Report No. COO-2164-13

FOURTH ANNUAL TECHNICAL PROGRESS REPORT

FOR

ENERGY EXCHANGE WITHIN ECOSYSTEMS

at

The University of Michigan
Biological Station
Ann Arbor, Michigan

Principal Investigator
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Energy Research Development
and Administration
Contract No. AT(11-1)-2164
January 1, 1976 - December 31, 1976

September 20, 1975

427 attached to top of report

DISCLAIMER

Technical Progress Report: Model of Photosynthesis In Whole Leaves of Aquatic Vascular Plants

During the term of the present grant, we have assembled an apparatus which will continuously measure photosynthesis while maintaining light, temperature and pH constant (Fig. 1). We have begun taking measurements of the photosynthetic rate of Elodea densa under varying conditions of light, temperature, pH and inorganic carbon concentration. Light, temperature and pH all were found to affect photosynthetic activity. Enough data were accumulated on the effect of pH on photosynthesis (Fig. 2) to allow us to present a paper at the AIBS meetings in August ~~(a copy of the paper is attached)~~. Typical light curves are presented in Fig. 3. Some temperature data has been gathered which indicates that in this species the optimum temperature may be greater than 30°C (Fig. 4).

We now have a pH-Stat system which will maintain pH to $\pm$0.02 pH units. Preliminary calculations, based on the amount of CO_2-enriched titrant added, of photosynthesis have been carried out. This rate of carbon fixation agrees, within 10-20%, with the rate of oxygen evolution at high light intensities. However, without a recorder to plot titrant versus time, only rough estimates of the rate of CO_2 fixation can be made.

One problem has emerged which has somewhat handicapped our efforts. The oxygen analyzer which we have been using is not as stable as we feel we need. We are, therefore, requesting funds to replace it with a more stable unit. The data at low rates of photosynthesis are sometimes obscured by the noise in the system. However, further studies of the effects of pH, temperature and inorganic carbon concentration are definitely possible in conjunction relatively high light intensities.

Much of the past year has been devoted to acquiring equipment and assembling and testing the apparatus. Even so, many experiments were run and valuable data obtained. Dr. Weber has devoted 100% of his time to the project; Dr. Gates 10%.

More data on the effect of temperature will be collected during the remainder of the contract period. The study of the gas composition of the internal atmosphere of the plant will commence as soon as the mass spectrophotometer is available and the necessary modifications to the plant chamber are made.

Publications Directly Resulting

From This Grant

Weber, James A. and David M. Gates. 1975. The effects of light intensity and pH on photosynthesis in Elodea densa. Plant Physiol. 56 (Suppl.):12. (Abstract of paper presented at AIBS meetings in Corvallis, Oregon. August 1975.)

Figure 1. Diagram of apparatus for measuring the photosynthesis of submerged aquatic vascular plants.

Figure 2. The effects of pH on the photosynthesis of Elodea densa. (25°C, alkalinity 6.0 meq ℓ^{-1}, 0.05 strength Hoagland's, light intensity 640 $\mu E\ m^{-2}\ s^{-1}$.)

Figure 3. The effect of light intensity on the photosynthesis of Elodea densa. (25°C, alkalinity 6.0 meq ℓ^{-1}, 0.05 strength Hoagland's, pH 8.2)

Figure 4. The effect of temperature on the photosynthesis of Elodea densa. (alkalinity approximately 6.0 meq ℓ^{-1}, 0.05 strength Hoagland's, pH 8.0 - 8.5, light intensity 640 $\mu E\ m^{-2}\ s^{-1}$).

