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Quote

. . . Certainly the biblical world view implies that since God is the creator of all that exists, He ultimately is the rightful owner of all that exists. Whatever possessions a human being may acquire, he holds them temporarily as a steward of God and is ultimately accountable to God for how he uses them. However omnipresent greed and avarice may be in the human race, they are clearly incompatible with the moral demands of the biblical world view.

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CARBON DIOXIDE IN THE ANTEDILUVIAN ATMOSPHERE

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Abstract

Data are presented which define the role of atmospheric carbon dioxide in plant growth. The amount of atmospheric carbon dioxide required to support a unit amount of carbon in the biosphere is determined from this data. This permits the determination of the minimum amount of atmospheric carbon dioxide required to support the antediluvian biosphere based on the amount of coal reserves and resources. The increased atmospheric carbon dioxide may also require an additional source of atmospheric water vapor to support the antediluvian biosphere. Furthermore, increased atmospheric carbon dioxide may have implications for the respiration and diet of mankind and the animals before the Flood. Carbon dating and the preferential growth of selected plant types in the pre-Flood world would probably be affected by increased atmospheric carbon dioxide as well.

Effect of CO_2 on Plant Growth

During the 1600s a classical experiment was performed in which a

> 5 pound willow tree was planted in a container with 200 pounds of oven-dried soil. Water was added as needed. After 5 years the tree had increased to 169 pounds, 3 ounces, but the soil itself still weighed 199 pounds and 14 ounces (Wittwer and Robb, 1964, p. 34).

This experiment demonstrated that more than 99 percent of the increase in weight of this plant was derived from ground water, atmospheric CO_2, and water vapor.

Numerous experiments have been performed that show that the amount of CO_2 in the present atmosphere is the limiting factor for plant growth.

> We have not in our experimentation, either under controlled conditions in plant growth chambers, or in greenhouses, reached the upper limit where above normal carbon dioxide concentrations in the atmosphere, no longer increased plant growth. Our objective has been to maintain greenhouse atmospheres of carbon dioxide at 1000-2000 p.p.m. [parts per million] during daylight hours. This is higher than that initially aimed for in Colorado for carnations and roses. At a moderate light intensity, cucumbers responded by increased growth to the highest level provided (8000 p.p.m.). There are other reports where crops have responded to levels of carbon dioxide ranging from 20,000 to 30,000 p.p.m. Lake has reported that no harmful effects on tomatoes were observed at 30,000 p.p.m. (Wittwer and Robb, 1964, p. 50).

Even though optimum light, temperature, water, and humidity are provided for plants along with adequate fertilizer, the growth rate and final size of the plants is limited by the amount of atmospheric CO_2 available to the plants. That increased CO_2 increases plant growth is a well known fact particularly in the nursery industry, where for many years nurserymen have routinely increased the available CO_2 in the greenhouse. It is also a requirement for growing plants in a greenhouse where CO_2 enrichment is not used, that a continual exchange of air be maintained with the outside. Otherwise the CO_2 within the greenhouse will be depleted and plant growth will be reduced or cease. In the green house the number of plants are limited so that increased CO_2 results in increased growth rate and plant size, whereas in the natural environment, total live plant material will continue to increase until some limiting factor is reached. For our purposes the important fact is that the atmospheric CO_2 is usually the limiting factor for total amount of live plant growth. The exceptions are the desert and polar regions where ground water in the former and temperature in the latter are the limiting factors. However, if the amount of atmospheric CO_2 is increased, the total live plant material will also increase until a balance is established or until some other limiting factor such as ground water, temperature, light, space, humidity, or soil fertility is attained.

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The Carbon Cycle

The carbon cycle provides the method whereby energy from the sun is made available for food, fiber, and shelter to the animal kingdom and mankind. Through photosynthesis, atmospheric CO_2 and water are synthesized within the plant into various hydrocarbons and the excess oxygen is released to the atmosphere. Most of the carbon thus derived from atmospheric CO_2 is not returned to the atmosphere but is stored within the plant as tubers, fruits, seeds, and as plant growth. When the plant remains are oxidized, the carbon is once again released into the atmosphere as CO_2.

