 Schmitt et al. 1981 Koller and Delius 1982a,c,d Kuntz et al. 1982 Ravel-Chapuis et al. 1982 Stiegler et al. 1982 Dix et al. 1983 Passavant et al. 1983

TABLE I. Continued

Plant source (common name)	Type ^a of repeat	Organization into segments ^b (kbp)					Total size (kbp)	Genes ^c or regions mapped	Reference [*]
								Schlunegger et al. 1983 Hallick et al. 1984 Koller and Delius 1984 Koller et al. 1984a Montandon and Stutz 1984 Schlunegger and Stutz 1984	
<i>Euglena gracilis</i> B	T(R,E)						23SrDNA 16SrDNA 5SrDNA <i>trns</i>	Helling et al. 1979 El-Gewely et al. 1981, 1984 Koller and Delius 1982b Koller et al. 1984a	
<i>Euglena gracilis</i> Z-S	No (R)						23SrDNA 16SrDNA	Wurtz and Buetow 1981	
<i>Euglena gracilis</i>	T	2 ribosomal operons							Ravel-Chapuis et al. 1984
<i>Euglena gracilis</i> B- ATCC No. 10616	T (E)	5 complete operons and 2 extra					16SrDNAs		Koller and Delius 1982b Flamant et al. 1984
<i>Glycine max</i> (soybean)	I (R)	22	ND	22	ND	ca. 150	23SrDNA 16SrDNA <i>rbcL</i> <i>tufA</i> <i>rps19</i> <i>psbA</i> <i>ori</i>	Palmer et al. 1983b Spielmann et al. 1983	
<i>Hordeum vulgare</i> (barley)	I (R)						<i>rbcL</i>	Poulsen 1983, 1984	
<i>Lactuca sativa</i> (lettuce)	I (E)	24.4	20	24.4	87	156		Kolodner and Tewari 1979	
<i>Linum usitatissimum</i> (common flax)								Coates and Cullis 1982	
<i>Lycopersicon</i> sp.	I (R)	18+	ND	18+	ND		23SrDNA 16SrDNA <i>rbcL</i>	Palmer and Zamir 1982	
<i>Marchantia polymorpha</i>	I (R)	11.7	15.7	11.7	81.9	121	23SrDNA 16SrDNA 5SrDNA <i>rbcL</i>	Ohyama et al. 1983 Yamano et al. 1984	
<i>Medicago sativa</i> (alfalfa)	No (R)					126	23SrDNA 16SrDNA <i>rbcL</i> <i>psbA</i> <i>atpA,B,E</i>	Palmer et al. 1985	

TABLE 1. Continued

Plant source (common name)	Type ^a of repeat	Organization into segments ^b (kbp)				Total size (kbp)	Genes ^c or regions mapped	Reference*
<i>Narcissus pseudonarcissus</i> ^d	I (E)	28.5	16.6	28.5	87.8	161		Thompson et al. 1981
<i>Nicotiana accuminata</i>	I (R)	22.7	ND	22.7	ND	171		Shen et al. 1982
<i>Nicotiana otophora</i>	I (R)					160.5	23SrDNA 16SrDNA <i>rbcL</i>	Zhu et al. 1982
<i>Nicotiana tabacum</i> (tobacco)	I(R,E)	22.6 24 20.4 19.3	ND 13 24 ND	22.6 24 20.4 19.3	ND 99 95 ND	ND 160 160 160	23SrDNA 16SrDNA 5SrDNA 20 <i>trns</i> <i>rbcL</i> <i>rpl2</i> <i>rps7</i> , 12, 19 <i>atpA</i> , B, E, H <i>petA</i> , C <i>ars</i>	Sugiura and Kusada Jurgenson and Bourque 1980 Fluhr and Edelman 1981b Seyer et al. 1981 Shen et al. 1982 Fluhr et al. 1983a Bergmann et al. 1984 Lin and Kung 1984 Ohtani et al. 1984 Sugita et al. 1984 Tassopulu and Kung 1984
<i>Oenothera</i> sp. (evening primrose)							23SrDNA 16SrDNA	Gordon et al. 1981, 1982
plastome I	I (R)	23	20	23	87	153	5SrDNA	
plastome II	I (R)	23	20	23	87	153		
plastome III	I (R)	23	20	23	88	154		
plastome IV	I (R)	23	20	23	86	152		
plastome V	I (R)	24	20	24	87	154		
<i>Osmunda cinnamomea</i>	I (R)	13.4-	ND	13.4-	ND	144	23SrDNA 16SrDNA <i>rbcL</i> <i>atpA</i> , B <i>psbA</i>	Palmer and Stein 1982
<i>Pennisetum americanum</i> (pearl millet)	I (R)	ND	12	ND	ND	127-138	23SrDNA 16SrDNA 5SrDNA <i>rbcL</i> <i>atpB</i> <i>psbA</i>	Rawson et al. 1981a Thomas et al. 1984
<i>Petunia hybrida</i> (petunia)	I(R,E)	15 +	20	15 +	ca. 102	ca. 152	23SrDNA 16SrDNA 5SrDNA 4.5SrDNA <i>rbcL</i> <i>atpB</i> , E, H <i>arsA</i> , B ^f	Bovenberg et al. 1981, 1984a, b Palmer and Thompson 1982 Overbeeke et al. 1984

