Nucleotide sequence of *rbcl* from *Amaranthus hypochondriacus* chloroplasts

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The gene encoding *rbcl*, the large subunit protein (LSU) of ribulose-1,5-bisphosphate carboxylase/oxygenase (E.C.4.1.1.39), from *Amaranthus hypochondriacus* (line 1023), a grain amaranth, was determined. The gene had been cloned into the BamHI-site of plasmid pBR322 (1). The sequence was established using the chain termination method after deletion subcloning (2). The *rbcl* sequence is flanked by the sequence of gene *atpB* (transcribed from the opposite strand) at its 5'-end (not shown), as it is found in most land plants (3). A sequence, 1,786 nucleotides in length, is shown. The region encoding LSU is 475 codons long. The deduced amino acid sequence is very similar to that of other higher plant *rbcl* genes (4). The large number of *rbcl* sequences that are now available from photosynthetic bacteria, cyanobacteria and higher plants (4) together with structural information (5) makes it now possible to attempt to predict structure-function relationships. We were interested in determining the *Amaranthus* *rbcl* structure because this plant is one of the few dicotyledonous plants that assimilate carbon dioxide following the C₄ mode (1). The *Amaranthus* LSU shows five amino acid variations (underlined) that make this subunit protein different from all other higher plant sequences. Other replacements indicate that the *Amaranthus* *rbcl* sequence may be more closely related to the sequences of the monocots *Z. mays* and *Oryza sativa* than to those of other dicotyledonous plants.

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1  GTCTATTACGAACCATTTGATTAGTGATAATATTAATTTAGAAATTTTGTAAAGGTTTTTTTAA
81  GGCCGAATTTATGTCGAGTAGACCTTGTTGCTTTGTTGTAATAAATTTAAATTTGAATTTGTAGGGAGGGAGCTTAATGTC
      M S
161  CCACAACGAGACTAAAGCAAGTGTGGATTAAAGCTGGTGTAAAGATTACCGATTGACTTATTATCTCTGAGTA
      P Q T E T K A S V G F K A G V K D Y R L T Y Y T P E Y
241  TGAACCCGAGATCTGATATCTTGGCAGCATTCGAGTAGTCTCAACCTGGAGTCCACCTGAAGAAGCGGGGCTG
      E T Q D T D I L A A F R V S P Q P G V P P E E A G A
321  CAGTAGCTGCCGAATCTTCTACTGGTACATGGACAAGTGTAGGACCGACGGACTTACCAATCTTGATCGTTACAAAGGA
      A V A A E S S T G T M T S V M T D G L T N L D R Y K G
401  CGATGCTACACATCGAGCCCGTTCCTGGAGAGAAATCAATATATTGTTATGTAGCGTATCCTTTAGACCTTTTGA
      R C Y M I E P V A G E E N Q Y I C Y V A Y P R D L F E
481  AGAAGGTTCTGTTACTAATGTTTACTTCCATTGTGGTAACGTATTGGGTCAAAGCTTTCGCTGCTACGTGTTGG
      E G S V T N M F T S I V G N V F G F K A L R A L R L
561  AAGATTGCGAATCCCTGTTGCTTATGTCAAACTTCCAAAGCCCGCTCACGGTATCCAGGTGAAGAGATAAATG
      E D L R I P V A Y V K T F Q G P P H G I Q V E R D K L
641  AACAACTACGGTCTGCCCTATTGGGATGCACTTAAACCAAAATGGGGTATCCGCTAAAACTATGGTCGAGCATG
      N K Y G R P L L G C T I K P K L G L S A K N Y G R A C
721  TTATGAATGCTCTCGTGGTGAATGATTACCAAGATGATGAAACGTGAATCCAGCCGTTACGCTGCTGGAGAG
      Y E C L R G G L D F T K D D E N V N S Q P F M R W R
801  ACCGTTTCTATTGTCGCGAAGCTATTATAAATCACAAGCCGAACAGGTGAATCAAAGGGCATTATTGAATGCT
      D R F L F C A E A I Y K S Q A E T G E I K G H Y L N A
881  ACCGAGGTACTTGCAGAAATGATAAAAGAGCTGATTGCTAGAGAGTGGGAGTCCAAATCGTAATGCATGACTA
      T A G T C E E M I K R A V F A R E L G V P I V M H D Y
961  CTTAACAGGTGATTCAGTCAAACTACTGCTGCTAGTATGCCGAGCAATGCTTCTTCTACATCCAGCTG
      L T G G F T A N T S L S Q Y C R D M G L L L H I H V
1041  CAATGACCGAGTATTGATAGACAGAAATCATGTTATGCACTTCCGTGTACTAGTAAAGCGTACGTCTGTCTG
      A M H A V I D R Q K N H G M H F R V L A K A L R L S G
1121  GGAGACCATATTCTGTTACCGTAGTAGGTAAGCTTGAAGGGGAAGAGATATTACTTTAGGCTTTGTTGATTACT
      G D H I H S G T V V G K L E G E R D I T L G F V D L L
1201  ACGTGATGATTATACAGAAAGACAGATGTCGGGTATCTTTTCACTCAATCTTGGGTTTCCACACCTGCTGTTCT
      R D D Y T E K D R E R G I F F T Q S W V S T P G V L
1281  CTGTTGCTTCAGGAGTATTCACGTTTGGCATATGCTGCTTAAACCGAAATCTTCGGGGATGATTCTGTACTACAGTT
      P V A S G G I H V W H M P A L T E I F G D D S V L Q F
1361  GGTGGAGGAACCTTAGGACACCTTGGGGGAATGCACCGGTGCTGTAGCGAATCGAGTAGCTCTAGAACCATGTGTACA
      G G G T L G H P W G N A P G A V A N R V A L E A C V Q
1441  AGCTCGTAATGAGGACGTGACCTTGTCTCGGAGGTAATACATATTTCGTGAAGCTGCTAAATGGAGTCCGAACTAG
      A R N E G R D L A R E G N T I I R E A A K W S P E L
1521  CTGCTGCTTGAAGTATGGAAGAAATCAAAATTTGAATCCCGCAATGGATACAAATTTAGTCTAAGTCATTAAATGTC
      A A C E V W K E I K F E F P A M D T I
1601  GGTCTCTTAATGAATTTGAATTAATTAATCTGCGCCCAATCTTTTACTAAAGGATGAGCCGATACAAATTTTGTATATA
1681  TCTTGATCTCTCTATTATATAGAACTCTTTTATATATACAAAGCAAGATCTTCAATCAAATTTGAATCTAAACACTC
1761  AAATTTCTATTATTGCTTGGATCC

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Figure 1. Nucleotide sequence of *Amaranthus hypochondriacus* chloroplast *rbcl*. Underlined are the initiation and stop codons, amino acids that are unique to this *rbcl* gene and a putative inverted repeat which may function as a transcription termination signal.

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