Figure 1

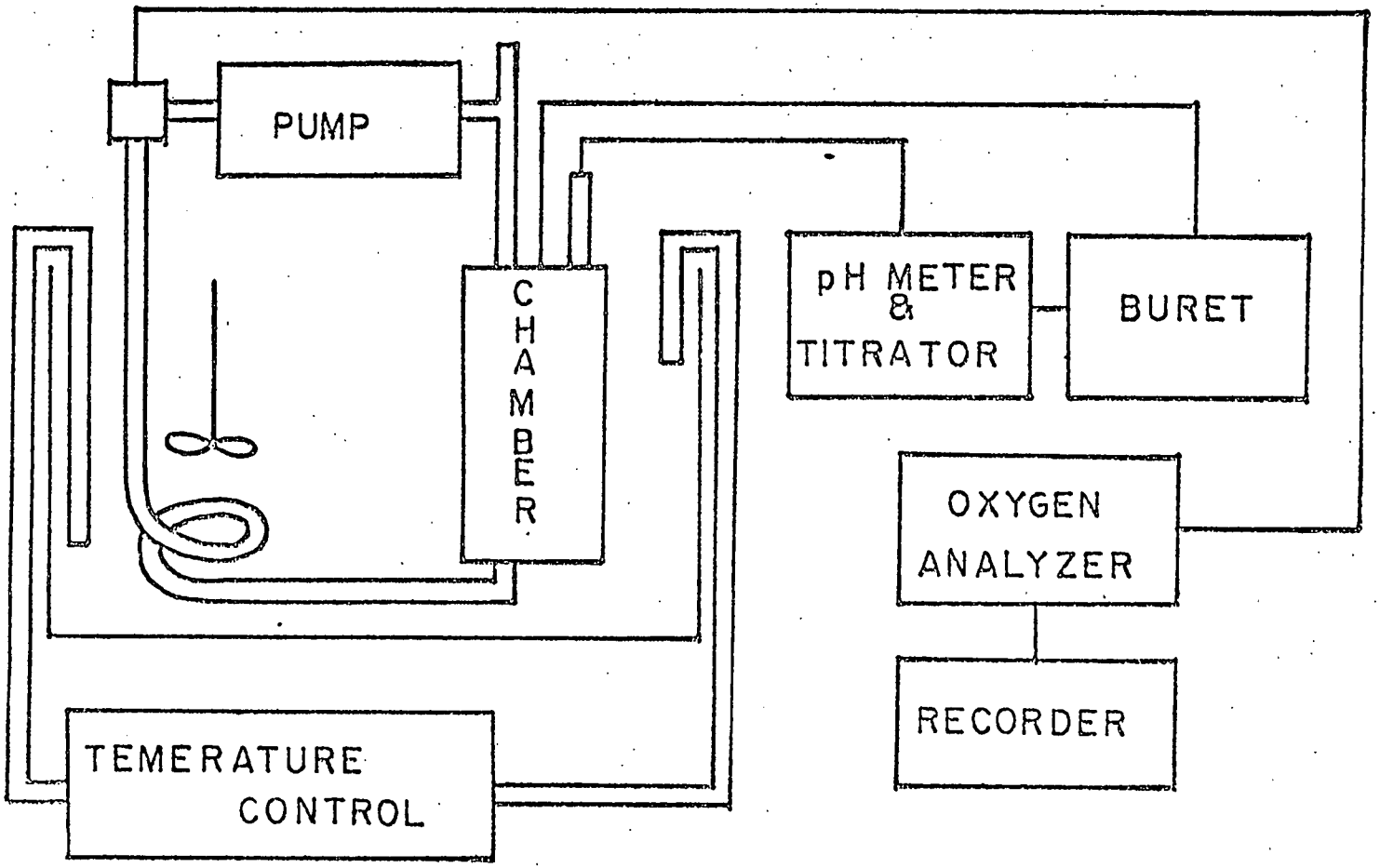

PUMP
CHAMBER
pH METER
&
TITRATOR
BURET
OXYGEN
ANALYZER
RECORDER
TEMERATURE
CONTROL

Figure 2