TABLE I. Continued

Plant source (common name)	Type ^a of repeat	Organization into segments ^b (kbp)				Total size (kbp)	Genes ^c or regions mapped	Reference*
<i>Petunia parodii</i>	I (R)					160		Fluhr and Edelman 1981a
<i>Phaseolus vulgaris</i> (common bean)	I (R)	22+	23-	22+	82+	150	23SrDNA 16SrDNA 27 trns rbcL psbA	Mubumbila et al. 1983 Palmer 1983 Palmer et al. 1983b
<i>Pisum sativum</i> (pea)	No(R,E)					135 120	23SrDNA 16SrDNA 28 trns rbcL atpA,B,E,H psaA psbA petA	Chu et al. 1981 Palmer and Thompson 1981a,b, 1982 Chu and Tewari 1982 Willey et al. 1983, 1984b Huttly and Gray 1984 Smith and Gray 1984a,b Mubumbila et al. 1985b
<i>Sinapis alba</i> (mustard)	I (R)	ca. 22	ca. 30	ca. 22	ca. 84	ca. 158	23SrDNA 16SrDNA trns rbcL psbA	Link 1981a Link et al. 1981 Link and Langridge 1984
<i>Solanum</i> sp.	I (R)	15.1+	20.9	15.1+	106.9	158	23SrDNA 16SrDNA rbcL psbA	Palmer and Zamir 1982 Edelman, pers. comm.
<i>Spinacia oleracea</i> (spinach)	I(R,E)	23	19	23	80	145	23SrDNA 16SrDNA 5SrDNA 4.5SrDNA 27 trns rbcL atpA,B,E,H rpl2 rps12,19 psaA1,A2 psbA,B,C,D petA,B,C,D	Crouse et al. 1978 Whitfeld et al. 1978b Driesel et al. 1979, 1980 Kolodner and Tewari 1979 Herrmann et al. 1980a Whitfeld and Bottomley 1980 Erion et al. 1981 Schmitt et al. 1981 Westhoff et al. 1981, 1983a,b Alt et al. 1983a,b
<i>Spirodela oligorrhiza</i> (duckweed)	I (R)	27	28	27	100	182	23SrDNA 16SrDNA 5SrDNA 4.5SrDNA trns rbcL atpA,B,E psbA	van EE et al. 1980, 1982 Groot and van Harten- Loosbroek 1981 deHeij et al. 1983 Keus et al. 1983a,b,c

TABLE I. *Continued*

<i>Plant source</i> (common name)	<i>Type^a</i> of <i>repeat</i>	<i>Organization into segments^b</i> (<i>kbp</i>)				<i>Total</i> <i>size</i> (<i>kbp</i>)	<i>Genes^c or</i> <i>regions</i> <i>mapped</i>	<i>Reference[*]</i>
<i>Triticum aestivum</i> (wheat)	I(R,E)	21	12.8	21	80.2	135	23SrDNA 16SrDNA 26 <i>trns</i> <i>atpA</i> ,B,E,H <i>rbcL</i>	Bowman et al. 1981, 1983 Howe et al. 1982a,b, 1983 Koller et al. 1982e Day and Ellis 1984 Mubumbila et al. 1985a
<i>Tropaeolum majus^d</i> (nasturtium)	I (E)	27.1	18.5	27.1	82.3	155	23SrDNA 16SrDNA	Thompson et al. 1981
<i>Vicia faba</i> (broad bean)	No(R,E)					121	23SrDNA 16SrDNA 25 <i>trns</i> <i>rbcL</i> <i>atpA</i> ,B,E <i>psbA</i>	Delius and Koller 1980 Koller and Delius 1980 Palmer and Thompson 1982 Ko et al. 1983, 1984 Mubumbila et al. 1984 Shinozaki et al. 1984
<i>Vigna radiata</i> (mung bean)	I (R)	23	21	23	83	150	23SrDNA 16SrDNA <i>rbcL</i> <i>atpA</i> ,B,E <i>psbA</i>	Palmer and Thompson 1981a,b, 1982 Palmer et al. 1982, 1983b
<i>Zea mays</i> (maize)	I(R,E)	22.5	13	22.5	77	135	23SrDNA 16SrDNA	Bedbrook and Bogorad 1976
		22.5	12.6	22.5	78.5	136	5SrDNA 4.5SrDNA 26 <i>trns</i> <i>rbcL</i> <i>atpB</i> ,E <i>rps4</i> <i>psbA</i>	Bedbrook et al. 1977, 1979 Kolodner and Tewari 1979 Link and Bogorad 1980 Koller et al. 1982e Krebbers et al. 1982 Palmer and Thompson 1982 Larrinua et al. 1983 Selden et al. 1983 Subramanian et al. 1983

^aRepeat structures (I = inverted; T = tandem; No = no repeat) were determined by restriction endonuclease analysis (R) and/or electron microscopy (E).

^bThe size of the repeated segments are given in bold numbers.

^cFor additional information and references dealing with sequenced genes for rRNAs, tRNAs and proteins, and in some cases their sequenced RNAs, see Tables 2, 3 and 4, respectively

^dChromoplast DNA investigated

^e*rpoB*,C = RNA polymerase subunits

^f*arsA*,B = autonomously replicating sequences

^g*ppcB* = gene for the beta-phycoyanine of the cyanobacterial phycobilisomes.

*References are listed in chronological order.