Oxidation can occur in different forms, the most familiar of which is rapid oxidation through burning. Oxidation can also occur slowly without fire. This form of oxidation takes place more rapidly in the tropics (though it occurs in all climates) where plant remains are exposed to the heat of the sun and bacterial decay. This is one reason why tropical soils which are not covered with a plant canopy or water are extremely poor. That is, all the decayed plant material (humus) is rapidly oxidized, leaving the earth barren. Another form of oxidation is the digestion of plant material by people and animals to obtain energy. Various estimates have been made for the amount of unoxidized carbon contained in humus. The majority of these estimates are in the range of 1400×10^{15} gC, [grams of carbon] (Trabalka, 1985, p. 181).

CO_2 Equilibrium

The term *preagricultural* is used to indicate the period from post-glacial times until approximately 1800 AD. This period was chosen for the discussion and calculations that follow because the amount of atmospheric CO_2 was relatively constant over this period (Trabalka, 1985, pp. 34-35; Vardiman, 1990). A constant amount of atmospheric CO_2 would indicate that equilibrium had been established between the assimilation of CO_2 in live plant material from the atmosphere and the release of CO_2 into the atmosphere through oxidation. The ratio of preagricultural atmospheric CO_2 to the carbon in the preagricultural biomass is required in the following calculations.

It will also be assumed that equilibrium had been established in the pre-Flood biosphere between unoxidized humus and living plant material. Additionally, it will be assumed that the increase in the size of the biosphere is linear with the increase in atmospheric CO_2. In the plant growth experiments with increased CO_2, the number of plants used to determine the effect of increased CO_2 was limited and the increase in plant size was decidedly non-linear. As mentioned, however, in the natural environment the total number of plants will increase and this increase in total plant weight will probably be much closer to a linear increase. Also it will be shown below that the type of plant growth was probably different in the pre-Flood world from that of the post-Flood environment. Based on these assumptions, it will be possible to determine the *minimum* amount of pre-Flood atmospheric CO_2 required to support the pre-Flood biosphere. Although the assumption of a linear increase is probably not strictly correct, the values obtained for the amount of CO_2 in the pre-Flood atmosphere from these assumptions will be conservative.

Preagricultural Atmospheric CO_2

There does not appear to be any reason to presume that the composition of the antediluvian atmosphere was different from the preagricultural atmosphere except for the amount of CO_2 and quite possibly the amount of water vapor. The preagricultural level of atmospheric CO_2 has been estimated through indirect measurements of carbon-containing marine sediments, the amount of CO_2 trapped in air bubbles in the polar ice sheets, and from tree ring data. Such estimates have indicated that the amount of CO_2 has remained reasonably constant at 260-290 ppm throughout the preagricultural period (Trabalka, 1985, pp. 34-35).

As was demonstrated, the size of the biosphere is limited by the amount of CO_2 in the atmosphere. Therefore, this period of relatively constant atmospheric CO_2 likewise would have been a period when the amount of live vegetation was reasonably constant.

Preagricultural Biomass

The size of the preagricultural biosphere has been estimated to be 900×10^{15} gC. Approximately 4×10^{15} gC is represented by heterotrophic organisms: animals and nongreen plants (Trabalka, 1985, p. 181). The amount of carbon contained in the heterotrophic sources is probably less than the error in these values and, therefore, will not be included in the following calculations.

It is noted that the amount of carbon reported by Trabalka in the preagricultural biomass is considerably greater than the 300×10^{15} gC quoted by Morton (1984) from Hunt (1972) for the present biomass. Although there certainly would have been some reduction in the biomass from preagricultural conditions to the present due to the removal of forest for farming, a three-fold reduction seems to be quite large. Also, the 1.45×10^{18} gC derived by Morton (1984) for the antediluvian biosphere is only a 60 percent increase over the preagricultural biosphere as reported by Trabalka (1985). This small increase hardly seems to qualify for lush tropical plant growth that extended from pole to pole which is generally believed to have existed during the pre-Flood period.

If it is assumed that all the vegetation which formed the coal deposits was growing at the time of the Flood, the minimum amount of CO_2 required to support the antediluvian biosphere can be estimated by multiplying the ratio of preagricultural CO_2 to the carbon in the preagricultural biomass by the sum of the carbon in the preagricultural biomass and the coal beds. This ratio is 275 ppm / 900×10^{15} gC or 0.3056×10^{-15} ppm/gC.

Coal Reserves and Resources

Trabalka defines three terms to describe the reserves and resources of coal which will be used here.

