



SEASONAL OCCURRENCE AND
ABUNDANCE OF MAYFLIES,
OR EPHEMEROPTERA, FROM A
RESTRICTED AREA OF GULL LAKE

Thesis for the Degree of M. S.
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Phyllis E. Vinton

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ABSTRACT

SEASONAL OCCURRENCE AND ABUNDANCE OF CULEX MOSQUITOES,
GENUS CULEX,
FROM A RESTRICTED AREA OF GREAT LAKES

BY

Phyllis E. Vinton

Field trapping was conducted from March 25, 1967, to September 15, 1967, at Bull Lake, in Kalamazoo and Barry Counties of southern Michigan. Four species of culex (Anopheles) were taken from May through August. Details of the occurrence and abundance of each species are included. Air temperature, water temperature, incident radiation, and relative humidity are presented as possible parameters operating as modifying factors in the emergence pattern and activity of the culex. Weather conditions which prevailed on nights with unusually high or low catches are compared. A discussion of the sex ratio of Culex tritaeniorhynchus (Servillo) in relation to abundance is presented. Suggestions are made concerning further investigations of this type.

The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

Secondly, it highlights the role of internal controls in preventing fraud and ensuring the integrity of the financial statements. Proper segregation of duties and regular audits are essential for this purpose.

Thirdly, the document addresses the challenges of managing complex financial data and the need for robust information systems. It suggests investing in modern software solutions to streamline data collection and analysis.

Finally, it stresses the importance of staying up-to-date with the latest accounting standards and regulations. Continuous professional development is key to ensuring compliance and accuracy.

In conclusion, effective financial management requires a combination of strong internal controls, reliable data systems, and a commitment to high standards of accuracy and transparency.

The following table provides a summary of the key findings and recommendations discussed in the report.

Overall, the findings indicate that while there are areas for improvement, the organization has a solid foundation for achieving its financial goals through diligent management and adherence to best practices.

It is recommended that the management team implement the suggested measures to enhance the organization's financial performance and ensure long-term sustainability.

The report concludes with a call to action for all stakeholders to work together in promoting a culture of financial responsibility and excellence.

SEASONAL OCCURRENCE AND ABUNDANCE OF NAUPLIIA,
OR EUTIMHOPTERA,
IN A LIMITED AREA OF GULL LAKE

By

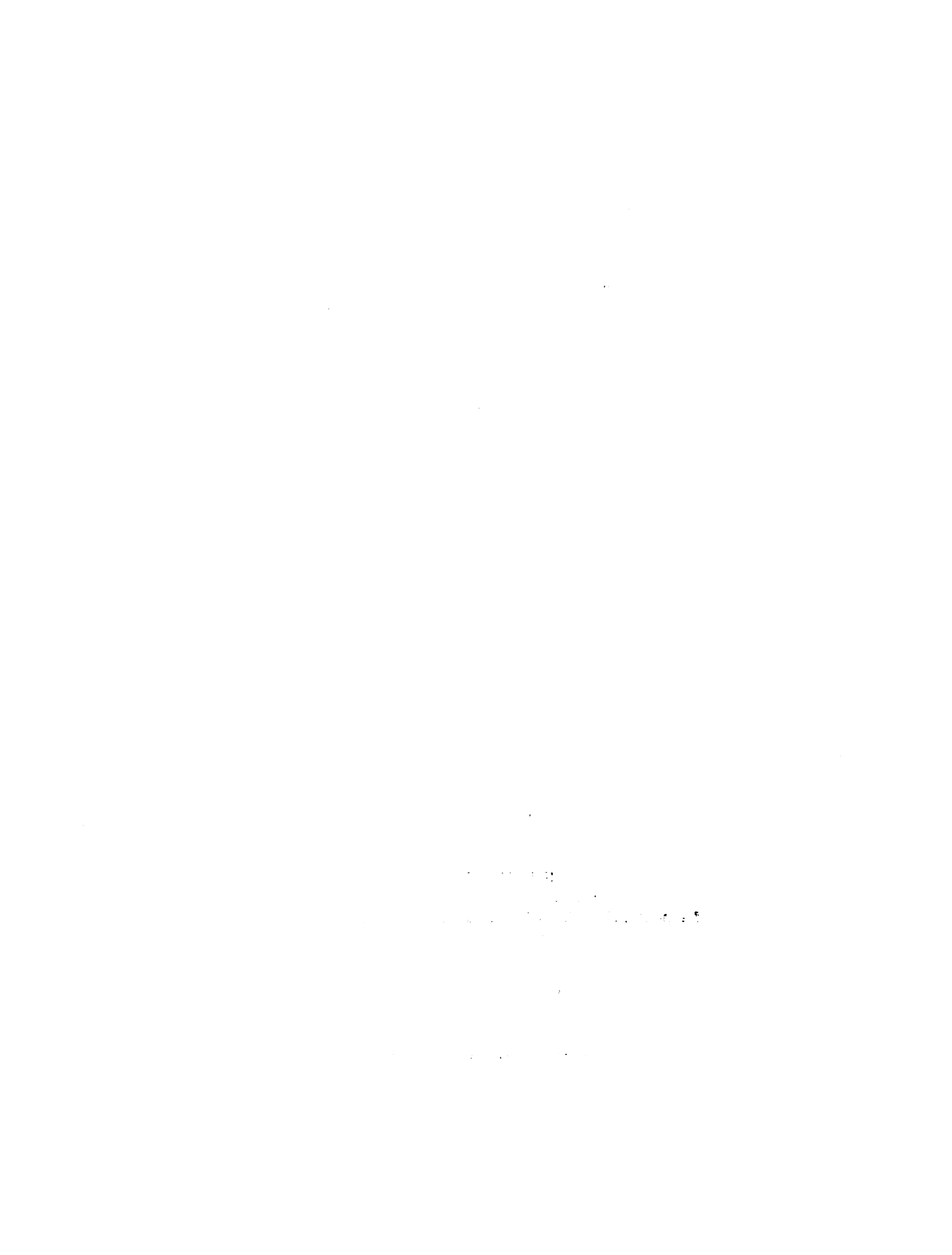
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A THESIS

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INTRODUCTION

Mayflies living under natural conditions are exposed to a continually changing combination of environmental factors. The physical environment is comprised partly of climatic factors, which are relatively stable, and weather factors which, like biological factors, are continually varying, although they usually vary about climatic means which change slowly.

Relative population estimates may be used for making population comparisons in space and time. Biological interpretation of such estimates is difficult, however, since the sample size is influenced by changes in actual numbers of individuals, changes in their activity, the degree to which a species or sex is responsive to the trap stimulus, and changes in efficiency of the trap.

Prevailing climatic conditions, as well as biological factors, greatly determine the species which may be present, and the season during which adults are likely to be active, while changes in weather have immediate effects on the number of individuals caught. Wilkins (1939, 1940) approached the problem of analyzing long range effects of climate and more immediate effects of weather by making comparisons between the same months of different years, of the number of insects trapped. Similar studies, conducted at the specific level, are few.

The objectives of this investigation were (1) to report the numbers and seasonal occurrence of mayflies (Ephemeroptera) emerging from a restricted area of Cull Lake, Michigan, and, (2) to evaluate several environmental parameters as possible elements operating as modifying factors in the emergence pattern of the mayflies.

LITERATURE REVIEW

Historical Review

A few species of large conspicuous mayflies often come to the general attention every year when they emerge in enormous numbers. Adults of many species appear consistently year after year in the same localities, on approximately the same dates for those localities, often forming vast swarms near the water. The earliest published records concerning American mayflies were descriptions of such swarms. In 1749, Philadelphia botanist John Bartram (1750) made observations which were published in the Transactions of the Royal Society of London, being communicated as follows:

May the 4th, 1749, Mr. Bartram perceived many Mayflies had attained wings, and were very thick spread on the bushes and grass, and by the river side. The second day after their leaving their aquatic abode they cast another skin, after which their tails are longer, and their wings drier and more transparent. The 5th and 6th was rainy, the 7th windy; so very few came out. The 8th was cool; so very few were seen: but many swarmed late in the evening; and on the 11th, 12th and 13th, they swarmed abundantly. What he calls swarming, was their gathering thick as bees, near the rivers to lay their eggs in the water.

Numerous papers, including keys and descriptions of the mayflies of a particular region, have been published. Eaton's Monograph of the Recent Ephemeridae, issued 1838-1850, still serves for the

generic and specific identification of much of the then known fauna of the world.

Most North American species were described by Traver (1938) and in a long series of papers published by McDunnough (1926, 1943) from 1921-1943. Needham, Traver and Hsu (1935) published a detailed account of the biology of mayflies and keys to North American mayflies. Two excellent references for mayflies of the Michigan area are: The Mayflies, or Ephemeroptera, of Illinois (Burks 1953), and Mayflies of Michigan Trout Streams (Leonard and Leonard 1962).

Insects and Weather

Early investigations made before statistical methods were developed were frequently descriptive in nature. The earliest extensive study of insects and their relation to climate was conducted by B. P. Uvarev (1931). In studying the responses of insects to environmental factors, Uvarev said that it was necessary to apply the analytical method and to investigate the influence of each factor separately. He indicated that it would be incorrect to assume that the response of an insect to the combined action of several factors will represent a sum of the responses to each factor involved.

C. B. Williams (1930, 1940), with the aid of R. L. Fisher, both working at the Rothamsted Experiment Station, Harpenden, England, analyzed four years' capture of insects in a light trap. Most analyses were made by methods of partial regressions and

QUESTION 1: The following table shows the results of a survey of 1000 people.

Age Group	Gender	Response
18-24	Male	150
	Female	120
25-34	Male	180
	Female	160
35-44	Male	200
	Female	180
45-54	Male	220
	Female	200
55-64	Male	240
	Female	220
65+	Male	260
	Female	240

QUESTION 2: A company has two departments, A and B. Department A has 10 employees and Department B has 15 employees. The following table shows the number of employees in each department who are male and female.

Department	Male	Female
A	6	4
B	8	7

QUESTION 3: A company has three departments, A, B, and C. Department A has 10 employees, Department B has 15 employees, and Department C has 20 employees. The following table shows the number of employees in each department who are male and female.

Department	Male	Female
A	6	4
B	8	7
C	12	8

QUESTION 4: A company has four departments, A, B, C, and D. Department A has 10 employees, Department B has 15 employees, Department C has 20 employees, and Department D has 25 employees. The following table shows the number of employees in each department who are male and female.

Department	Male	Female
A	6	4
B	8	7
C	12	8
D	15	10

analysis of variance. Williams' works from 1935 to present constitute the most comprehensive studies to date dealing with meteorological factors and their effect upon the total insect population and activity. Williams investigated large heterogeneous populations about which he assumed the total changed slowly, and hence, daily changes in the catch were due to changes in activity of the insects. Utilizing several years information, he was able to correct the mean total catch of each month for its departures from the normal (of the four years) in meteorological conditions (i.e., weather and climate), obtaining a value for what he believed would have been the catch had conditions been normal. The differences remaining he called the population effects, and these values were calculated. In his analyses he showed meteorological factors accounting for 59-63 percent of the variance of the total population.

The present study, dealing with *Helicoverpa* at the specific level, does not lend itself to similar analyses. The population of a single species of moths is not constant as was the general population studied by Williams. It can and does change very rapidly. The adult life span of moths is so short that population and activity are not easily separated.

In 1962, Williams conducted a similar study which was confined to a single group, the black flye (Williams 1962, Davis and Williams 1962).

Other workers have investigated one to several weather factors

as they affect abundance of a species or group of insects. Most work conducted to date at the specific level remains quite descriptive. Leonard and Leonard (1962) recorded the seasonal occurrence of winged mayflies over a single gravel riffle on the Pere Marquette River in Michigan.

Temperature

Williams (1940) believed temperature was the most important single climatic factor in a cool temperate zone. On nights when the catch of all insects was high, maximum day and minimum night temperatures were higher. He indicated that the effect of maximum temperature alone was of less significance than the effect of minimum temperature.

Cook (1924) noted that Lepidoptera catch increased with increasing air temperatures, the effect being much greater when humidity was low. Uvarov (1931) concluded that air temperature is the chief environmental factor influencing insect flight activities, such activities beginning about 10°C, with an optimum range between 20-25°C. With one exception, Scott and Opdyke (1941) found no general correlation between aquatic insect emergence and air temperature.

In his black fly studies, Williams found that maximum and minimum temperatures on days preceding the three nights of highest catch were 1°C above the monthly mean, with nights of high activity occurring at a minimum temperature above 9°C.