ND = Not determined

TABLE 2. Sequenced ribosomal RNAs and genes for rRNAs

Type of rRNA	Gene	Plant source	Number of nucleotides	Intron(s)	Reference
23S	23SrDNA	<i>Anacystis nidulans</i>	2,869	No	Kumano et al. 1983 Douglas and Doolittle 1984b
		<i>Chlamydomonas</i>		Yes 0.87 kbp ^a	Rochaix and Malnoe 1978 Allet and Rochaix 1979 Rochaix and Darlix 1982
		<i>Euglena gracilis</i> Z	partial		Graf et al. 1980 Orozco et al. 1980b
		<i>Euglena gracilis</i> B	partial		El-Gewely et al. 1981, 1984
		tobacco	2,804	No	Kusuda et al. 1980 Tohdoh et al. 1981 Takaiwa and Sugiura 1982a
		<i>Spirodela</i>	partial		Keus et al. 1983b
		maize	2,890	No	Edwards and Kossel 1981 Koch et al. 1981 Briat et al. 1982a Zenke et al. 1982 Strittmatter and Kossel 1984
16S	16SrDNA	<i>Anacystis nidulans</i>	1,487	No	Tomioka et al. 1981 Tomioka and Sugiura 1983
		<i>Chlamydomonas</i>	1,475	No	Rochaix and Malnoe 1978 Dron et al. 1982b
		<i>Euglena gracilis</i> Z	1,491 partial truncated	No	Orozco et al. 1980b Graf et al. 1982 Steege et al. 1982 Roux et al. 1983
		tobacco	1,486	No	Tohdoh et al. 1981 Tohdoh and Sugiura 1982
		mustard			Przybyl et al. 1984
		<i>Synechococcus</i>			Borbely and Simoncsits 1981

TABLE 2. Continued

Type of rRNA	Gene	Plant source	Number of nucleotides	Intron(s)	Reference
		<i>Spirodela</i>	partial		Keus et al. 1983b
		maize	1,491	No	Schwarz and Kossel 1979, 1980 Koch et al. 1981 Schwarz et al. 1981b
7S	7SrDNA	<i>Chlamydomonas</i>	282	No	Rochaix and Darlix 1982
5S ^b	5SrDNA	<i>Anacystis nidulans</i>			Corry et al. 1974 Douglas and Doolittle 1984a
		<i>Chlamydomonas</i>			Rochaix and Malnoe 1978
		<i>Dryopteris acuminata</i>	119 120 122	— — —	Takaiwa and Sugiura 1982b
		<i>Eisenia bicyclis</i>	118	—	Lim et al. 1984
		<i>Euglena gracilis</i> Z.		No	Karabin et al. 1983
		<i>Euglena gracilis</i> B	ca. 121	No	El-Gewely et al. 1984
		<i>Jungermannia</i> sp.	119		Yamano et al. 1984
		<i>Lemna minor</i>	119 121	— —	Dyer and Bowman 1979
		<i>Marchantia</i> sp.	119		Yamano et al. 1984
		tobacco	119 120 121	— No —	Dyer and Bowman 1979 Takaiwa and Sugiura 1980a, b, 1981
		dwarf bean	120	—	Dyer and Bowman 1979
		<i>Sargassum fulvellum</i>	118	—	Lim et al. 1984
		spinach	121 122	—	Delihias et al. 1981 Pieler et al. 1982
		<i>Spirodela oligorbiza</i>	120	No	Keus et al. 1983a
		<i>Synechococcus lividus</i> III			Delihias et al. 1982

TABLE 2. *Continued*

Type of rRNA	Gene	Plant source	Number of nucleotides	Intron(s)	Reference
		<i>Ulva pertusa</i>	120	—	Lim et al. 1984
		broad bean	121 122	—	Dyer and Bowman 1979
		maize	122	No	Dyer and Bedbrook 1980 Strittmatter and Kossel 1984
4.5S	4.5SrDNA	<i>Dryopteris acuminata</i>	103	—	Takaiwa et al. 1982
		<i>Lemna minor</i>	ca. 63 96 103	— — —	Bowman and Dyer 1979
		tobacco	101 103	— No	Bowman and Dyer 1979 Takaiwa and Sugiura 1980a, b, c
		dwarf bean	103	—	Bowman and Dyer 1979
		spinach	106	—	Kumagai et al. 1982
		<i>Spirodela oligorbiza</i>	102	No	Keus et al. 1983a
		wheat	96	—	Wildeman and Nazar 1980
		broad bean	72	—	Bowman and Dyer 1979
		maize	95	No	Edwards et al. 1981
3S	3SrDNA	<i>Chlamydomonas</i>	47	No	Rochaix and Darlix 1982

*Determined by electron microscopy and by hybridization of purified rRNA to various rDNA restriction fragments.

^bsee also, Erdmann et al., 1984

TABLE 3. Identified and/or sequenced transfer RNAs and genes for tRNAs

<i>tRNAs</i> accepting:	Plant source	No. of isoacceptors identified	<i>tRNAs</i> sequenced ^{a,b}	<i>tRNA</i> genes mapped	<i>tRNA</i> genes sequenced ^c	Reference
Ala	<i>Anacystis nidulans</i>				<i>trnA</i> -UGC	Tomioka and Sugiura 1984
	<i>Chlamydomonas</i>	1		1		Bergmann et al. 1985
	<i>C. paradoxa</i> ^d	1		2		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		2 or 3	<i>trnA</i> -UGC	Graf et al. 1980 Keller et al. 1980 Orozco et al. 1980b
	soybean	1				Swamy and Pillay 1982
	lupin	1				Mubumbila 1984
	tobacco	1		2	<i>trnA</i> -UGC 710 bp intron	Takaiwa and Sugiura 1982c Bergmann et al. 1984
	common bean	1		2		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1		1		Driesel et al. 1979
	wheat	2		2		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		2	<i>trnA</i> -UGC 806 bp intron	Koch et al. 1981 Selden et al. 1983
Arg	<i>C. paradoxa</i>	2		2		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	2		1	<i>trnR</i> -ACG	Kuntz et al. 1982 Orozco and Hallick 1982b
	lupin	2				Mubumbila 1984
	tobacco	2		3	<i>trnR</i> -UCU <i>trnR</i> -ACG	Sugiura et al. 1983 Bergmann et al. 1984 Deno and Sugiura 1984a
	common bean	2		2		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	2		1		Driesel et al. 1979
	wheat	1		2		Mubumbila et al. 1985a
	broad bean	2		2		Mubumbila et al. 1984
	maize	1		2		Selden et al. 1983
Asn	<i>Chlamydomonas</i>			1		Bergmann et al. 1985
	<i>C. paradoxa</i>	1		1		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		1	<i>trnN</i> -GUU	Kuntz et al. 1982 Orozco and Hallick 1982b
	tobacco			2	<i>trnN</i> -GUU	Kato et al. 1981
	common bean	2		2		Mubumbila et al. 1983
	pea	2		1		Mubumbila et al. 1985b
	spinach	1		1		Driesel et al. 1979