1. *Demonstrated reserves* - resources already discovered that can be produced with current technologies and under current economic conditions;
2. *Undiscovered recoverable resources* - resources that are thought to exist and that can be produced, given technological and economic conditions likely in the foreseeable future;

> 3. *Remaining total* resources - all remaining deposits such that some portion could be economically produced. (Trabalka 1985, p. 72)

As would be expected, there is considerable variation in the reported quantities of coal deposits due to the uncertainty of estimating in place coal beds.

> The World Energy Conference (WEC) has periodically provided estimates of proved reserves and energy resources. The data assembled by the WEC were compiled by an international advisory panel and published as the *Survey of Energy Resources* . . . Table 4.6 was constructed from WEC data, and estimates of recoverable resources were made by Parent. His estimates were generally made by taking 50% of the total resources reported in WEC, but they included some adjustments for the United States, the United Kingdom, and India (Trabalka pp. 72-73).

Four categories of calculations will be presented here, including three which were established by Trabalka and one from Morton. These categories are:

1. *Demonstrated Reserves* - the same as defined above.
2. *Recoverable Resources* - the same as defined above.
3. *Total in-place Resources* - the sum of categories 2 and 3 defined above.
4. The quantity reported by Morton (1984) quoted from Hunt (1972).

The quantities in the first three categories of Table I for the coal reserves and resources are excerpted from Table 4.6 in Trabalka (1985, p. 73), which were in tons of coal equivalent (tce). These values, when multiplied by 7 x 10^5 gC/tce, give values in grams of carbon. Similarly, when the sum of the coal plus the preagricultural biomass is multiplied by the ratio of the preagricultural CO_2 to carbon in the preagricultural biomass the minimum amount of CO_2 required to support the antediluvian biomass is obtained.

Table I. Carbon in world coal deposits, plus the preagricultural biomass, and the CO2 required to sustain the total as live plants.

Category	Quantity of Coal tce (10^9)	gC (10^{18})	Coal plus Biomass gC (10^{18})	CO_2 ppm
1.	687.4	.48	1.38	422
2.	5137.5	3.6	4.50	1375
3.	11066.2	7.7	8.60	2628
4.		15.0	15.90	4859

Estimates of the quantity of coal in 1. demonstrated reserves; 2. recoverable resources; 3. total in-place resources; and 4. the quantity reported by Morton (1964) are presented in tons of coal equivalent (tce) and grams of carbon (gC). The third column is the sum of these quantities of carbon and the carbon in the preagricultural biosphere. The final column is the atmospheric CO_2 in parts per million (ppm) required to sustain this amount of carbon as live plant material.

As was noted in the previous quote, Parent (1983) reduced the WES estimates by 50 percent. Therefore, if the values quoted by Trabalka (1985) are doubled there is essential agreement between the total in-place resources and the value quoted by Morton (1984).

It is also recognized that some of the unoxidized pre-Flood humus may have been incorporated in the present day coal beds. Nevertheless, this amount is probably small compared to the total carbon in the coal deposits and will be disregarded in the following calculations.

The basis for suggesting that only a small amount of pre-Flood humus is contained in the coal deposits is that two likely situations exist for the location of the pre-Flood humus. The first is that the pre-Flood humus was evenly mixed throughout the sedimentary deposits including the coal deposits. For this case the percentage of coal deposits to total sedimentary deposits will be calculated. The largest estimate of the volume of coal (V_c) can be determined from the equation, $V_c = W/d$. Here the weight W, is 13,477.6 x 10^9 tons (Trabalka, 1985, 73) and the average density d, is 86.33 lbs/ft^3 (Baumeister, 1967, pp. 6-8). This gives a total volume of coal of 1061.2 cubic miles. The volume of sedimentary deposits have been estimated to be 9.3 x 10^7 cubic miles (Pettijohn, 1957, p. 3). Pettijohn's estimate was based on the work of American geochemist F. W. Clarke with some revisions for oxidation, carbonation, and hydration. In this situation there would only be approximately 0.001 percent of pre-Flood humus in the coal deposits. A second possibility is that the pre-Flood humus was sorted by the Flood waters. Sedimentary deposits formed through rapid settling are graded by particle size with the largest particles forming the lowest layers (Foster, 1971, p. 118). The lower layers of humus that have been subjected to insects and bacterial action are composed of very fine particles. Therefore, this humus would be deposited in the upper layers of the sedimentation. The actual situation was probably some combination of these two cases, however either would justify neglecting the amount of pre-Flood humus in the coal deposits.