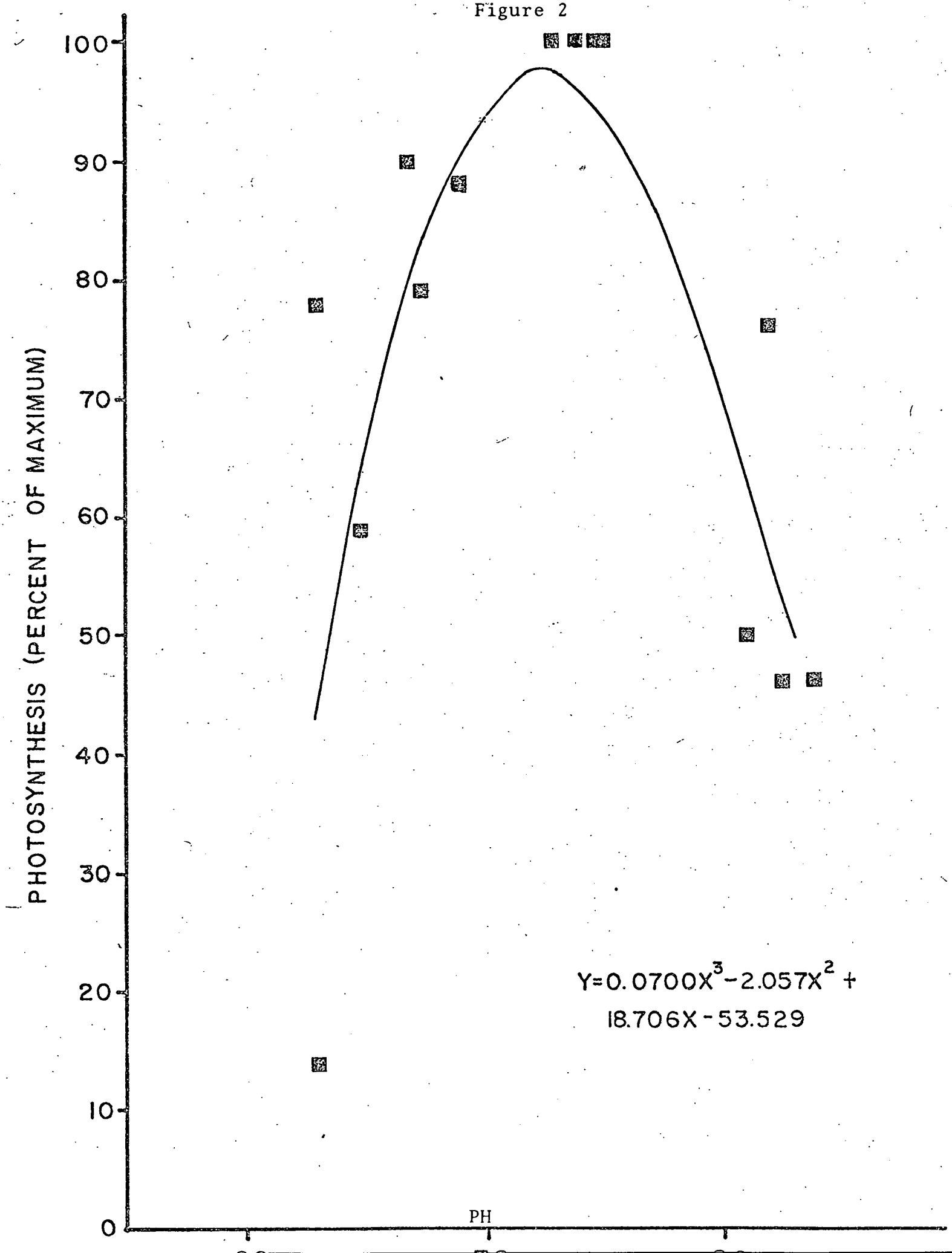

100
90
80
70
60
50
40
30
20
10
0
PHOTOSYNTHESIS (PERCENT OF MAXIMUM)
PH
Y=0.0700X³-2.057X² +
18.706X-53.529

Figure 3