TABLE 3. continued

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	<i>No. of isoacceptors</i> <i>identified</i>	<i>tRNAs</i> <i>sequenced</i> ^{a,b}	<i>tRNA</i> <i>genes</i> <i>mapped</i>	<i>tRNA</i> <i>genes</i> <i>sequenced</i> ^c	<i>Reference</i>
	wheat	1		2		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	2		4		Selden et al. 1983
Asp	<i>C. paradoxa</i>	1		1		Kuntz et al. 1984a
	soybean	1				Swamy and Pillay 1982
	lupin	2				Mubumbila 1984
	tobacco			1		Bergmann et al. 1984
	pea	1		1		Mubumbila et al. 1985b
	spinach				<i>trnD</i> -GUC	Holschuh et al. 1983
	wheat	2		1	<i>trnD</i> -GUC	Mubumbila et al. 1985a Quigley et al. 1985
	broad bean	2		2		Mubumbila et al. 1984
	maize	1		1		Selden et al. 1983
Cys	<i>E. gracilis</i> Z			1	<i>trnC</i> -GCA	Hallick et al. 1984
	pea	1				Mubumbila et al. 1985b
	spinach			1	<i>trnC</i> -GCA	Holschuh et al. 1983
	wheat			1	<i>trnC</i> -GCA	Quigley et al. 1985
Glu	<i>E. gracilis</i> Z	1		1	<i>trnE</i> -UUC	Hollingsworth and Hallick 1982 Kuntz et al. 1982
	tobacco			1	<i>trnE</i> -UUC	M. Sugiura, pers. comm.
	pea	1				Mubumbila et al. 1985b
	<i>Scenedesmus</i> <i>obliquus</i>				<i>trnE</i> -	McCoy and Jones 1980a,b
	spinach			1	<i>trnE</i> -UUC	Holschuh et al. 1984b
	wheat			1	<i>trnE</i> -UUC	F. Quigley, pers. comm.
	broad bean	1			<i>trnE</i> -UUC	Kuntz et al. 1984b Mubumbila et al. 1984
Gln	<i>E. gracilis</i> Z	1		1	<i>trnQ</i> -UUG	Kuntz et al. 1982 Karabin and Hallick 1983
	tobacco			1	<i>trnQ</i> -UUG	Deno and Sugiura 1983
	pea	1				Mubumbila et al. 1985b
	broad bean			1	<i>trnQ</i> -UUG	A. Steinmetz, pers. comm.
Gly	<i>E. gracilis</i> Z	1		2	<i>trnG</i> -GCC <i>trnG</i> -UCC	Hollingsworth and Hallick, 1982 Kuntz et al. 1982 Karabin and Hallick 1983

TABLE 3. continued

<i>tRNAs</i> accepting:	Plant source	No. of isoacceptors identified	<i>tRNAs</i> sequenced ^{a,b}	<i>tRNA</i> genes mapped	<i>tRNA</i> genes sequenced ^c	Reference
	soybean	1				Swamy and Pillay 1982
	lupin	1				Mubumbila 1984
	tobacco	1		2	<i>trnG</i> -UCC 691 bp intron <i>trnG</i> -GCC	Sugiura et al. 1983 Bergmann et al. 1984 Deno and Sugiura 1984b Ohme et al. 1984
	common bean	2		1		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	2		1 or 2		Driesel et al. 1979
	wheat	1		2	<i>trnG</i> -GCC <i>trnG</i> -UCC	Mubumbila et al. 1985a Quigley et al. 1985 F. Quigley, pers. comm.
	broad bean	1		1 or 2		Mubumbila et al. 1984
	maize	2		4		Selden et al. 1983
His	<i>Chlamydomonas</i>	1		2		Bergmann et al. 1985
	<i>C. paradoxa</i>	1		1		Kuntz et al. 1984a
	<i>E. gracilis</i> Z.	1			<i>trnH</i> -GUG	Hollingsworth and Hallick 1982 Kuntz et al. 1982
	soybean	1			<i>trnH</i> -GUG	Swamy and Pillay 1982 Spielmann and Stutz 1983
	cotton	1				Merrick and Dure 1972
	lupin	1				Mubumbila 1984
	<i>N. debneyi</i>				<i>trnH</i> -GUG	Zurawski et al. 1984a
	tobacco	1		1	<i>trnH</i> -GUG	Sugiura et al. 1983 Bergmann et al. 1984 Sugita et al. 1984
	common bean	1		1		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1		1	<i>trnH</i> -GUG	Driesel et al. 1979 Zurawski et al. 1984a
	wheat	1		2		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		2	<i>trnH</i> -GUG	Schwarz et al. 1981a Selden et al. 1983
Ile	<i>Anacystis nidulans</i>				<i>trnI</i> -GAU	Tomioka and Sugiura 1984
	<i>Chlamydomonas</i>	1		2		Bergmann et al. 1985
	<i>C. paradoxa</i>	1		2		Kuntz et al. 1984a