CO_2 may or may not have been the limiting factor for plant growth in the antediluvian atmosphere. That is, other growth factors such as sunlight, temperature, water, and soil fertility may have been limiting factors for plant growth. Nonetheless, the values obtained from this analysis for the amount of CO_2 in the antediluvian atmosphere are the minimum amount required to sustain the antediluvian biosphere. It should also be noted that the coal reserves used in these calculations were reported as of 1980. Therefore the value obtained is understated by the amount of coal mined before 1980.

Effect on Climate

A considerable number of atmospheric General Circulation Models (GCMs) have been run in an attempt to determine the effects of increased atmospheric CO_2 and other radiatively active (greenhouse) gases on specific climatic elements (surface air temperature, vertical air temperature profile, precipitation rates, and soil moisture) (MacCracken and Luther, 1985). Considerable controversy surrounds the results obtained from simulations by these GCMs which have generally been run with two to four times the present level of atmospheric CO_2 (Bartz, 1992). Nevertheless, the general indication is that increased CO_2 will increase atmospheric temperature (MacCracken and Luther, 1985, p. 271).

Likewise, increased atmospheric CO_2 is believed to be capable of altering the global precipitation patterns. In Africa south of the Sudano-Sahelian region and in Andean South America, desertification is accelerating. The trend toward desertification is greatest near the semi-arid interface with rain-fed cropping systems. Desertification is continuing in most other regions of the developing world, including China (Mabbutt, 1984). However, the extent of desertification is also controversial (Dregne, 1985).

If the results from the GCMs prove correct and the increasing desertification is the consequence of increasing atmospheric CO_2 the increased atmospheric CO_2 required to sustain the antdiluvian biosphere would require an additional source of water vapor. One possible source for increased atmospheric moisture would be a canopy of water surrounding the earth, such as that proposed by numerous creationists (Whitcomb and Morris, 1961, pp. 255-258; Peterson, 1981; Dillow, 1982; Johnson, 1986; Rush and Vardiman, 1992). In all of these proposals, the canopy is presumed to exist over and to be segregated from the atmosphere. This arrangement would not be beneficial to plant growth. Rather, the water vapor would need to be mixed throughout the atmosphere or at least be increased at the level where the plants were growing. Should a water vapor canopy be required to sustain the pre-Flood vegetation, this canopy would also increase the atmospheric pressure.

Effect of Increased CO_2 on Animals and Mankind

As noted, CO_2 enrichment in greenhouses to enhance plant growth is a well known practice. Yet when enrichment is practiced, a warning system should be installed which sounds an alarm if the concentration of CO_2 goes above approximately 5000 ppm, the maximum recommended or a normal work day (Mastalerz, 1977, p. 304).

Smith (1981) has reported the effects of increased atmospheric pressure on animals and mankind, particulary as it relates to increased difficulty in breathing and damage to tissues within the body associated with increased oxygenation. It may be that difficulty in breathing with increased atmospheric CO_2 and increased oxygenation which results from increased atmospheric pressure are offsetting phenomena. If so, then increased atmospheric CO_2 could be the means which permitted human and animal life to survive with increased atmospheric pressure resulting from a water vapor canopy.

> Mortimer found in beans, sugar beets and barley that increasing the carbon dioxide level from 0.25 [2,500 ppm] to 2.0 [20,000 ppm] percent favored the conversion of the assimilated $C^{14}O_2$ into sucrose rather than into serine and glycine. Others have shown that with high levels of carbon dioxide the synthesis of sugars is increased and at low carbon dioxide partial pressures, organic acid synthesis predominates (Wittwer and Robb, 1964. p. 46).

Before the Flood, man was given fruit and seed bearing plants for food (Genesis 1:29). After the Flood, meat was added to the diet of mankind (Genesis 9:3). Although this field is outside the expertise of the present author, the difference in the assimilation of carbon at increased levels of CO_2 may account for the change in the diet of mankind following the Flood.

In addition the change in atmospheric CO_2 may be indicated through the longevity of the patriarchs. Prior to the Flood the age of the patriarchs was reasonably constant. After the Flood the age of the patriarchs continually decreased to that of the present average age.

Although some of the atmospheric CO_2 probably was dissolved in the rain that flooded the earth, the greater portion would have remained in the atmosphere. And in the initial months following the Flood, the pre-Flood humus that was exposed to the sun would have been oxidized, returning more CO_2 to the atmosphere. However, the regrowth of vegetation would have required a number of years to develop to that of the preagricultural period.