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Chant and McLeod (1952) found temperature range to have a close inverse relation to early abundance. This is in agreement with Davidson and Andrewartha (1948) who found temperature range to have a definite influence on the abundance of thrips.

Taylor (1933) believed there were both an upper and lower temperature threshold for insect flight. In a study of aerial insects, J. A. Freedman (1945) collected most species at a temperature above 61°F (16°C), but believed that appearance of many species in the air is more closely associated with their life history than with immediate effects of temperature. Further, that "regular daily catches of an aerial insect population would throw more light on the problem."

Incident Radiation

The source of heat which alters air temperature is radiation from the sun. There is a tendency for good catches to follow sunny days (Williams 1940).

Moisture

Williams (1940) found rain did not have a great effect on the catch, although the catch was usually lower after a rainy day. He found relative humidity to have no effect on catch. Svarov (1931) believed relative humidity had an effect on the

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activity of Lepidoptera, there being an inverse relation between relative humidity and activity above 54 percent relative humidity and a direct relation below 54 percent relative humidity.

Other Meteorological Parameters

Atmospheric pressure.--Ghent and Coleod (1952), Williams (1940) found atmospheric pressure to have no significant effect on insect abundance.

Cloud cover.--In addition to indicating high humidity, cloud cover prevents radiation of heat from the ground at night, thereby keeping night temperature higher, and partly blocks re-radiation from the sun, thereby lowering maximum temperature. Cloudy days usually have a lower maximum and higher minimum temperature than clear days (Williams 1940, Ghent and Coleod 1952).

Wind.--An analysis of the effect of wind is difficult due to its rapid variation in strength and its interaction with other weather factors. It is perhaps for this reason that this parameter has been incompletely investigated.

Moonlight.--Prior to 1950 Williams claimed that moonlight had a definite effect on nocturnal insects and that low catches in a light trap, at full moon, are not solely due to a physical reduction in efficiency of the trap. After evaluations utilizing suction traps were conducted from 1951 to 1953, Williams, Singh, and El Zaidy (1956) concluded that the 1950 cycle, on which they had based

The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting. The second part outlines the various methods used to collect and analyze data, including surveys, interviews, and focus groups. The third part presents the results of the study, highlighting key findings and trends. Finally, the document concludes with recommendations for future research and implementation strategies.

The study was conducted over a period of six months, during which time a large amount of data was collected and analyzed. The results show that there is a significant correlation between the variables being studied. This finding is supported by statistical analysis and is consistent with previous research in the field. The data also indicates that there are several factors that influence the outcome of the study, and these factors should be taken into account in future research.

The findings of this study have important implications for the field of research. They provide a new perspective on the relationship between the variables being studied and offer valuable insights into the underlying mechanisms. The results also suggest that there are several areas that need further investigation, and these areas should be the focus of future research. The study also highlights the need for more robust data collection and analysis methods, and these methods should be adopted in future studies.

In conclusion, this study has provided a comprehensive analysis of the relationship between the variables being studied. The findings are significant and provide valuable insights into the underlying mechanisms. The results also suggest that there are several areas that need further investigation, and these areas should be the focus of future research. The study also highlights the need for more robust data collection and analysis methods, and these methods should be adopted in future studies.

their claims, was accidental and of no biological significance. Further, that there was no evidence relating the effect of moonlight to the activity or distribution of night flying insects. They did indicate an exception in the case of some aquatic species, where light appears to influence emergence from the water.

Scott and Oxyke (1941) caught far more emergent aquatic insects in light colored than dark colored emergence traps. They hypothesized that when about to emerge, pupae or nymphs must be strongly phototactic to light of rather weak intensity.

Lunar periodicity.--A lunar rhythm has been associated with the changes in activity of certain animals, but most of the established cases are marine, and the effect may be partly due to tides. Hora (1927) noted in India that swarms of several species of mayflies usually appeared during the full moon period. Hartland-Rowe (1955) suggested that swarming in an African mayfly (Povilla adusta Navas) is related to the lunar cycle. He hypothesized that the lunar rhythm may only be maintained near the equator where there is little annual variation in day length and air temperature.

Sex Ratio

Williams (1939) found in Agrotis exclamationis and several other species of Noctuidae that females formed a smaller proportion

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial reporting and auditing.

2. The second part of the document outlines the various methods and techniques used to collect and analyze data. This includes both qualitative and quantitative approaches, as well as the use of statistical tools and software to process large volumes of information.

3. The third part of the document focuses on the interpretation of results and the drawing of conclusions. It highlights the need for critical thinking and the ability to identify patterns and trends within the data.

4. The fourth part of the document discusses the ethical considerations and standards that must be followed throughout the research process. This includes issues related to data privacy, confidentiality, and the integrity of the research findings.

5. The fifth part of the document provides a summary of the key findings and conclusions drawn from the study. It also includes recommendations for future research and practical applications of the results.

6. The sixth part of the document contains a list of references and sources used in the research. This section is crucial for providing context and supporting the claims made in the document.

7. The seventh part of the document includes a list of appendices and supplementary materials. These materials provide additional details and data that support the main findings of the study.

8. The eighth part of the document contains a list of figures and tables. These visual aids are used to present complex data in a more accessible and understandable format.

9. The ninth part of the document includes a list of footnotes and endnotes. These notes provide further information and clarification on specific points mentioned in the text.

10. The tenth part of the document contains a list of glossary terms and definitions. This section is useful for ensuring that all readers have a clear understanding of the terminology used in the document.

of the catch on nights when the species was abundant. According to Davis and Williams (1960) several species of black flies show a similar trend.

METHODS AND MATERIALS

Study area

Gull Lake is located in Kalamazoo and Barry Counties, T.1S. and 1 N.; R. 9 and 10 W., in the southwestern section of Lower Michigan. The study was conducted at the W. K. Kellogg Biological Station, located on the northeast side of the lake.

Gull Lake is among the deeper and larger of the inland lakes in southern Michigan. The surface area is 625 hectares. A major part of the lake is over 13 meters in depth, with a maximum depth of 36 meters. It is classified as a cold-water lake. The water is alkaline (pH 7.4-9.4).

Sand, gravel, and rubble are the principal bottom types on the shoals. Marl, muck, and pulpy peat are found in the deeper areas. Twenty-four species of aquatic plants were recorded when a biological survey of the lake was made in 1941.

The climate at Gull Lake alternates between Continental and Semiarid, due to prevailing westerly winds crossing Lake Michigan. The air temperature falls to -20°C during most winters; there are approximately 15 days each summer when the temperature reaches 33°C or above. Average dates of the first freezing temperature in fall and the last in spring are October 6 and May 8, respectively.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This not only helps in tracking expenses but also ensures compliance with tax regulations. The document further explains that regular audits are essential to identify any discrepancies or errors in the accounting process.

In the second section, the author highlights the role of technology in modern accounting. The use of cloud-based software allows for real-time data synchronization and secure storage. This reduces the risk of data loss and makes it easier for multiple users to access the system from different locations. Additionally, automation of routine tasks like invoicing and payroll processing can significantly improve efficiency and reduce human error.

The third part of the document focuses on budgeting and financial forecasting. It provides a detailed guide on how to set realistic goals and allocate resources effectively. By comparing actual performance against the budget, businesses can identify areas where they are overspending or underspending. This information is crucial for making informed decisions and adjusting strategies to stay on track.

Finally, the document concludes with a strong emphasis on transparency and communication. It advises businesses to maintain open lines of communication with stakeholders, including investors and employees. Regular financial reports and clear explanations of the company's financial health can build trust and ensure that everyone is aligned with the organization's long-term vision.

About 61 percent of the annual total precipitation occurs from April to September, with rainfall heaviest in June.

Microclimatic Records

An official weather station is located at the W. K. Kellogg Biological Station. Air temperature and relative humidity were obtained utilizing a continuous recording Hygro-Thermograph. A continuous record of water temperature was obtained utilizing a Taylor temperature recorder (76 J type recorder). A log was maintained for weather conditions throughout the study period. Air temperature and relative humidity were recorded at a distance of 2 meters from the trap and 1 meter above ground level. Water temperature was recorded at a depth of 15-30 centimeters and at a distance of 3 meters from the lake shore in proximity to the light trap. Thus, measurements of the daily physical environment were available for comparison with light trap captures.

Records of the average air temperature, total precipitation, and departures of each from the normal during the past 33 years were obtained from A. H. Eichmeyer, State Climatologist, Weather Bureau Office, Lansing.

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance to a desired state or goal.

2. Once a problem is identified, the next step is to define the problem more precisely. This involves determining the scope of the problem and the specific areas that are affected.

3. The third step is to analyze the causes of the problem. This is done by identifying the factors that contribute to the problem and determining how they are related to each other.

4. The fourth step is to develop a plan of action. This involves identifying the specific steps that need to be taken to solve the problem and determining the resources that will be needed.

5. The fifth step is to implement the plan. This involves putting the plan into action and monitoring progress to ensure that the problem is being solved.

6. The sixth step is to evaluate the results. This involves comparing the current performance to the desired state and determining whether the problem has been solved.

7. The seventh step is to take corrective action. This involves identifying any areas that still need to be addressed and taking steps to solve them.

8. The eighth step is to prevent the problem from recurring. This involves identifying the underlying causes of the problem and taking steps to address them.

9. The ninth step is to review the process. This involves reflecting on the steps that were taken and determining what was learned from the experience.

10. The tenth step is to share the results. This involves communicating the findings of the process to others who may be affected by the problem.

Species studied, with notes on their biology

General biology.--Mayflies have a life cycle of 4 stages: egg, aquatic nymph, aerial subimago and imago. Hereafter the imago and subimago will be referred to as "adults."

Nymphs of nearly all Michigan species require a year to mature (Leonard and Leonard 1962). Often an overlap in broods results in a long seasonal appearance by these species. A few species have a shorter life cycle with two broods per year, and the large ephemeroids usually require two years to mature (Burks 1953).

Duration of the winged stage is usually 2-3 days, but varies somewhat with the species, individuals, and probably with weather conditions (Goodman, Traver and Hsu 1935, Burks 1953). Subimagos usually emerge in late afternoon or evening, spend the subimaginal stage resting near the water, and make the final molt a day or so later; then males swarm, mating occurs, and females deposit eggs soon afterward (Burks 1953).

Collecting at lights usually yields the largest number of adults. Subimagos are often strongly attracted to light (Goodman, Traver and Hsu 1935, Burks 1953, and Leonard and Leonard 1962).

Species present.--It is assumed that adults of all species caught emerged from Gull Lake.

Panagrion libanata (Serville)

Habitat: Hole-like logs of the nymphs enable them to burrow into



bottom sediments of streams and larger lakes (Leonard and Leonard 1962).

Life cycle: Two years are usually required, although the cycle is completed in a year in some of the warmer southern Michigan lakes (Hunt 1953). The winged stage often lasts three days (Hunt 1953). Emergence and swarming are greatest from dusk to midnight (Hunt 1953).

Etheona similans (Walker)

Habitat: Like E. lineata, mole-like legs of nymphs enable them to burrow into the substrate. They inhabit streams and lakes with considerable wave action, and are most abundant in waters having a sand and gravel substratum (Leonard and Leonard 1962). They are less common in silt and mud bars where E. lineata predominates (Leonard and Leonard 1962).

Life cycle: The cycle usually takes two years to complete (Burks 1953). Emergence is during the evening and swarming occurs over the water at dusk (Leonard and Leonard 1962). According to Leonard and Leonard (1962) heavy emergence of E. similans usually takes place about ten days before that of E. lineata.

Stenonema rubrum (McDermough)

Habitat: Legs and body of the nymphs are flattened, offering little resistance to water movement or action as they cling to stones and other submerged objects. They frequently occur in the shallow water (less than 15 centimeters) of streams and lakes with

strong current or wave action (Leonard and Leonard 1962).

Life cycle: The cycle is completed in a year. Emergence occurs from afternoon through evening (Burks 1953, Leonard and Leonard 1962).

Limnia similis (McDunnough)

Habitat: The operculate gilled nymphs inhabit quiet waters where silt and debris collect. Adults are assumed to have emerged from a large area at the Biological Station, as well as from Gull Lake.

Life cycle: The life cycle is completed in a year with heaviest emergence and swarming occurring at darkness (Burks 1953). The subimago stage is greatly abbreviated, as evidenced by Burks (1953), who observed the subimago being shed during flight immediately after emergence.