TABLE 3. continued

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	<i>No. of isoacceptors</i> <i>identified</i>	<i>tRNAs</i> <i>sequenced</i> ^{a,b}	<i>tRNA</i> <i>genes</i> <i>mapped</i>	<i>tRNA</i> <i>genes</i> <i>sequenced</i> ^c	<i>Reference</i>
	<i>E. gracilis</i> Z	2		2 or 3	<i>trnI</i> -GAU	Graf et al. 1980 Keller et al. 1980 Orozco et al. 1980b
	soybean	2				Swamy and Pillay 1982
	cotton	2				Merrick and Dure 1972
	lupin	2				Mubumbila 1984
	<i>N. debneyi</i>				<i>trnI</i> -CAU	Zurawski et al. 1984a
	tobacco	2		4	<i>trnI</i> -GAU 707 bp intron	Takaiwa and Sugiura 1982c Bergmann et al. 1984
	common bean	2		4		Mubumbila et al. 1983
	pea	2		2		Mubumbila et al. 1985b
	spinach	2	tRNA ^{Leu} _{GAU} tRNA ^{Leu} _{XAU}	4	<i>trnI</i> -CAU	Bohnert et al. 1979 Guillemaut and Weil 1982 Francis and Dudock 1982 Kashdan and Dudock 1982b Zurawski et al. 1984a
	wheat	2		4		Mubumbila et al. 1985a
	broad bean	2		2		Mubumbila et al. 1984
	maize	2	tRNA ^{Leu} _{GAU}	4	<i>trnI</i> -GAU 949 bp intron	Koch et al. 1981 Guillemaut and Weil 1982 Selden et al. 1983
Leu	<i>Chlamydomonas</i>	1		1		Bergmann et al. 1985
	<i>C. paradoxa</i>	4		3		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	2		2 or 3	<i>trnL</i> -UAG <i>trnL</i> -UAA	Kuntz et al. 1982 Orozco and Hallick 1982b Hallick et al. 1984 Keller and Stutz 1984
	soybean	3	tRNA ^{Leu} _{U*AA} tRNA ^{Leu} _{CmAA} tRNA ^{Leu} _{UAm⁷G}			Pillay et al. 1984
	cotton	3				Merrick and Dure 1972
	lupin	3				Mubumbila 1984
	tobacco	3		4	<i>trnL</i> -UAG	Bergmann et al. 1984 M. Sugiura, pers. comm.
	common bean	3	tRNA ^{Leu} _{U*AA} tRNA ^{Leu} _{CmAA} tRNA ^{Leu} _{UAm⁷G}	4		Canaday et al. 1980a Osorio-Almeida et al. 1980 Mubumbila et al. 1983 Pillay et al. 1984

TABLE 3. *continued*

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	<i>No. of isoacceptors</i> <i>identified</i>	<i>tRNAs</i> <i>sequenced</i> ^{a,b}	<i>tRNA</i> <i>genes</i> <i>mapped</i>	<i>tRNA</i> <i>genes</i> <i>sequenced</i> ^c	<i>Reference</i>
	pea	3		3		Mubumbila et al. 1985b
	spinach	3	tRNA ^{Leu} _{UAG}	3 to 5		Driesel et al. 1979 Canaday et al. 1980a
	wheat	3		4	<i>trnL</i> -UAA bp intron	Mubumbila et al. 1985a F. Quigley, pers. comm.
	broad bean	3		3 to 5	<i>trnL</i> -UAA 451 bp intron <i>trnL</i> -CAA	Bonnard et al. 1984, 1985 Mubumbila et al. 1984
	maize	3		4	<i>trnL</i> -UAA 458 bp intron <i>trnL</i> -CAA	Steinmetz et al. 1982 Selden et al. 1983 Steinmetz et al. 1983
Lys	<i>Chlamydomonas</i>	1				Bergmann et al. 1985
	<i>C. paradoxa</i>	1		1		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		1		Kuntz et al. 1982
	soybean	1				Swamy and Pillay 1982
	cotton	1				Merrick and Dure 1972
	lupin	1				Mubumbila 1984
	tobacco	1		1		Bergmann et al. 1984
	common bean	1		1		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1				Driesel et al. 1979
	wheat	1				Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		1		Selden et al. 1983
Met	<i>Chlamydomonas</i>	2				Bergmann et al. 1985
	<i>C. paradoxa</i>	2		1		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	2		2	<i>trnM</i> -CAU (f) <i>trnM</i> -CAU (m)	Hollingsworth and Hallick 1982 Kuntz et al. 1982 Karabin and Hallick 1983
	soybean	2				Swamy and Pillay 1982
	cotton	2				Merrick and Dure 1972
	barley			1	<i>trnM</i> -	Zurawski and Clegg 1984
	tobacco			2	<i>trnM</i> -CAU (m) <i>trnM</i> -CAU (f)	Deno et al. 1982 Sugiura et al. 1983 Ohme et al. 1984
	common bean	2	tRNA ^{Met} _{CAU} (f)	1		Canaday et al. 1980b Mubumbila et al. 1983
	pea	1		1	<i>trnM</i> -CAU	Mubumbila et al. 1985b Zurawski (see Karabin and Hallick 1983)