Notwithstanding the fact that God added meat to the diet of mankind (Genesis 9:3), none would have been available for food. Consider that for cattle the gestation period is nine months and it is highly unlikely the first calf would have been slaughtered immediately. It is much more probable they would have been retained for herd building so that a few years elapsed before meat was actually added to the diet. Nor would any of the sacrificial animals been available for food because they were sacrificed prior to the addition of meat to the diet (Genesis 8:20).

Therefore, the transitional period required for the reduction of the atmospheric CO_2 probably corresponded to the transition in the ages of the patriarchs and the diet of mankind and the carnivorous animals. Also without this transitional period, the carnivorous animals could have eliminated a number of species of animals and possibly even mankind.

Effect on Plant Growth

The change in metabolic pathways for the assimilation of carbon during photosynthesis has been labeled the C_3 and C_4 pathways (Strain and Cure, 1985, p. 57).

> The effect of CO_2-doubling on biomass accumulation among C_3 grasses appears to be reasonably similar at about +28 percent, but the values for C_3 broadleaf species are sparse and erratic. If soybean may be taken to represent C_3 broadleaf crops, the effect of CO_2-doubling on biomass accumulation appears to be higher than for the C_3 grasses, which is in keeping with their carbon assimilation responses. Biomass response to CO_2-doubling was low for the C_4 species corn (+9 percent) and sorghum (+3 percent), which also agrees with the generally low response of carbon assimilation for these species (Strain and Cure, 1985, p. 112).

The change in the synthesis of plant material under increased CO_2 for different plant types may account for the giant ferns in the coal record. Similarly, the preferential growth rates of different plant types under pre- and post-Flood conditions may be the source of what is presumed to be evidence of evolution within the plant kingdom. Further, this may account for some extinct plant types which could not survive in the post-Flood environment.

C^{14} Dating

Increased atmospheric CO_2 would probably alter the amount of C^{14} formed in the atmosphere and the change in metabolic pathways noted above may increase the assimilation of C^{14} within plants. Both of these effects would distort the indicated age of pre-Flood biologic materials if the dating is based on present atmospheric conditions.

C. J. Yapp and H. Poths have arrived at a similar conclusion to that presented in this article based on an analysis of goethites from an ironstone in the Upper Ordovician Neda Formation. In their analysis the atmospheric CO_2 was determined to be approximately 16 times greater than the present (Yapp and Poths, 1992, p. 342). This value is in very close agreement with that derived under category 4.

Conclusion

The minimum amount of atmospheric CO_2 required to sustain the antediluvian biosphere based on total in-place resources would have been at least 2628 ppm / 275 ppm or approximately 10 times greater than the amount in the preagricultural atmosphere. Furthermore, the minimum amount of CO_2 in the antediluvian atmosphere based on the report by Morton would require 4859 ppm / 275 ppm or in excess of 17 times that in the preagricultural biosphere.

This increase in atmospheric CO_2 could also create a need for an additional source of water vapor to sustain the antediluvian biosphere. Similarly, the increased CO_2 in the atmosphere is approaching the level that would interfere with breathing. However, this difficulty with breathing could be ameliorated through increased atmospheric pressure resulting from a water vapor canopy.

Additionally, increased CO_2 causes differences in the pathways through which carbon is assimilated within plants. This would produce different food values for plant material and could affect the diet of both people and animals. This phenomenon would result in differential plant growth rates that could be interpreted as part of the evolutionary process.

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CHAOS: MAKING A NEW HERESY

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Abstract

New and exciting mathematical strategies in science have been rapidly developing over the lust two decades. A field of study has emerged, collectively called "Chaos" or nonlinear dynamics. A brief summary of the history and findings are given, and various features of chaos theory are discussed regarding creation and evolutionary world views.

Introduction

Are fractals, solitons, and bifurcations attracting us toward a paradigm shift in science? Can you say "deterministic chaos" without wincing? Is there really something new under the sun? Authors James Gleick (1988, p. 7) and Ian Stewart (1989, pp. 2-3) in their respective reviews of chaos theory say so, and they are note alone. Others suggest that this "new" science will contribute to everything from understanding evolutionary mechanisms to ushering in a new age (Briggs and Peat, 1989, p. 166). The AAAS (Anon., 1989) appears to be advancing a little chaos in the educational advancement of evolution, and deterministic chaos is

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