Sampling techniques

Description of Traps.--A New Jersey type light trap was utilized for the collections from March 29, 1967 to July 29, 1967. At this time the trap became inoperable, and was replaced with a Spinsect Night Flying Insect Trap, which operated from July 30, 1967 to September 15, 1967. Both traps combine light (New Jersey: incandescent, Spinsect: black light fluorescent) and suction (rotary fan) and, therefore, are especially useful for weak fliers. Information is not available to determine the effect that changing traps had on the number and types of insects collected.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial reporting and compliance with regulatory requirements. The text notes that without reliable records, it becomes difficult to track performance, identify trends, and address any discrepancies or errors that may arise.

2. The second section focuses on the role of internal controls in ensuring the integrity of the data. It highlights that a robust system of internal controls is necessary to prevent fraud, reduce the risk of errors, and ensure that all operations are conducted in accordance with established policies and procedures. The document suggests that regular audits and reviews of these controls are crucial for their effectiveness and for maintaining the trust of stakeholders.

3. The third part of the document addresses the challenges associated with data management in a complex and rapidly changing environment. It points out that the volume and variety of data are increasing significantly, which can lead to information overload and make it difficult to extract meaningful insights. The text recommends investing in advanced data management tools and technologies, as well as providing training to staff to ensure they are equipped to handle and analyze the data effectively.

4. The final section discusses the importance of data security and privacy. It stresses that organizations must implement strong security measures to protect sensitive information from unauthorized access, theft, or loss. This includes using encryption, firewalls, and secure communication channels. Additionally, the document emphasizes the need to comply with data protection regulations, such as the General Data Protection Regulation (GDPR), to ensure that personal data is handled lawfully and ethically.

Trap site.--The trap was located at the W. H. Kellogg Biological Station, in an open area 3 meters from the lake shore, 1.3 meters above water level, and 1 meter above ground level. Nearby trees, shrubs and surrounding hills afforded some protection from high winds sufficient to alter natural dispersion of the insects.

Method of determining number of mayflies per catch.-- A trolley balance was utilized to determine the dry weight of Gaaris sixtina. The number trapped was estimated by comparing the dry weight of each daily sample to the known dry weight of 600 individuals. All other species were counted directly. Imago and sub-imago were counted as adults. Several times the trap was not emptied for two or three days; 1/2 or 1/3 of the catch was arbitrarily assigned to each day.

RESULTS

Use of logarithms

In comparing the number of mayflies caught, logs of the numbers were used, as suggested by Williams (1936, 1961).

Night to night variation in numbers was more geometrical than arithmetical, i.e., high emergence periods were associated with a multiplication of the catch by some factor, not the addition of some number to the catch. It was necessary to convert the catch to a log scale, so that geometric changes became linear and normal statistical formulas could be used. Since catches were zero on many nights, logarithm of the number caught plus one [$\log. (n + 1)$] was used.

Any increase of .301 in the log. catch indicates that the catch is doubled.

Statistical analysis of log. catch in relation to meteorological factors was limited to events during the emergence peak of a species. Only then can adults of that species be expected to be present. Due to biological factors, one would not expect to find E. simulans in August, hence there is no point in considering weather conditions in August as they directly influence the occurrence of E. simulans adults.

QUESTION

1. The following table shows the number of people who visited the National Gallery in London in each year from 1990 to 2000. The number of people is given in thousands.

Year	Number of people (in thousands)
1990	120
1991	125
1992	130
1993	135
1994	140
1995	145
1996	150
1997	155
1998	160
1999	165
2000	170

ANSWER

The number of people who visited the National Gallery in London in each year from 1990 to 2000 is given in the table below.

Year	Number of people (in thousands)
1990	120
1991	125
1992	130
1993	135
1994	140
1995	145
1996	150
1997	155
1998	160
1999	165
2000	170

Seasonal emergence of the species studied

Two major widely separated peaks of emergence were observed for S. rubrus. Emergence patterns for other species were temporally close and therefore considered as one peak.

Homocidus litator

Emergence: June 23 to August 30 (Figure 1)

Peak emergence period: July 29 to August 30

Heterospilus similans

Emergence: May 31 to June 9 (Figure 1)

Note: Emergence of H. similans was 15 days prior to the emergence of H. litator.

Stenomacrus rubrus

Emergence: May 26 to August 24 (Figure 2)

Peak emergence period: May 31 to June 11, July 29 to August 24

Coelinius similans

Emergence: June 13 to July 24 (Figure 3)

Peak emergence period: June 13 to July 11

Stenomacrus rubrus adults which emerged during the first peak were noticeably larger than those from the second peak.

Water temperature, maximum and minimum air temperature, and incident radiation on days during the June and August peaks when

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part outlines the various methods and tools used to collect and analyze data. This includes the use of surveys, interviews, and focus groups to gather qualitative information, as well as the application of statistical techniques to quantitative data.

3. The third part describes the process of identifying and measuring key performance indicators (KPIs). It highlights the need to select metrics that are relevant to the organization's strategic goals and to establish a clear baseline for comparison.

4. The fourth part details the implementation of a data management system. This involves the selection of appropriate software, the design of a secure database, and the establishment of protocols for data access and security.

5. The fifth part discusses the importance of data privacy and protection. It outlines the necessary steps to ensure that all data is handled in accordance with applicable laws and regulations, and that appropriate safeguards are in place to prevent unauthorized access or disclosure.

6. The sixth part addresses the challenges of data integration and interoperability. It explores the various factors that can hinder the seamless flow of information between different systems and departments, and offers strategies to overcome these obstacles.

7. The seventh part focuses on the role of data in decision-making. It argues that data-driven insights are crucial for identifying trends, spotting opportunities, and mitigating risks, and provides examples of how data has been used to inform strategic decisions.

8. The eighth part discusses the importance of data literacy and training. It emphasizes that all employees should have a basic understanding of data and be able to interpret and use it effectively in their work.

9. The ninth part outlines the future of data and analytics. It discusses emerging technologies such as artificial intelligence and machine learning, and their potential to revolutionize the way data is analyzed and used.

10. The tenth part concludes the document by summarizing the key findings and recommendations. It reiterates the importance of a data-driven approach and provides a clear roadmap for the organization to follow in its data management journey.

the log. catch was 1.00 or greater were compared. Using the Mann-Whitney test, no significant difference was found between June and August maximum air temperatures [$.10 < P(U \leq 48)$]; no significant difference was found between June and August minimum air temperatures [$.10 < P(U \leq 46)$]; but a highly significant difference was found between June and August water temperatures [$P(U \leq 10.5) < .002$].

Correlations between nights of high and low catch

Prior to a more detailed survey of circle factors, it is of interest to note the weather conditions that prevailed on nights with unusually high or low log. catch. Average and minimum air temperatures were generally higher when the log. catch was high (Figures 1-6). Maximum air temperature and temperature range appeared to have little direct effect on the log. catch (Figures 7, 8). Days prior to numerous nights of high log. catches had more sunshine. High emergence occurred during many periods of rainy weather, although prolonged rain at the time of emergence peaks usually coincided with a tapering off in number of individuals captured (Figures 4-6). The effect of rain was more apparent during non peak periods. High as well as low numbers of individuals were taken when there was rain at night, but day rain was often followed by a low catch (Figures 4-6). No emergence was observed until the water temperature averaged 17°C (Figures 1-3).

Meteorological Parameters

Meteorological parameters investigated were:

1. Temperature
2. Incident Radiation
3. Moisture

Temperature

Air temperature.--

Table 1.--Average temperature and departure from the normal,
May-September, 1957

Month	Av. temp.	Departure from normal [*]
May	12.1°C (53.7°F)	-2.2°C (-4.3°F)
June	21.3°C (70.3°F)	+1.1°C (+2.0°F)
July	37.6°C (99.6°F)	-1.7°C (-3.0°F)
August	29.4°C (84.7°F)	-1.4°C (-2.5°F)
September	17.1°C (62.7°F)	-0.3°C (-0.6°F)

^{*} Normal of the past 33 years.

Table 1 shows that average temperatures for all months except June were below the normal of the previous 33 years.

Daily air temperature.--The daily maximum temperature was usually recorded about 3 p.m. It increased from 13-15°C in early May to 23°C by late May, when several exceptionally warm

Section 1: Introduction

The first part of the document discusses the importance of maintaining accurate records.

This section covers the various methods used to collect and analyze data.

The results of the study are presented in the following table.

Table 1: Summary of Data

Table 1: Summary of Data

The data shows a significant increase in the number of participants over the course of the study.

Table 1: Summary of Data

Year	Participants	Percentage
2010	100	100%
2011	150	150%
2012	200	200%
2013	250	250%
2014	300	300%

Table 1: Summary of Data

The data indicates a steady growth in the number of participants over the five-year period.

This growth is attributed to the increased awareness of the study's benefits.

The following table provides a detailed breakdown of the data.

Table 2: Detailed Breakdown of Data

The data shows a clear trend of increasing participation over time.

days preceded the first mayfly emergence. Figure 7 shows that the maximum temperature was 19-26°C during most mayfly emergence, but within this range, maximum temperature had no effect on catch.

Minimum air temperature.--The daily minimum was usually recorded about 6 a.m. It increased from 1-3°C in early May to 11°C before any mayflies emerged. High minimum temperatures often accompanied periods of high mayfly emergence (Figures 1-3).

Stenonema libanum was most frequently taken when a minimum temperature of 11-17°C was recorded (Table 2). Within this range, there was no significant correlation between size of the log. catch and minimum temperature [Spearman Rank Correlation: $.10 < P (r_s = .253)$].

Stenonema similis was taken at all minimum temperature ranges considered (Table 2). The log. catch was about the same for each range.

Stenonema rubrum also was taken at all ranges considered (Table 2) but, using a Kruskal-Wallis One Way Analysis of Variance by Rank, there was a highly significant difference shown among log. catches at each minimum temperature range [$P(\chi^2 \geq 23.3) < .001$]. Ranges III and IV were combined for testing because of the small Range IV sample. Inspection of these data shows that the log. catch size was greatest from 14-19°C and decreased with decreasing minimum temperatures. There appeared to be a correlation between log. catch size and minimum temperature except on three nights with an unusually

high log. catch (Figure 2). At this time a minimum temperature of 27° would have been required for temperature to remain proportional to the increase in log. catch. Omitting these three observations, there was a significant correlation shown between the log. catch size and minimum temperature [Spearman Rank Correlation: $P(r_s \geq .405) < .05$].

Log. catch was taken at $11-15^{\circ}$ minimum temperature (Table 2). Least netters caught (Figure 3) during cool weather in early June, although large catches were also taken at higher minimum temperatures.

Average air temperature.--Usually the 6 p.m. temperature approximated the daily average temperature. Early July temperatures averaged 5° , and increased to the 17° prior to the earliest nightly emergence (Figures 4-6).

Temperature minima was most frequently taken when the average temperature ranged between $11-21^{\circ}$. Within this range there was no significant correlation between size of log. catch and average air temperature [Spearman Rank Correlation: $.05 < P(r_s \geq .342) < .10$].

Temperature minima was taken at all average temperatures considered. When the three nights of unusually high log. catch were omitted from the test, (see the above explanation) using a Spearman Rank Correlation test, there was a significant difference shown between size of log. catch and average temperature [$P(r_s \geq .473) < .05$].

Table 2.--Log. catch of each species at increasing minimum temperature ranges.

Species	Range I (less than 10°C)	Range II (11 - 13°C)	Range III (14 - 15°C)	Range IV (17 - 19°C)
<u>Neoverania</u>		.70		
<u>11/10/12</u>	1.30	.48	1.66	1.26
			1.66	0.00
	1.90	2.63	1.66	2.22
	2.11	1.96	2.66	0.00
		1.93	.81	.70
	.65	.43	.81	.70
		1.11	0.00	1.26
		1.73	2.55	1.81
<u>Leberomyia</u>	.30			2.27
<u>similaris</u>	2.73	2.37	2.19	1.20
	2.73		1.75	
<u>Stenonema</u>	.30	1.32	3.59	
<u>11/10/12</u>	1.35	.73	3.57	1.52
	1.35	1.36	2.51	1.58
	.73	0.00	1.15	1.43
	.73	1.00	1.26	1.61
	.65	1.32	1.91	
	.70	.95	0.00	
	.95	0.00	1.30	
	.30	1.63	1.43	
		1.76	1.66	
		.53	1.63	
		.43		
		.45		
<u>Coelis</u>	3.73	3.72	3.72	3.73
<u>similaris</u>	3.73	3.73	3.73	1.13
	3.71	3.46	2.37	0.00
	3.70	2.34	.73	1.85
	3.79	2.93	2.83	
	3.71	3.22	1.90	
	3.73	.85		

1. The first section of the document discusses the importance of maintaining accurate records and the role of the auditor in this process.