TABLE 3. continued

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	No. of isoacceptors identified	<i>tRNAs</i> sequenced ^{a,b}	<i>tRNA</i> genes mapped	<i>tRNA</i> genes sequenced ^c	Reference
	<i>Scenedesmus</i> ^e	2	tRNA ^{Met} _{CAU} (f) tRNA ^{Met} _{CAU} (m)			Jones 1980b McCoy and Jones 1980a
	spinach	3	tRNA ^{Met} _{CAU} (f) tRNA ^{Met} _{CAU} (m)	2 or 3		Driesel et al. 1979 Calaghan et al. 1980 Pirtle et al. 1981
	wheat	1		1	<i>trnM</i> -CAU (f)	Mubumbila et al. 1985a F. Quigley, pers. comm.
	broad bean	2		1		Mubumbila et al. 1984
	maize	2		2	<i>trnM</i> -CAU (m)	Selden et al. 1983 Steinmetz et al. 1983
Phe	<i>Chlamydomonas</i>	1		2		Bergmann et al. 1985
	<i>C. paradoxa</i>	2				Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1	tRNA ^{Phe} _{GAA}	1	<i>trnF</i> -GAA	Chang et al. 1976 Kuntz et al. 1982 Hallick et al. 1984
	<i>E. gracilis</i> B	1		1		El-Gewely et al. 1982
	soybean	1				Swamy and Pillay 1982
	cotton	2				Merrick and Dure 1972
	barley	2				
	lupin	1				Mubumbila 1984
	tobacco	1		2		Bergmann et al. 1984
	common bean	2	tRNA ^{Phe} _{GAA}	2		Guillemaur and Keith 1977 Canaday et al. 1980a Mubumbila et al. 1983
	pea	2		1		Mubumbila et al. 1985b
	spinach	1	tRNA ^{Phe} _{GAA}	1		Driesel et al. 1979 Canaday et al. 1980a
	wheat	1		1	<i>trnF</i> -GAA	Mubumbila et al. 1985a F. Quigley, pers. comm.
	broad bean	1		1	<i>trnF</i> -GAA	Mubumbila et al. 1984 Bonnard et al. 1985
	maize	1		1	<i>trnF</i> -GAA	Selden et al. 1983 Steinmetz et al. 1983
Pro	<i>Chlamydomonas</i>	1		1		Bergmann et al. 1985
	<i>C. paradoxa</i>	2		2		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1				Kuntz et al. 1982
	lupin	1				Mubumbila 1984
	tobacco	1		2	<i>trnP</i> -UGG	Bergmann et al. 1984 Ohme et al. 1984

TABLE 3. *continued*

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	<i>No. of isoacceptors</i> <i>identified</i>	<i>tRNAs</i> <i>sequenced</i> ^{a,b}	<i>tRNA</i> <i>genes</i> <i>mapped</i>	<i>tRNA</i> <i>genes</i> <i>sequenced</i> ^c	<i>Reference</i>
	common bean	1		2		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1	tRNA ^{Pro} _{U*GG}	1		Driesel et al. 1979 Francis et al. 1982
	wheat	1		2		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		1		Selden et al. 1983
Ser	<i>C. paradoxa</i>	3		3		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		1	<i>trnS</i> -GCU	Kuntz et al. 1982 Karabin and Hallick 1983
	soybean	1				Swamy and Pillay 1982
	lupin	3				Mubumbila 1984
	tobacco	1		3	<i>trnS</i> -GCU	Deno and Sugiura 1983 Bergmann et al. 1984
	common bean	3		3		Mubumbila et al. 1983
	pea	3		3		Mubumbila et al. 1985b
	spinach	3		2	<i>trnS</i> -UGA	Driesel et al. 1979 Holschuh et al. 1984a
	wheat	3		3		Mubumbila et al. 1985a
	broad bean	2		1		Mubumbila et al. 1984
	maize	3		3	<i>trnS</i> -GGA <i>trnS</i> -UGA	Selden et al. 1983 Steinmetz et al. 1983 Krebbbers et al. 1984
Thr	<i>Chlamydomonas</i>	3				Bergmann et al. 1985
	<i>C. paradoxa</i>	1		1		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	2		1	<i>trnT</i> -UGU	Kuntz et al. 1982 Karabin and Hallick 1983
	soybean	1				Swamy and Pillay 1982
	lupin	1				Mubumbila 1984
	tobacco	2		2		Bergmann et al. 1984
	common bean	1		2		Mubumbila et al. 1983
	pea	1		2		Mubumbila et al. 1985b
	spinach	2	tRNA ^{Thr} _{GGU}	1	<i>trnT</i> -GGU	Driesel et al. 1979 Kashdan et al. 1980 Kashdan and Dudock 1982a Holschuh et al. 1984b
	wheat	2		2	<i>trnT</i> -GGU	Mubumbila et al. 1985a F. Quigley, pers. comm.
	broad bean	1		1	<i>trnT</i> -GGU	Mubumbila et al. 1984 Kuntz et al. 1984b

