It seems that one thing being confused here is the difference between a true efficiency of energy transfer and a food transfer efficiency in which not all of the energy transferred changes state. When a fish eats protein food it may digest and separate amino acids of the proteins and immediately stick them back together to form new tissue. Much of the energy in the amino acids in such a case never changes form. In the case of photosynthesis all of the energy changes form. As discussed below it is suggested that there is a definite thermodynamic reason why efficiencies must be low and why increasing efficiency would cut down total production. When one refers to a 50% food chain transfer efficiency, one is referring to the sum of energetic efficiency for the energy actually changing form in the metabolism and the energy transferred in unmodified chemical molecules.

4. The total [illegible] output of a living or non-living machine is a [illegible] of the rate of inflow of energy and the efficiency of energy utilization. It is suggested here that there are two extremes in living and non-living machines that both produce a zero energetic output per time. One extreme is a machine with a 100% efficiency as in a reversible carnot cycle but an infinitely slow utilization so that the output is zero. The other extreme is an infinitely rapid energy intake and transfer which is so fast that the thermodynamic efficiency is zero and so the total output of this high speed system is again zero for all the energy goes into heat. These two extremes seem to be a necessary result of the second Law of Thermodynamics. If this reasoning is correct (and an actual calculation has been made on a physical system, the Atwoods machine) then there must be an optimum efficiency for the maximum power. If this is the case, then one sees a reason for efficiencies of photosynthesis being what they are. The machines are set to go at the optimum speed to get the best combination of both efficiency and speed. At times, under some ecological conditions, an organism that goes faster and less efficiently may have the edge over one that is slow but efficient. However, if correct, these notions suggest no hope for higher human food production without repeal of the second Law.

Second Six Months:

Having made beginnings in the 5 divisions of the study, the immediate objectives seem clearly outlined. Except for completing identifications, community species-summer analysis of coastal runs as part of Mr. Sloan's master's program, and the chemical survey of nitrogen metabolism in the fresh-water springs with the help of an undergraduate assistant, Mr. Hampton, all attention is to be directed to completing the production measurements of all trophic levels in Silver Springs. To complete this and to insure adequate attention to the all important algae, Dr. L. A. Whitford, of North Carolina State, has been engaged to work with us this summer on identification and production. Tentatively, objectives following these are the comparison of productivities between springs using methods which work best in the intensive Silver Springs study.

Measurement of the amount of light diurnally and seasonally that reaches the organisms in these clear water aquatic communities has not yet commenced pending the procurement of a suitable instrument. So far physical and chemical measurements have been made solely for their implications for productivity. A number of splendid problems in physical and chemical limnology and oceanography await future investigation.