2. The second section details the various methods used to collect and analyze data, including interviews, observations, and document analysis.

3. The third section describes the findings of the study, highlighting the key areas where improvements are needed.

4. The fourth section provides a detailed analysis of the data, including statistical tests and the interpretation of the results.

5. The final section concludes the study and offers recommendations for future research and practical applications.

Range in air temperature.--Temperature range varied irregularly throughout the study period and had no apparent relation to log. catch (Figure 8).

Average water temperature.--Since daily temperatures fluctuated less than 3°C, only average temperatures were reported. Ice left the lake on April 1, 1967. A water temperature of 17°C was recorded in late May, at which time the first mayfly emergence was observed (Figures 1, 2). Water temperature continued increasing to 25°C, varied between 23°C and 26°C until early August, then slowly declined (Figure 1).

Temperatures recorded in this study were obtained in the littoral zone of the lake. Water temperature information for all strata of the lake as well as substrate temperatures might allow for a more detailed analysis of the temperature more closely experienced by the mayflies.

Stenonema lineatum

Water temperature decreased from 25 to 20°C during the July and August emergence peak.

Plecoptera sp.

Water temperature during the June emergence peak steadily increased from 17 to 22°C.

Stenonema lineatum

Water temperatures increased from 17 to 24°C during the June emergence, and fell from 25 to 20°C during the August emergence.

Caenis similans

Water temperature during C. similans emergence was 24 to 26°C.

Incident Radiation

Sunlight does not directly affect the catch since trapping is between sundown and sunrise.

Peaks in incident radiation often occur during the day of, or a day or two prior to, an observed increase in log. catch. One marked exception did occur when the S. vittata catch was high during a period of cloudy, rainy weather (Figure 5). A period of very high radiation, however, immediately preceded the emergence peak. At low log. catch levels there appeared to be a linear relation between log. catch and incident radiation, but the relation became geometric, even though logarithms were used, during periods when great numbers of individuals emerged.

Incident radiation and Ephemera similans log. catch appeared to correspond very closely (Figure 4), but the number of days of emergence was too small to warrant statistical analysis. The log. catch appeared to increase geometrically in relation to incident radiation during very high emergence periods of the other three species, therefore normal statistical tests assuming linearity could not be used.

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Table 3.--Total precipitation and departures from the normal

Month	Total Precipitation	Departure from normal*
May	5.94cm(2.34 in)	-4.90cm(-1.39 in)
June	15.32cm(6.03 in)	+4.57cm(+1.80 in)
July	7.32cm(2.88 in)	+ .03cm(+.01 in)
August	4.83cm(1.90 in)	-4.5cm(-1.76 in)
September	7.82cm(3.08 in)	- .03cm(- .01 in)

* Normal of the past 33 years.

Table 3 shows that total precipitation was about normal in July and September, but well above normal in June, and well below normal in May and August.

In standard weather records rain is recorded from 9:00 a.m. to 9:00 a.m. Rain falling up to 9:00 a.m. is credited to the previous day. During this study, day rain was recorded from 6:00 a.m. to 6:00 p.m., and night rain recorded from 6:00 p.m. to 6:00 a.m. (Figure 4).

The effects of rain have been discussed previously (page 7).

Relative humidity.--Maximum relative humidity commonly reached 80 to 92 percent about 6 a.m. There appears to be no relation between log. catch and maximum relative humidity (Figure 9).

Minimum relative humidity varied from 13 to 92 percent, and was usually recorded about 3 p.m. No relation between log. catch and minimum relative humidity was apparent (Figure 10). Average relative humidity was usually 45 to 75 percent with no apparent relation to log. catch (Figure 11).

Lunar periodicity.--Days of full and new moon were noted. Lunar periodicity in emergence was not apparent. The time span of the study was too short, however, to warrant any conclusions.

Sex ratio of *Coqueania listata* in relation to emergence.-- Table 4 shows the number of individuals of each sex caught during periods of high emergence and low emergence.

Using the Wilcoxon sum test, a significant difference is shown between the numbers of each sex caught on nights of high emergence [$.01 < P(h \leq 9) < .02$]. The data show that the number of males greatly exceeds the number of females on these nights.

The first part of the paper discusses the importance of the
 \mathcal{L}^2 norm in the context of the problem. It is shown that
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Table 4.--Numbers of each sex taken on nights of high and low
Paragompha limbata (Serville) emergence.

Date	High emergence (over 40)			
	Males		Females	
	number	log.(n+1)	number	log.(n+1)
August 1, 1967	159	2.20	10	1.00
August 6, 1967	378	2.53	51	1.72
August 7, 1967	55	1.75	35	1.56
August 8, 1967	74	1.88	10	1.00
August 15, 1967	17	1.26	26	1.43
August 18, 1967	26	1.43	38	1.59
August 19, 1967	26	1.43	18.3	1.29
August 20, 1967	26	1.43	18.3	1.29
August 21, 1967	26	1.43	18.3	1.29
August 24, 1967	123	2.09	5	0.78
August 25, 1967	433	2.64	18	1.23
August 26, 1967	300	2.48	54	1.74
Low emergence (under 40)				
June 23, 1967	2	0.48	2	0.48
June 24, 1967	1	0.30	0	0.00
July 2, 1967	1	0.30	0	0.00
July 8, 1967	0	0.00	1.5	0.41
July 9, 1967	0	0.00	1.5	0.41
July 19, 1967	1	0.30	3	0.60
July 24, 1967	0	0.00	1	0.30
July 25, 1967	0	0.00	2	0.48
July 27, 1967	0	0.00	1	0.30
July 29, 1967	4	0.70	0	0.00
July 30, 1967	9	1.00	9	1.00
August 2, 1967	7	0.90	16	1.23
August 4, 1967	4	0.70	2	0.48
August 5, 1967	2	0.48	0	0.00
August 9, 1967	2	0.48	0	0.00
August 11, 1967	1	0.30	0	0.00
August 14, 1967	5	0.78	7	0.90
August 16, 1967	1	0.30	5	0.78
August 17, 1967	1	0.30	16	1.21
August 22, 1967	13	1.15	6	0.85
August 23, 1967	1	0.30	14	1.18
August 26, 1967	5	0.78	0	0.00
August 27, 1967	5	0.78	1	0.30
August 29, 1967	5	0.78	3	0.60

Section 1: Introduction

Section 2: Methodology

Section 3: Results

Section 4: Discussion

DISCUSSION AND CONCLUSIONS

The catch on any one night is assumed to be a representative sample of mayflies flying in the vicinity of the trap. The area from which they are attracted is not known, and probably differs for each species, for the same species on different nights, and possibly differs between both sexes of the same species.

The catch is proportional to both the population available for sampling, and activity of the individuals. In turn, population and activity are affected by biological factors such as habits and life history of the species, and meteorological factors, i.e., climate and weather.

Willians' study (1940) of the effects of meteorological conditions on the abundance of insects dealt with population and activity. This is because a continuous succession of insects results in a fairly constant total population. When considering insects at the specific level, however, the habits of that species dictate that there will be periods of high and low numbers of individuals. Since the life span of the aerial stage is short, light trap catches will indicate the relative size of the adult population, provided that the adults are active.

Climate greatly influences the occurrence of a given species, and the time of year during which the adults are likely to be active.

Variation in weather conditions can be expected to influence the daily emergence and activity of the mayflies.

Sources of error

Error from using a single trap.--More reliable results might be obtained by using several traps simultaneously. Williams (1940) used a second trap, set up under nearly identical conditions to the first, to test the reliability of a single trap. Correlation between traps for insects caught was .86-.92, showing that the error was small. Using but one trap may introduce only a negligible error.

Error from trap efficiency and choice of traps.--Traps with fans are more efficient in catching mosquitoes than traps without fans (Frost 1957). The same is probably true for mayflies, since they also are weak fliers.

Briggs, Glick, and Guelan (1961) found traps shielded from prevailing winds to be more efficient than traps in exposed locations.

Moonlight may alter trap efficiency, since it causes a reduction in the relative light intensity of the trap (Williams 1936, Williams and Singh 1951, Williams, Singh, and El Zaidy 1956). Several studies (Williams 1951, Williams, French and Horn 1955, Verheyens 1960, Barr et al. 1963) indicate that an increase in intensity or size of the lamp frequently brought about by the substitution of an ultra-violet lamp for an incandescent lamp usually led to an increased catch.

It is likely that the traps used in the study did vary

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This not only helps in tracking expenses but also ensures compliance with tax regulations. The second part of the document provides a detailed breakdown of the company's revenue for the quarter. It shows that sales have increased by 15% compared to the previous quarter, primarily due to the launch of a new product line. The third part of the document outlines the budget for the next quarter, highlighting areas where cost-cutting measures can be implemented without compromising the quality of the products. The fourth part of the document discusses the company's financial position and the need for a strong cash flow. It suggests that the company should consider diversifying its revenue streams to reduce the risk of market fluctuations. The fifth part of the document provides a summary of the key findings and recommendations. It concludes that the company is well-positioned for growth, provided it continues to invest in research and development and maintains a focus on customer satisfaction. The sixth part of the document includes a list of references and a glossary of terms. The seventh part of the document is a list of appendices, including a detailed financial statement and a list of supporting documents. The eighth part of the document is a list of footnotes and a list of references. The ninth part of the document is a list of references and a list of references. The tenth part of the document is a list of references and a list of references.

somewhat in efficiency. However, log. catch data collected during the operation of the first trap were not compared to those collected during operation of the second trap.

Error from unit of measurement.--A single mayfly, which is the unit of measurement, is small in comparison to the total catch if many individuals were caught. When the catch is small, the unit of measurement is high in comparison to the total, so small changes have a greater effect.

An estimate, rather than a direct count, should have no effect on the results, since estimates were made only when thousands of C. simulans were caught.

Metecological parameters

The number of insects present is affected by weather conditions prevailing at the time of activity and by the effect of previous weather conditions on the level of the population (Millman 1962). Since nymphs are aquatic, past and immediate aquatic environmental factors, and immediate terrestrial weather conditions, probably most influence the occurrence and relative abundance of adults.

Temperature

Air temperature.--With few exceptions, the adults of all four species studied were caught at a temperature range of 8-25°C. These temperatures fall within the range of 6-26°C at which Froehner (1945) expected to find an increase in density of population and

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Air temperature—With few exceptions, the adults of all

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These temperatures fall within the range of 6-28°C at which Freedman

(1962) expected to find an increase in density of population and

in numbers of species of total insects. Air temperature probably influenced the occurrence and abundance of adult mayflies studied more than any other single weather factor evaluated. This is in agreement with Williams' (1940) findings concerning the total insect population, but in contrast to conclusions of Scott and Opdyke (1941) that there is no general correlation between air temperature and aquatic insect emergence.

Several studies have shown that air temperature is the environmental factor most influencing flight activity (Cook 1934, Uvarov 1931, Taylor 1963).

The leg. catch was usually higher when minimum and average air temperatures were high, but maximum temperature and temperature range had no apparent effect as shown by Figures 7 and 8. Maximum temperature showed no effect probably because it was analyzed as a single factor, and normally occurred about 3 p.m., a time when mayflies are inactive (Needham, Traver and Hsu 1945). But since the catch tended to be higher on nights following warm days, maximum temperature probably had an indirect effect through average and minimum temperatures. Emergence and swarming activity of mayflies is usually highest from dusk to midnight, when the air temperature is usually less than the average daily temperature and greater than the minimum temperature. (About 6 p.m., the air temperature generally approximates the daily average; the minimum temperature is most often recorded about 6 a.m.)

The log. catch was often higher when minimum and average temperatures were higher.

Leonard and Leonard (1962) observed the subimaginal stage to be prolonged by daytime temperatures of 10°C or lower, but temperatures at Gull Lake during the emergence periods remained above 10°C. Minimum temperature throughout the study period remained above 6°C, a temperature above which Williams (1962) captured the greatest numbers of emergent black flies.

Since biology of the species as well as factors other than temperature influence the catch, and since extremely unfavorable conditions may act as a limiting factor to daily catch, exceptions occurred, in which the catch was sometimes low when temperature conditions seemed favorable, and vice versa.