TABLE 3. continued

<i>tRNAs</i> accepting:	<i>Plant</i> <i>source</i>	<i>No. of isoacceptors</i> <i>identified</i>	<i>tRNAs</i> <i>sequenced</i> ^{a,b}	<i>tRNA</i> <i>genes</i> <i>mapped</i>	<i>tRNA</i> <i>genes</i> <i>sequenced</i> ^c	<i>Reference</i>
	maize	2		2	<i>trnT</i> -UGU	Selden et al. 1983 Steinmetz et al. 1983
Trp	<i>Chlamydomonas</i>	2				Bergmann et al. 1985
	<i>C. paradoxa</i>	2		2		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		1	<i>trnW</i> -CCA	Hollingsworth and Hallick 1982 Kuntz et al. 1982
	soybean	1				Swamy and Pillay 1982
	cotton	2				Merrick and Dure 1972
	lupin	1				Mubumbila 1984
	tobacco	1		1	<i>trnW</i> -CCA	Bergmann et al. 1984 Ohme et al. 1984
	common bean	1		1		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1		<i>tRNA</i> ^{Trp} _{CCA}	1	Driesel et al. 1979 Canaday et al. 1981
	wheat	2		1		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		1		Selden et al. 1983
Tyr	<i>Chlamydomonas</i>	1		1		Bergmann et al. 1985
	<i>C. paradoxa</i>	3		3		Kuntz et al. 1984a
	<i>E. gracilis</i> Z	1		1	<i>trnY</i> -GUA	Hollingsworth and Hallick 1982 Kuntz et al. 1982
	soybean	2				Swamy and Pillay 1982
	lupin	1				Mubumbila 1984
	tobacco	1		1	<i>trnY</i> -GUA	Bergmann et al. 1984 M. Sugiura, pers. comm.
	common bean	1		1		Mubumbila et al. 1983
	pea	1		1		Mubumbila et al. 1985b
	spinach	1		1	<i>trnY</i> -GUA	Driesel et al. 1979 Holschuh et al. 1984b
	wheat	1		1	<i>trnY</i> -GUA	Mubumbila et al. 1985a F. Quigley, pers. comm.
	broad bean	1		1	<i>trnY</i> -GUA	Mubumbila et al. 1984 Kuntz et al. 1984b
	maize	1		1		Selden et al. 1983
	Val	<i>Chlamydomonas</i>	2			
<i>C. paradoxa</i>		2		2		Kuntz et al. 1984a

TABLE 3. continued

<i>tRNA</i> s accepting:	Plant source	No. of isoacceptors identified	<i>tRNA</i> s sequenced ^{a,b}	<i>tRNA</i> genes mapped	<i>tRNA</i> genes sequenced ^c	Reference
	<i>E. gracilis</i> Z	1		1	<i>trnV</i> -UAC	Kuntz et al. 1982 Orozco and Hallick 1982b
	soybean	1				Swamy and Pillay 1982
	cotton	1				Merrick and Dure 1972
	barley			1	<i>trnV</i> -	Zurawski and Clegg 1984
	lupin	1				Mubumbila 1984
	tobacco	2		3	<i>trnV</i> -GAC <i>trnV</i> -UAC 571 bp intron	Tohdoh et al. 1981 Deno et al. 1982 Bergmann et al. 1984
	common bean	2		2		Mubumbila et al. 1983
	pea	2		1		Mubumbila et al. 1985b
	spinach	2	<i>tRNA</i> ^{Val} _{U*AC}	3	<i>trnV</i> -GAC	Driesel et al. 1979 Sprouse et al. 1981 Briat et al. 1982b
	<i>Spirodela</i> <i>oligorbiza</i>			1	<i>trnV</i> -GAC	Keus et al. 1983b
	wheat	2 or 3		2		Mubumbila et al. 1985a
	broad bean	1		1		Mubumbila et al. 1984
	maize	1		2	<i>trnV</i> -GAC <i>trnV</i> -UAC 603 bp intron	Schwarz et al. 1981a Selden et al. 1983 Krebbbers et al. 1984

^a*tRNA*_{U*AA}^{Leu} = a leucine *tRNA* with the anticodon 5'-U*AA; U* is a derivative of uridine.

^bsee also Sprinzl and Gauss, 1984a

^csee also Sprinzl and Gauss, 1984b

^d*Cyanophora paradoxa* is classified as a red alga (Palmer, 1985)

^eblue-green alga (cyanobacteria)

TABLE 4. Sequenced genes for proteins

Protein product	Gene	Plant source	Size of primary transcripts or mRNA in nucleotides	Molecular weight of protein product and No. amino acids	Introns	Reference
Stromal Polypeptides:						
Ribulose-1,5-bisphosphate carboxylase, large subunit	<i>rbcL</i>	<i>Anabaena</i>				Curtis and Haselkorn 1983
		<i>Anacyctis nidulans</i>				Shinozaki and Sugiura 1983, 1984
		<i>Chlamydomonas</i>	ca. 1,600	(475)	No	Shinozaki et al. 1983b
		<i>Euglena gracilis</i> Z.	multiple: ca. 6,000-1,700	partial sequence	9	Dron et al. 1982a, 1983
		batley		partial sequence		Striegler et al. 1982
		tobacco	1,756	52,936 (477)	No	Koller et al. 1984b
		<i>Rhodospirillum rubrum</i>				Poulsen 1984
		spinach	1,690 +/ - 3	52,760 (475)	No	Zurawski and Clegg 1984
						Shinozaki and Sugiura 1982a
						Nargang et al. 1984
						Langridge, 1981
						Zurawski et al. 1981

<i>Synechococcus</i>				Reichert and Delaney 1983
maize	52,682 (475)	No		McIntosh et al. 1980 Poulsen 1981 Bloom et al. 1984 Crossland et al. 1984
<hr/>				
Elongation factor, <i>tufA</i> <i>Chlamydomonas</i> Tu (EF-Tu)				
	<i>Englena gracilis</i> Z	ca. 1,950	45,011 (408)	2 Montandon and Stutz 1983
50S ribosomal protein 2	<i>rpl2</i> <i>Nicotiana debneyi</i>		(264)	1 Zurawski et al. 1984a
	spinach		31,257 (286)	No Zurawski et al. 1984a
30S ribosomal protein 4	<i>rps4</i> maize		ca. 23,500 (201)	No Subramanian et al. 1983
30S ribosomal protein 7	<i>rps7</i> <i>Englena gracilis</i> Z	ca. 1,200	17,831 (155)	No Montandon and Stutz 1984
	tobacco		(154)	No M. Hildebrandt, pers. comm.
30S ribosomal protein 12	<i>rps12</i> <i>Englena gracilis</i> Z	ca. 1,200	13,828 (124)	No Montandon and Stutz 1984
	tobacco			2 M. Hildebrandt, pers. comm.
30S ribosomal protein 19	<i>rps19</i> soybean		10,538 (91)	No A. Spielmann and E. Stutz, pers. comm.
	<i>Nicotiana debneyi</i>		12,513 (114)	No Zurawski et al. 1984a
	tobacco		10,443 (92)	No Sugita and Sugitara 1983 Sugita et al. 1984