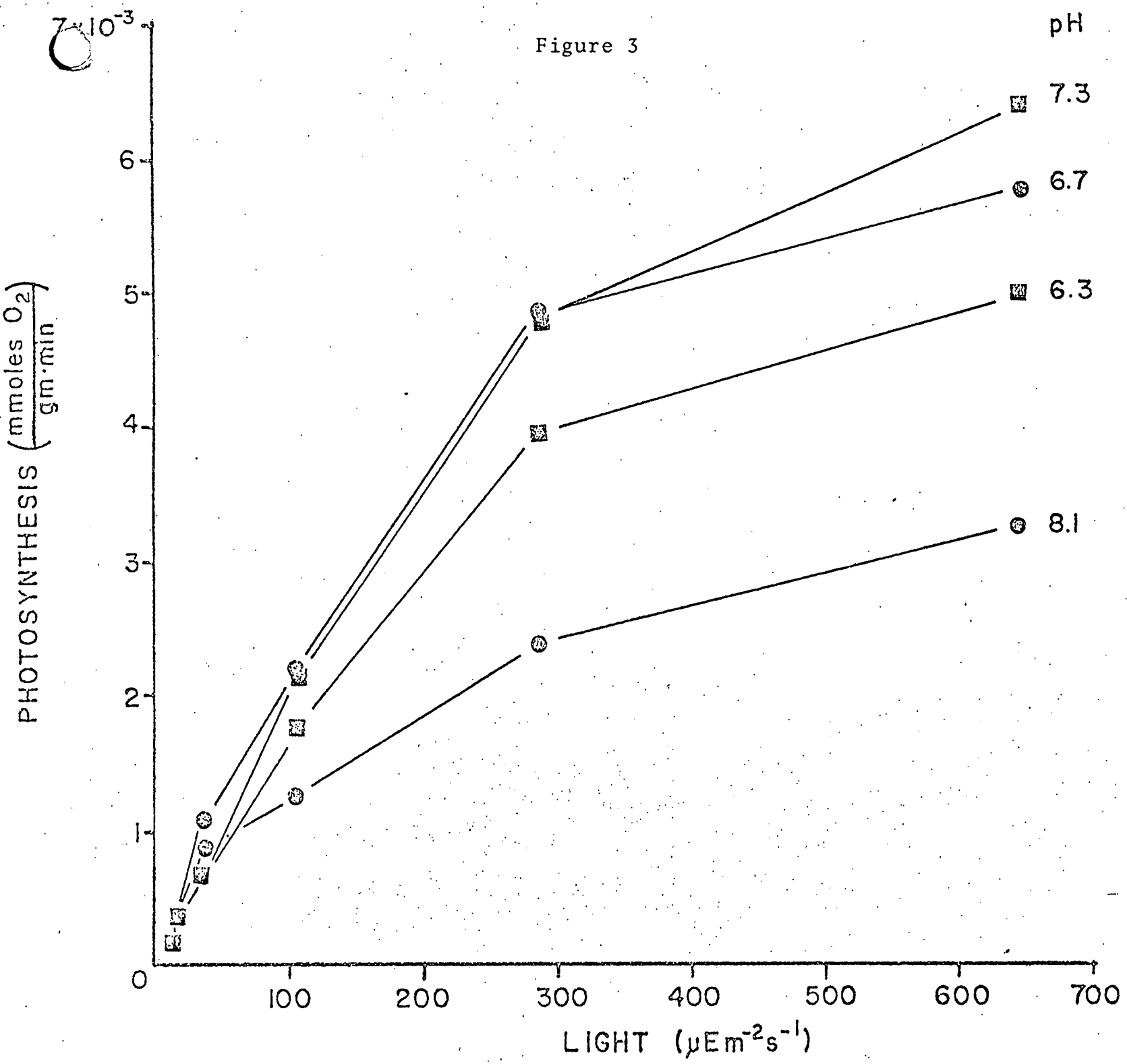
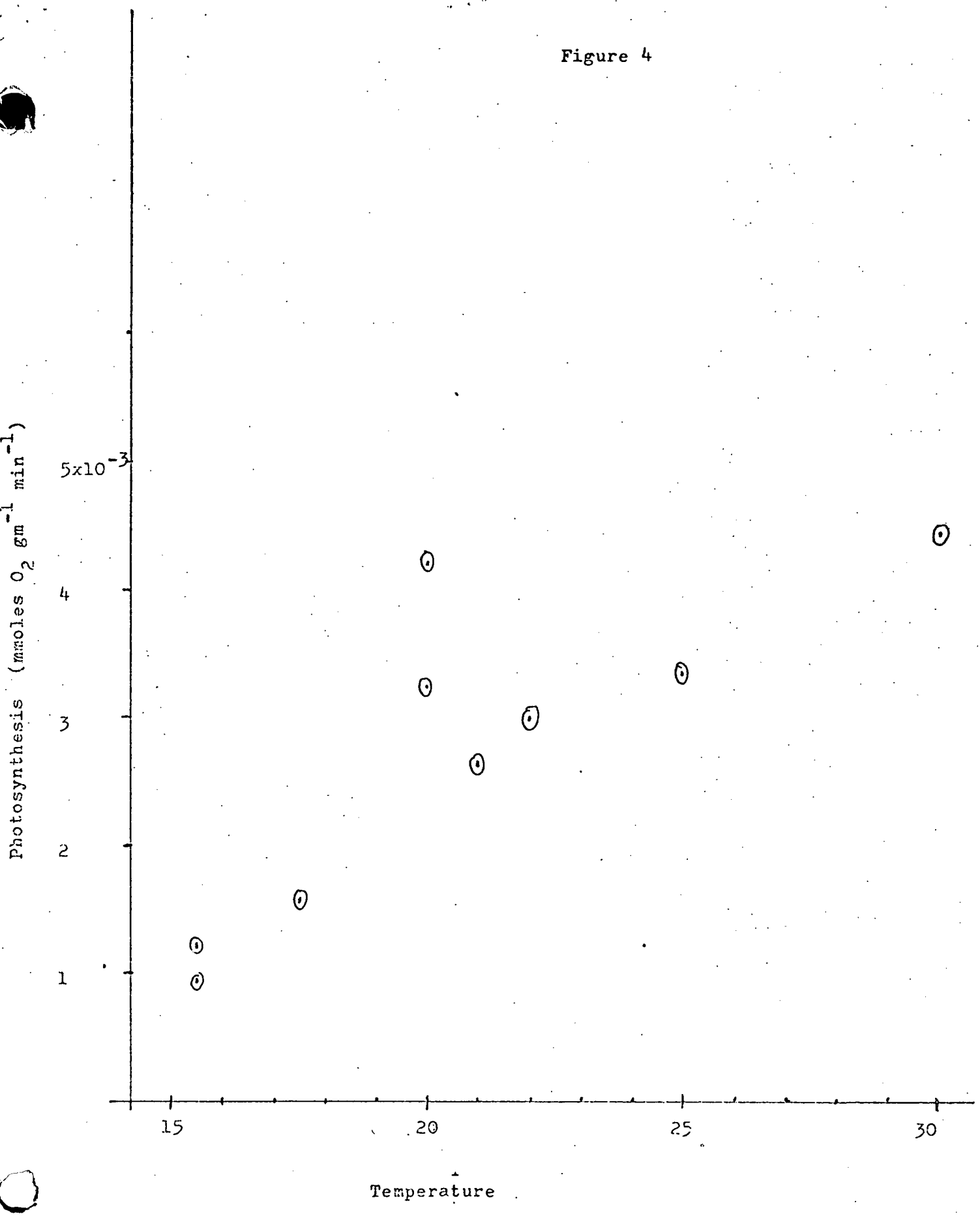

7 x 10⁻³
6
5
4
3
2
1
0
PHOTOSYNTHESIS (mmoles O2 / gm·min)
100
200
300
400
500
600
700
LIGHT (μEm⁻²s⁻¹)
pH
7.3
6.7
6.3
8.1

Figure 4


Photosynthesis (mmoles O_2 gm^{-1} min^{-1})
$5x10^{-3}$
4
3
2
1
15
20
25
30
Temperature