The air temperature at which activity of the adults was noted varied somewhat with the species; S. rubrum and E. simulans were active at a greater range in average and minimum temperatures than H. limata or C. simulans. This may be advantageous for S. rubrum and E. simulans, since their emergence peaks are earlier in the spring, when a greater fluctuation in temperature is likely.

Water temperature.--Water temperature increased steadily to 17°C before mayfly emergence was noted.

A comparison of weather parameters at the time of S. rubrum emergence peaks in June and in August showed no significant difference between any of the factors investigated, except water

Leonard and Leonard (1962) observed the embryonic stage to be prolonged by daytime temperatures of 10°C or lower, but temperatures at Gull Lake during the emergence periods remained above 10°C. Minimum temperatures throughout the study period remained above 6°C, a temperature above which Williams (1962) captured the greatest numbers of emergent black flies.

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The air temperature at which activity of the adults was noted varied somewhat with the species; *S. trivittatum* and *E. stimulans* were active at a greater range in average and minimum temperatures than *M. lundbecki* or *C. stimulans*. This may be advantageous for *S. trivittatum* and *E. stimulans*, since their emergence peaks are earlier in the spring, when a greater fluctuation in temperature is likely.

Water Temperature---Water temperature increased steadily to 17°C before daily emergence was noted.

A comparison of weather parameters at the time of *S. trivittatum* emergence peaks in June and in August showed no significant differences between any of the factors investigated, except water

temperature, which was higher during the August peak. Adults which emerged in June were larger than adults which emerged in August. Perhaps lower early season water temperatures had postponed emergence, resulting in a larger nymph and larger adult.

It appears that water temperature may trigger or postpone mayfly emergence. Laboratory studies and field data for several years would be needed before any such conclusions could be made with certainty.

Incident Radiation

Sunlight did not directly affect the catch, because trapping was done between sundown and sunrise. Sunny days often occurred immediately before or a day or two prior to nights with increased log. catch, but this is likely due to an indirect effect through the effect on air temperature. Radiation also influences the water temperature, but its effect is more gradual. Figure 4 shows that a high average air temperature very often coincides with high incident radiation.

Moisture

Rain did not greatly affect the catch of any of the species evaluated. Its effects were more noticeable during low emergence periods, but during emergence peaks, the catch was high regardless of rain, although emergence tapered off during periods of prolonged rain. Woodruff, Traver and Hou (1955), and Burks (1953) indicated that rain possibly hinders mating flight. Apparently, however, mayflies

temperature, which was higher during the August peak. Adults which emerged in June were larger than adults which emerged in August. Perhaps lower early season water temperatures had postponed emergence, resulting in a larger nymph and larger adult. It appears that water temperature may trigger or postpone mainly emergence. Laboratory studies and field data for several years would be needed before any such conclusions could be made with certainty.

Incident Radiation

Smith did not directly affect the catch, because trapping was done between sundown and sunrise. Sunny days often occurred immediately before or a day or two prior to nights with increased fog catch, but this is likely due to an indirect effect through the effect on air temperature. Radiation also influences the water temperature, but its effect is more gradual. Figure 4 shows that a high average air temperature very often coincides with high incident radiation.

Rain

Rain did not greatly affect the catch of any of the species evaluated. Its effects were more noticeable during low emergence periods, but during emergence peaks, the catch was high regardless of rain, although emergence tapered off during periods of prolonged rain. Needham, Traver and Han (1935), and Burke (1933) indicated that rain possibly hinders mating flight. Apparently, however, mayflies

are able to fly during most rainy weather, regardless of the size of the individual.

The effects of rain are probably closely related to those of temperature, since day rain seems to reduce the catch more than night rain, which might be expected to have the greater effect. Rainy days are usually cooler, and followed by cool nights. Rainy nights generally have a higher temperature due to cloud cover (Williams, 1943, Chant and McLeod 1952). It appears that some effects of rain tend to oppose those of temperature.

There was no apparent difference between maximum, minimum, or average relative humidity between nights of high and low log. catch. It might be inferred then, that there is no selection of damp or dry nights for activity or emergence. But relative humidity is dependent on temperature, and the actual moisture content of the air is much greater on warm nights than on cool nights of the same relative humidity. Since the catch is generally higher on warm nights, and since there is no difference in relative humidity between nights of high catch (warm) and nights of low catch (cold), it follows that moisture content of the air is higher on warm nights. Therefore, higher catches are associated with damp, warm nights, and lower catches are associated with dry, cool nights.

According to Leonard (1962), mayflies, especially subimagos, are very vulnerable to desiccation. Relative humidity at night generally reached 80-90 percent, and should not have been critical

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DISCUSSION

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... is usually positively associated with minimum and average temperature, but is negatively associated with day rain and cloud cover. Minimum temperature is positively associated with cloud cover and night rain. A decrease in barometric pressure is generally associated with the occurrence of rain. Many closely related meteorological factors are synergistic or antagonistic, thus it is extremely difficult to assess their individual effects.

For a discussion of meteorological factors other than those considered in this study, see pages 6 and 9 of the literature review.

Sex ratio of *M. lindsayi* in relation to abundance

The higher proportion of male mayflies on nights when *M. lindsayi* was abundant may reflect an actual change in the sex ratio. This disproportionate number of males might result from a rapid increase in emergence of males, decrease in death rate of males, or the activity of one sex may be governed by biological or environmental factors not affecting the other sex.

If no real difference in the sex ratio exists, the apparent difference might result from a different sensitivity of each sex to factors affecting the catch. Williams (1930) suggested that in the *Coctulidae*, the smaller proportion of females in high catches could be explained if females were less sensitive to the light stimulus of the trap. Further, if the light trap attracts males from a greater area than females on nights of high activity when females might be engaged in egg laying, a difference in catch might result. Fottle (1954) found an actual variation in the sex ratio in *Chlo-*
ocidus caught by several different methods.

the sex ratio exists, the apparent
different sensitivity of each sex to
factors affecting the catch. Williams (1939) suggested that in the
Noctuidae, the smaller proportion of females in high catches could
be explained if females were less sensitive to the light stimulus
of the trap. Further, if the light trap catches were from a
greater area than females on nights of high activity then females
might be engaged in egg laying, a difference in sex ratio might
Kesteven (1952) found an actual variation in the sex ratio in Gnath-
colpa caught by several different methods.

FUTURE WORK

The results described were based on one year of continuous trapping of insects with a single light trap. Most calculations were made for all the species of adult mayflies obtained at Gull Lake. If further studies of this type are done, the following suggestions are made:

1. There should be several traps working simultaneously under as similar conditions as possible. This will give large numbers of a species and reduce the sampling error.

2. The study should be extended over several years so data can be used for comparisons of nights from year to year as well as nights within years. This will allow the use of more powerful statistical tests.

3. A selected species should be considered, rather than all species of any one group. Sorting the thousands of delicate (3-4 mm in length) Gammarus simplicior from all of the other insects in each day's catch was an overwhelming task.

4. Hexagenia limbata is suggested for such an investigation on the basis of its following characteristics:

- a. It has relatively long periods of both peak and low emergence.
- b. It is readily attracted to light.
- c. It is easily distinguished from other insects caught in the trap.
- d. Sexes are easily distinguishable.

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SUMMARY

The objectives of this investigation were (1) to report the numbers and seasonal occurrence of mayflies (Ephemeroptera) emerging from a restricted area of Quil Lake, and (2) to evaluate several environmental parameters as possible elements operating as modifying factors in the occurrence of the mayflies.

An account was given of the aquatic environment, and of the climate and daily weather conditions of the area.

A light trap was operated from March 29, 1967, to September 15, 1967, at Quil Lake, in Kalamazoo and Barry Counties, Michigan. Four species of Ephemeroptera were caught from late May through August. A summary of emergence and peak emergence periods for each species follows:

Hexagenia illinoensis: Emergence was from June 23 to August 20, with the peak period of emergence from July 28 to August 20.

Ephemerella simulans: A continuous emergence was noted from May 31 to June 8.

Stenonema vittatum: Emergence was from May 26 to August 20. The first peak period was from May 31 to June 11; the second peak period occurred from July 27 to August 24.

Gaucha simulans: Emergence was from June 16 to July 24, with the peak period of emergence from June 16 to July 11.

The daily catch was assumed to be dependent upon the adult population and activity. The catch was considered in logarithmic proportions.

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Analysis of the effect of each weather factor on the occurrence and abundance of a species is made more difficult by the complex interaction of many of the factors.

A comparison of weather conditions on nights of high and low log. catch of a species showed that minimum and average air temperatures were usually higher on nights when the catch was high, and that a low log. catch was usually associated with a lower minimum and average air temperature. The maximum air temperature apparently had no direct effect, but probably had an indirect effect on the average and minimum air temperatures. A water temperature of 17°C was recorded in the littoral zone at the time of the first mayfly catch. Throughout the remainder of the study period, water temperature remained above this level. Water temperature may possibly have triggered or postponed emergence. Further studies would need to be conducted before any conclusions could be made with certainty.

Sunny days often preceded an increased log. catch, but this was likely the result of an indirect effect through temperature.

Rain tended to lower the log. catch somewhat, although not greatly. The log. catch often was lower following rainy days than it was on rainy nights, possibly because rainy days were cooler. High log. catch was usually associated with warm, damp nights, and a low log. catch was often associated with dry, cool nights.

On nights when *P. litorea* was abundant, males were taken in far greater numbers than females.

A comparison of weather conditions on nights of high and low catch of a species showed that minimum and average air temperatures were usually higher on nights when the catch was high, and that a low catch was usually associated with a lower minimum and average air temperature. The maximum air temperature apparently had no direct effect, but probably had an indirect effect on the average and minimum air temperatures. A water temperature of 15°C was recorded in the littoral zone at the time of the first early catch. Throughout the remainder of the study period, water temperatures remained above this level. Water temperatures may possibly have triggered or postponed spawning. Further studies would need to be conducted before any conclusions could be made with certainty.

Sunny days often preceded an increased log catch, but this was usually the result of an indirect effect through temperature. Rain tended to lower the log catch somewhat, although not significantly. The log catch often was lower following rainy days than it was on rainy nights, possibly because rainy days were cooler. High log catch was usually associated with warm, damp nights, and a low log catch was often associated with dry, cool nights. On nights when *H. littoralis* was abundant, males were taken in 1:2 greater numbers than females.

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The first part of the document discusses the importance of maintaining accurate records of all transactions. This includes not only sales and purchases but also the various expenses incurred in the course of business. It is essential to have a clear and organized system for tracking these items, as they form the basis for calculating the company's profit and loss.

In addition, the document emphasizes the need for regular reconciliation of accounts. This involves comparing the company's internal records with the statements provided by banks and other financial institutions. By doing so, any discrepancies can be identified and corrected promptly, ensuring the accuracy of the financial data.

Another key aspect of financial management is the timely payment of taxes and other legal obligations. Failure to do so can result in penalties and interest charges, which can significantly impact the company's cash flow and overall financial health. Therefore, it is crucial to stay up-to-date on the latest tax regulations and to consult with a professional advisor if needed.

Finally, the document highlights the importance of maintaining a strong relationship with creditors and suppliers. This involves communicating openly about the company's financial situation and negotiating favorable terms of payment. By doing so, the company can ensure a steady flow of goods and services, which is essential for its continued operation and growth.

In conclusion, effective financial management is a complex task that requires careful attention to detail and a proactive approach. By following the principles outlined in this document, businesses can ensure that they are always on top of their financial affairs, which is a key to long-term success and sustainability.

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Figure 1. The ratio of weight of the solid to the total weight of the polymer and the weight of the monomer.