TABLE 4. *continued*

<i>Protein product</i>	<i>Gene</i>	<i>Plant source</i>	<i>Size of primary transcripts or mRNA in nucleotides</i>	<i>Molecular weight of protein product and (No. amino acids)</i>	<i>Introns</i>	<i>Reference</i>
		spinach		12,513 (114)	No	Zurawski et al. 1984a
Thylakoid Membrane Polypeptides:						
CF ₁ , alpha subunit	<i>atpA</i>	tobacco		55,446 (507)	No	Deno et al. 1983
CF ₁ , beta subunit	<i>atpB</i>	barley		53,874 (498)	No	Zurawski and Clegg 1984
		tobacco		(498)	No	Shinozaki and Sugiura 1982b
		spinach		53,874 (498)	No	Shinozaki et al. 1983a
		maize	ca. 2,200	54,042 (498)	No	Zurawski et al. 1982b
					No	Krebbers et al. 1982
CF ₁ , epsilon subunit	<i>atpE</i>	barley		(137)	No	Zurawski and Clegg 1984
		tobacco		(133)	No	Shinozaki et al. 1983a
		spinach		14,702 (134)	No	Zurawski et al. 1982b
		maize	ca. 2,200	15,218 (139)	No	Krebbers et al. 1982

CF ₀ subunit I	<i>atpF</i>	spinach					
CF ₀ subunit III	<i>atpH</i>	tobacco		7,990 (81)	No	M. Sugiura, pers. comm.	
		spinach	multiple: ca. 2,500-560	7,968 (81)	No	Alt et al. 1983a	
		wheat		ca. 8,000 (81)	No	Howe et al. 1982a	
PS I, p700 apoprotein	<i>psaA</i>	spinach				Westhoff et al. 1983b	
PS I, p700 apoprotein	<i>psaB</i>	spinach				Westhoff et al. 1983b	
PS II, "32 kd" protein	<i>psbA</i>	<i>Amaranthus hybridus</i> <i>Anabaena</i>		ca. 34,600 (317)	No	Hirschberg and McIntosh 1983	
		<i>Chlamydomonas</i>	ca. 1,200	39,950		Curtis and Haselkorn 1984	
		<i>Euglena gracilis</i> Z.	multiple: 3,100-1,200	38,950 (352)	4	Erickson et al. 1984a, b	
		soybean	ca. 1,200	38,380 (345)	4	Hollingsworth et al. 1984	
		<i>Nicotiana debneyi</i>	ca. 1,250	38,950 (353)	No	Karabin et al. 1984	
		tobacco	1,240 + / - 2	38,950 (353)	No	Keller and Stutz 1984	
					No	Keller and Michel 1985	
					No	Spielmann and Stutz 1983	
					No	Zurawski et al. 1982a	
					No	Sugita and Sugiura 1984	

TABLE 4. continued

Protein product	Gene	Plant source	Size of primary transcripts or mRNA in nucleotides	Molecular weight of protein product and (No. amino acids)	Introns	Reference
		① mustard	1,231	ca. 39,000 (353)	No	Link 1984 Link and Langridge 1984
		<i>Solanum nigrum</i>				
		spinach	ca. 1,250	38,950 (353)	No	M. Edelman, pers. comm.
PS II, "51 kd polypeptide" reaction center	<i>psbB</i>	spinach	multiple: ca. 5,000-2,000	56,246 (508)	No	Morris and Herrmann 1984
PS II, "44 kd polypeptide" reaction center	<i>psbC</i>	spinach	multiple: ca. 4,600-1,600	51,785 (475)	No	Alt et al. 1984
			multiple: ca. 3,500-1,500	51,816 (473)	No	Holschuh et al. 1984b
PS II, "D-2 polypeptide"	<i>psbD</i>	<i>Chlamydomonas</i>		(339-350)	No	Rochaix et al. 1984
		pea		ca. 39,500		Rasmussen et al. 1984
		spinach	multiple: ca. 4,600-1,600	39,465 (353)	No	Alt et al. 1984

multiple: 39,536 No Holschuh et al. 1984b
 ca. 3,500- (353)
 1,500

Cytochrome <i>f</i> (preprotein)	<i>petA</i>	pea	/31,712 (285 + 35)	Willey et al. 1984a
		spinach	multiple: ca. 4,300- 1,400	Alt et al. 1984 Alt and Herrmann 1984
		wheat	/31,918 (285 + 35)	No Willey et al. 1984b
Cytochrome <i>b₆</i>	<i>petB</i>	spinach	multiple: 23,700 ca. 6,000-900 (211)	No Alt et al. 1983b Heinemeyer et al. 1984
Cytochrome <i>b₅₅₉</i>	<i>petC</i>	spinach	ca. 1,400 9,390 (83)	No Herrmann et al. 1984
Cytochrome <i>b_{6/f}</i> complex, "polypeptide IV"	<i>petD</i>	pea	multiple: 15,266 ca. 6,000-900 (139)	No Phillips and Gray 1984
		spinach	multiple: 15,200 ca. 6,000-900 (139)	No Alt et al. 1983b Heinemeyer et al. 1984

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