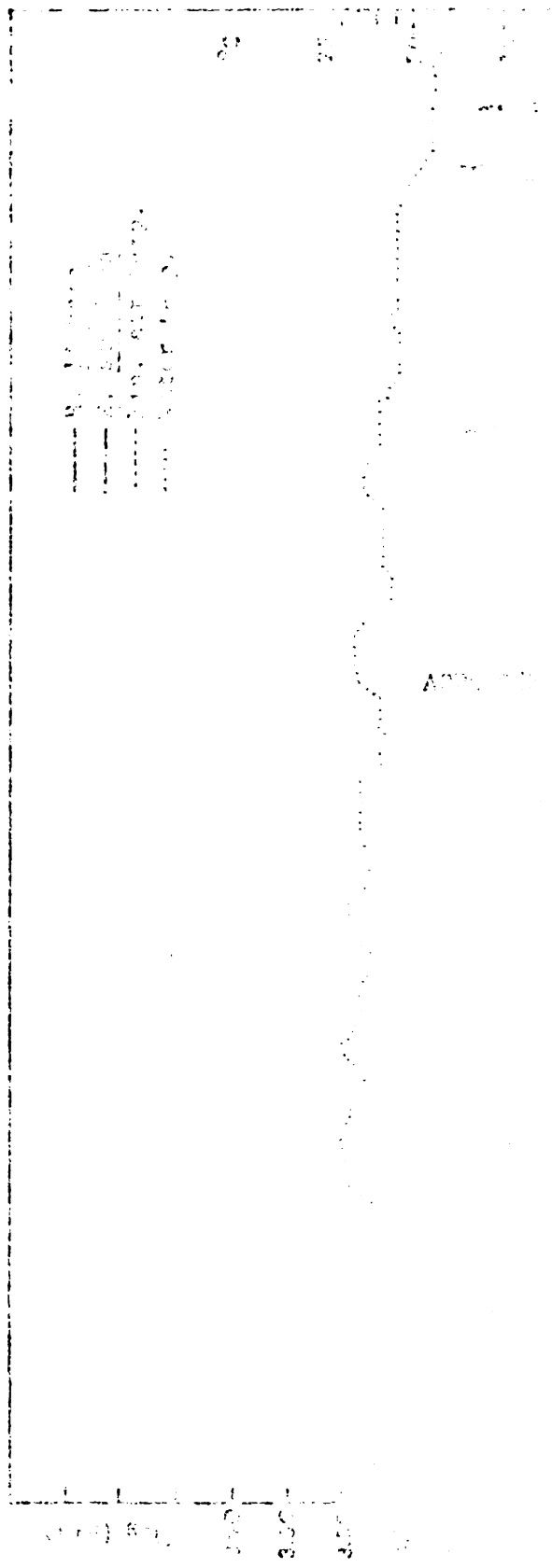


Figure 1.-- The relationship of log. catch to minimum air temperature and average water temperature.

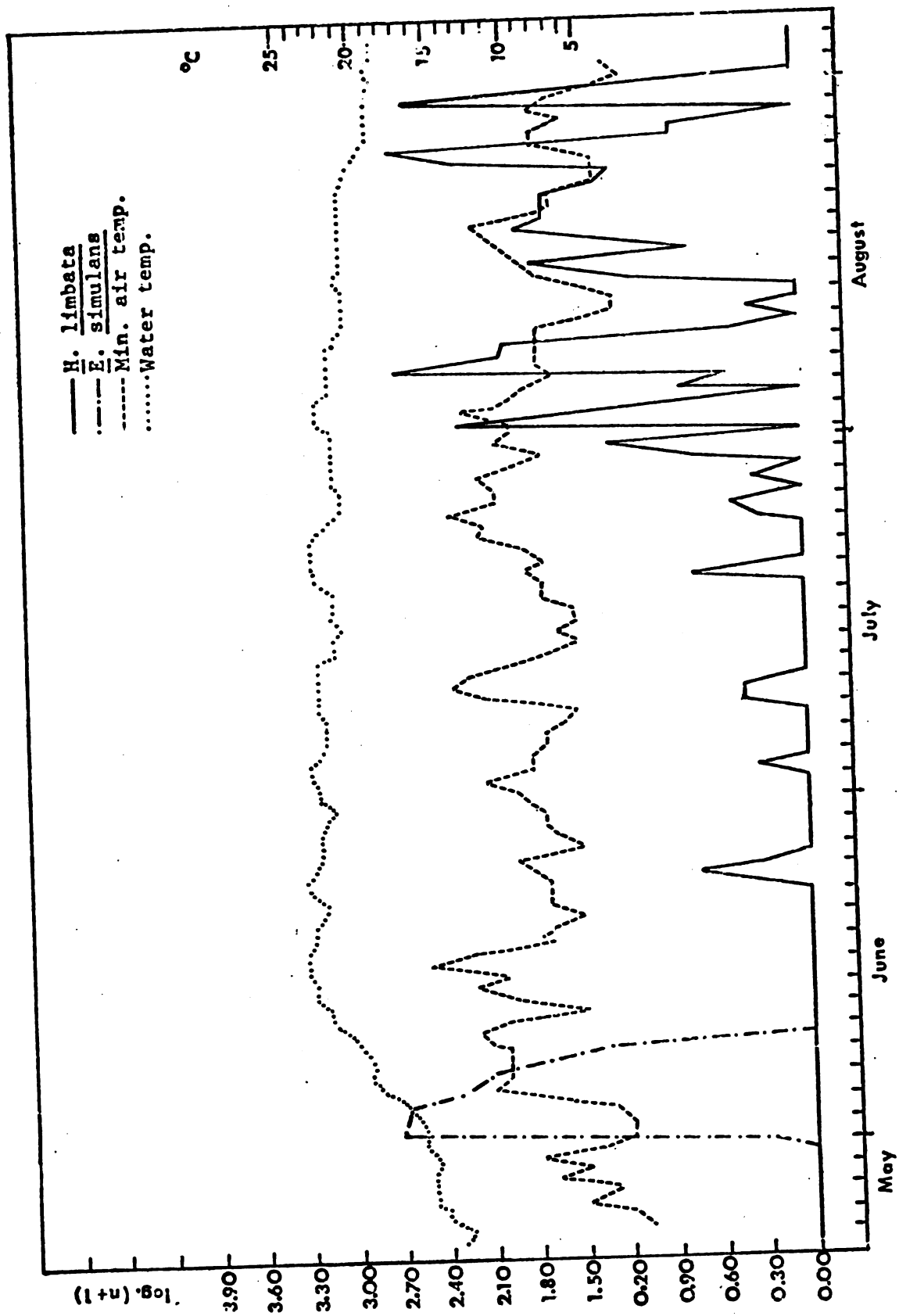


Figure 2.-- The relationship of log. catch to minimum air temperature and average water temperature.

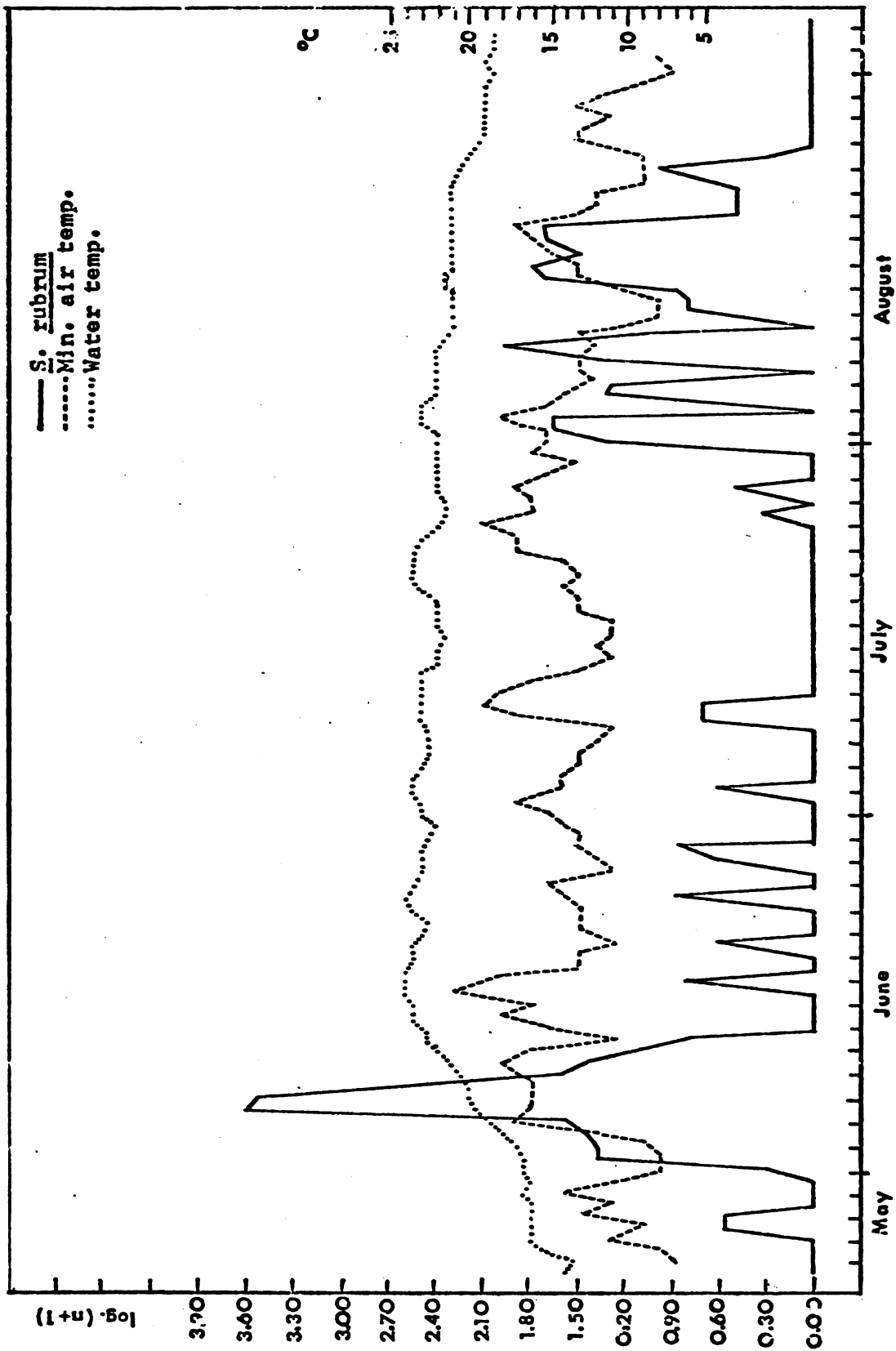


Figure 3.-- The relationship of log. catch to minimum air temperature and average water temperature.

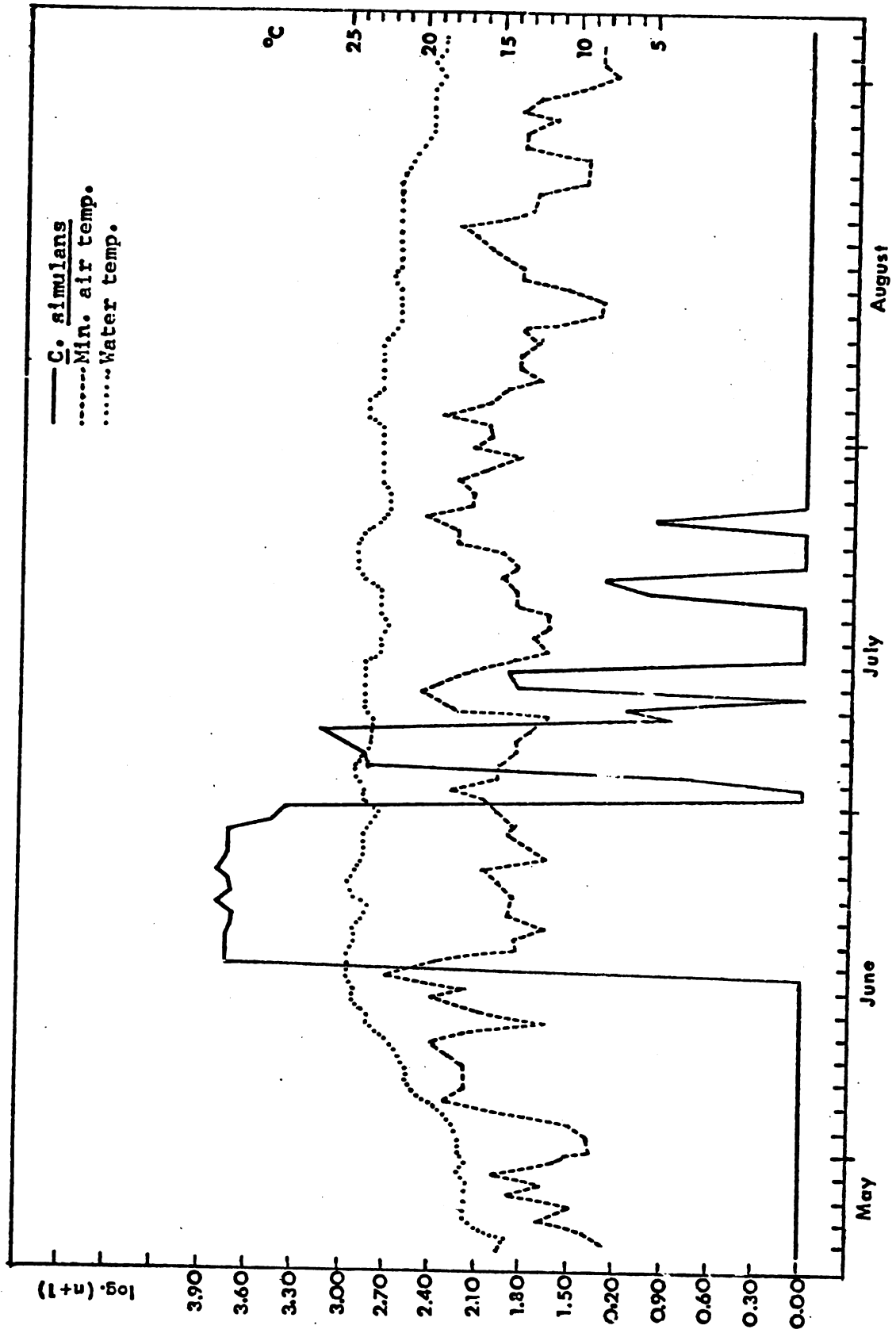


Figure 4.-- The relationship of log. catch to average air temperature, incident radiation, day rain, and night rain.

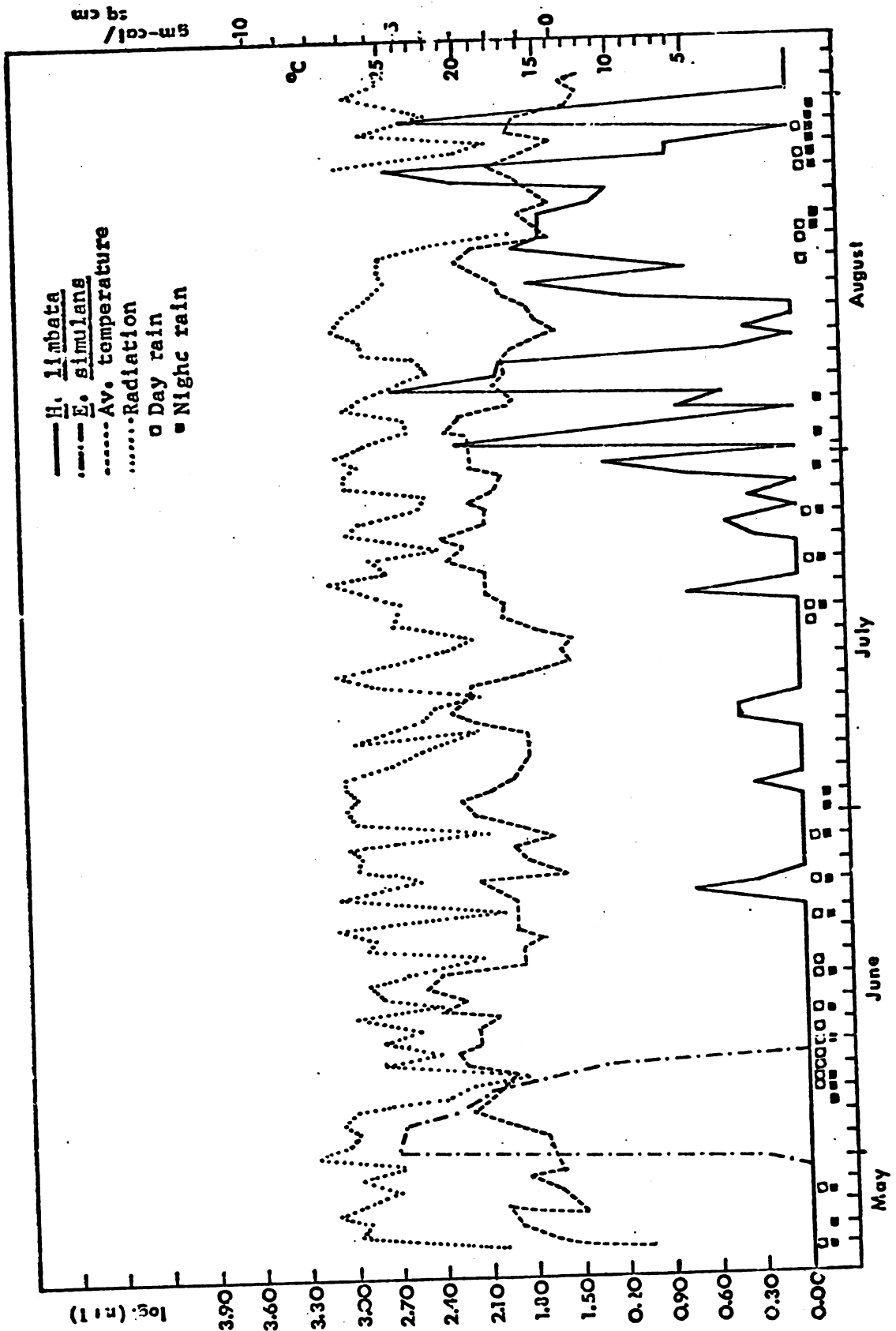


Figure 5.-- The relationship of log. catch to average air temperature, incident radiation, day rain, and night rain.

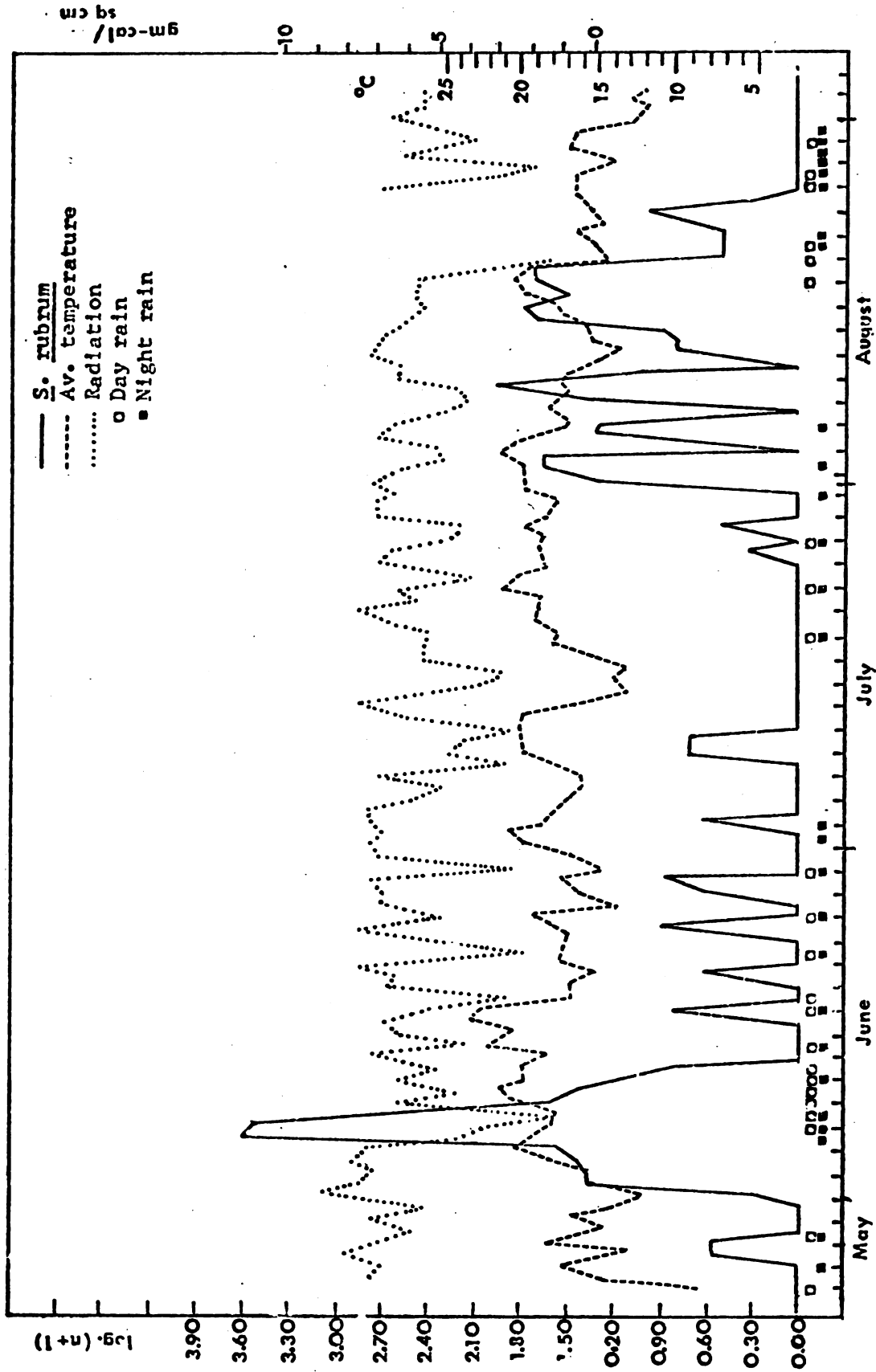


Figure 6.-- The relationship of log. catch to average air temperature, incident radiation, day rain, and night rain.

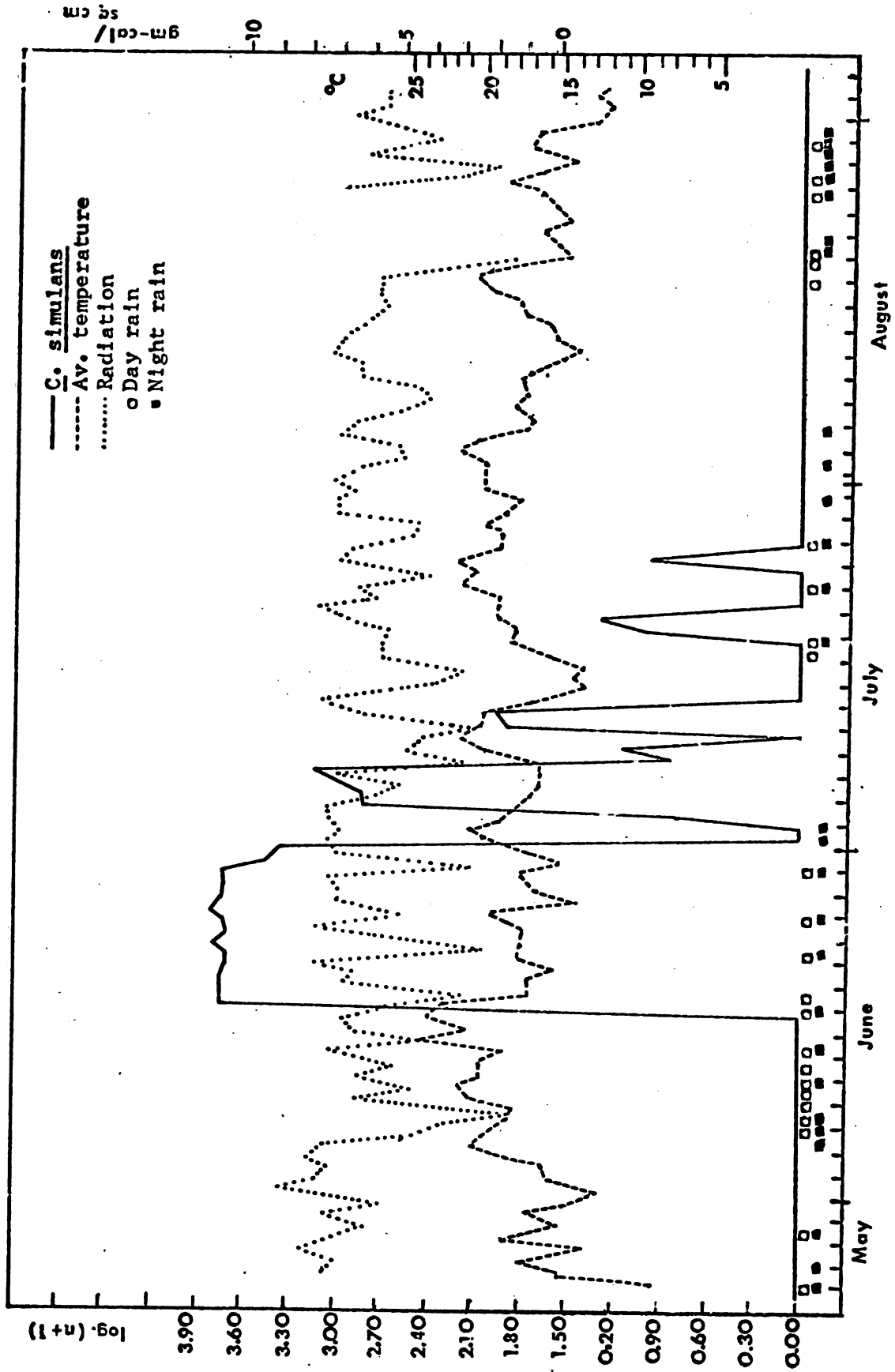


Figure 7.-- Scatter diagram showing the absence of any correlation between log. catch and maximum temperature for May through August, 1967.

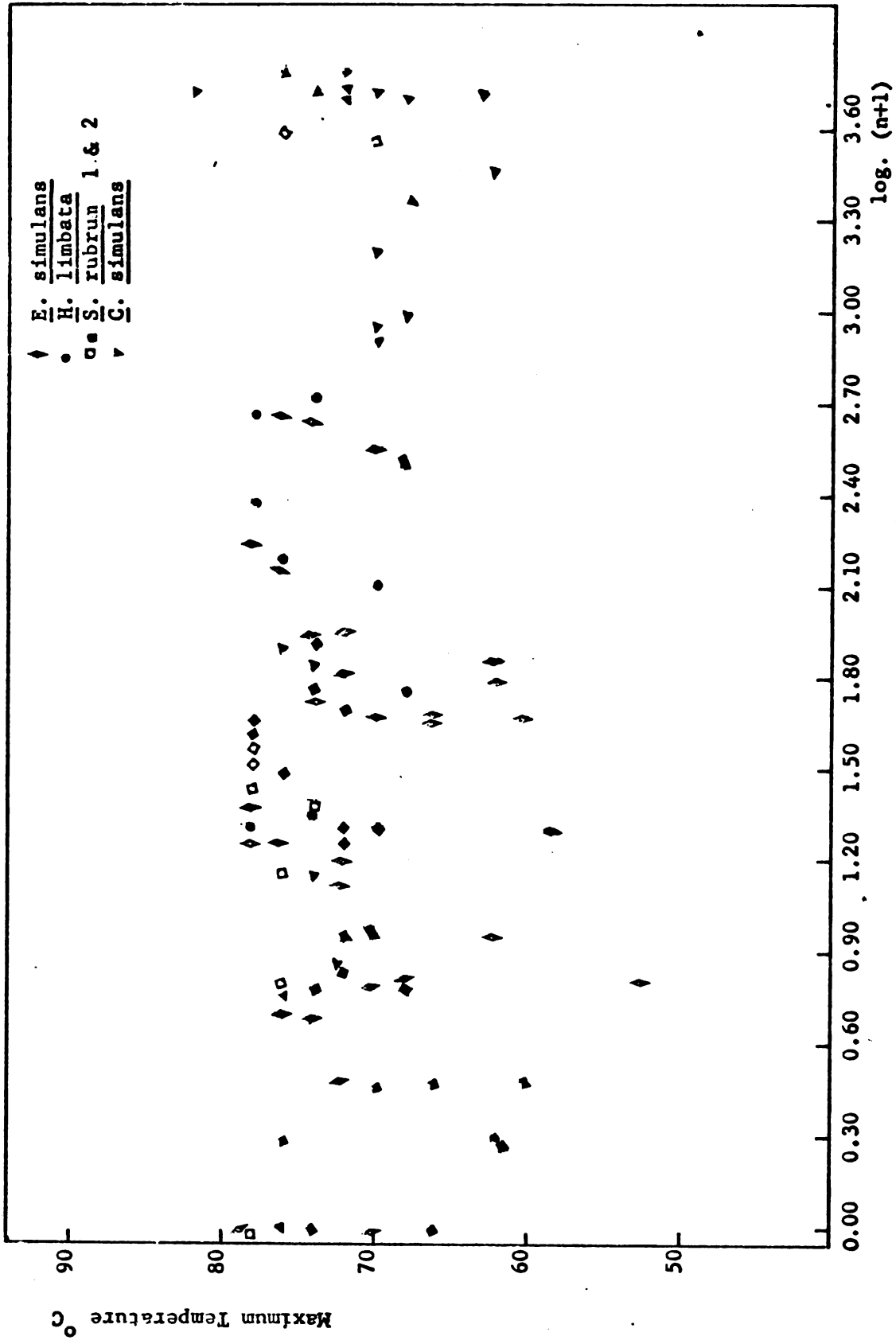


Figure 8.-- Scatter diagram showing the absence of any correlation between log. catch and daily range of temperature for May through August, 1967.

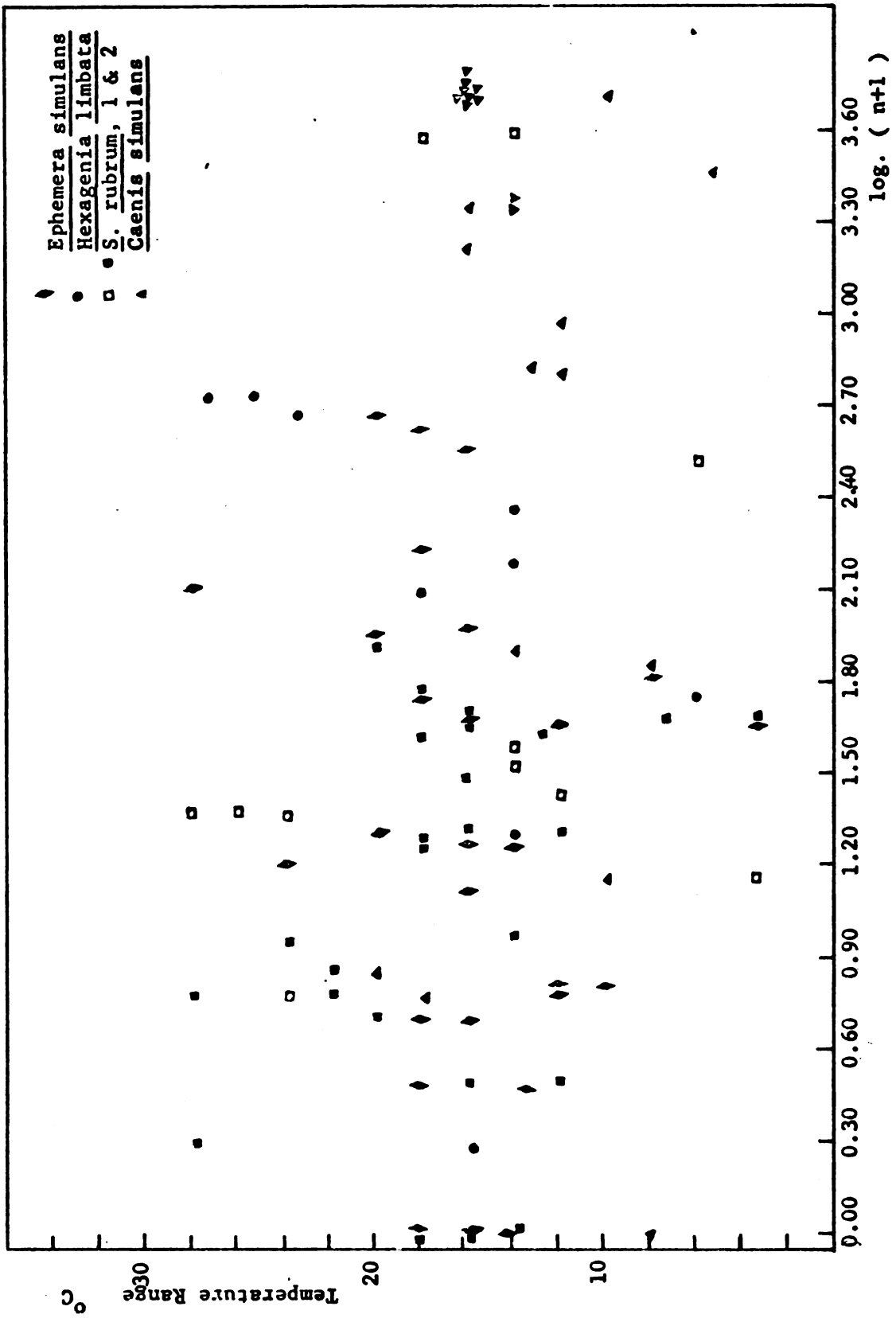


Figure 9.-- Scatter diagram showing the absence of any relation between log. catch and maximum humidity for May through August, 1967.

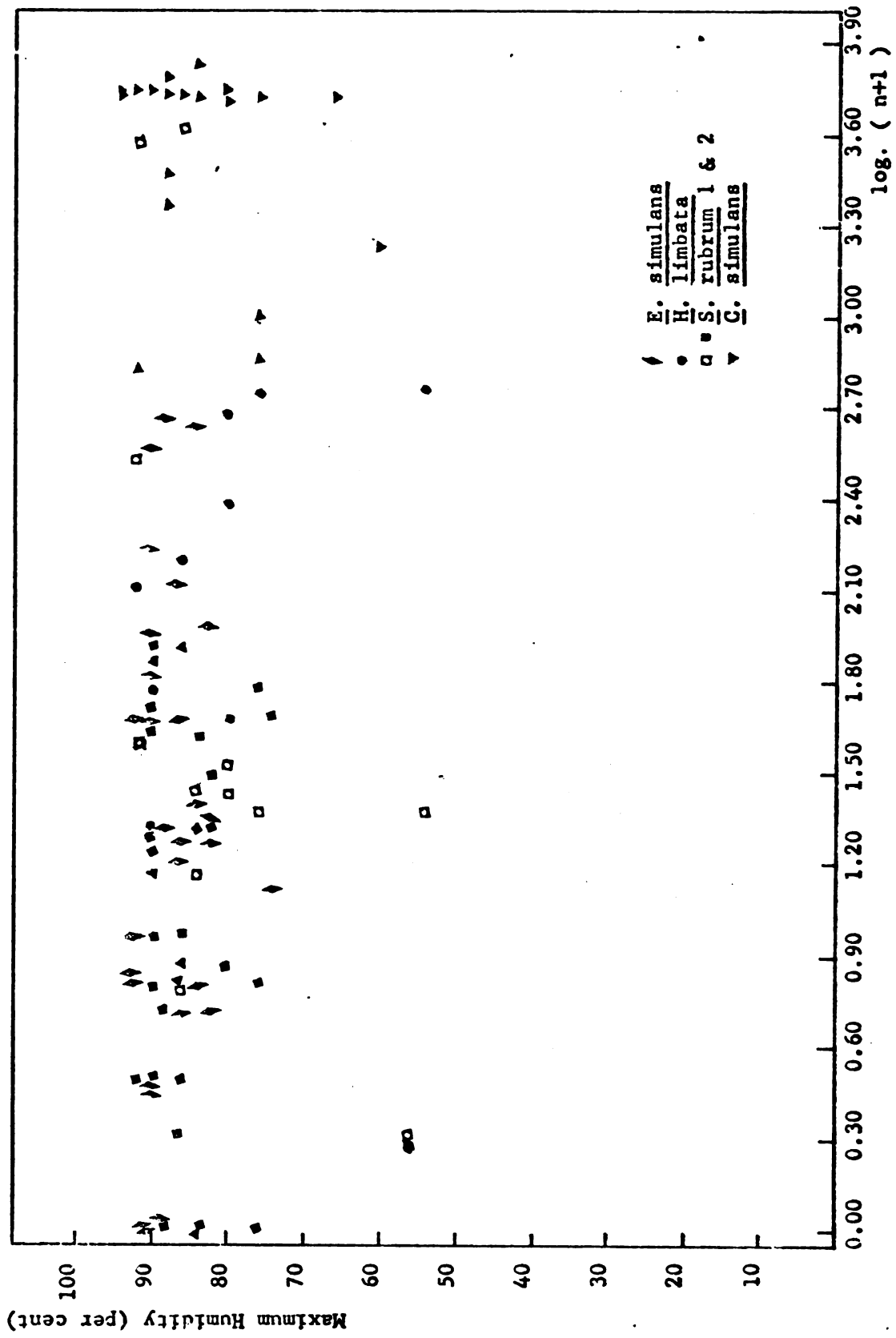


Figure 10.-- Scatter diagram showing the absence of any correlation between log. catch and minimum humidity for May through August, 1967.

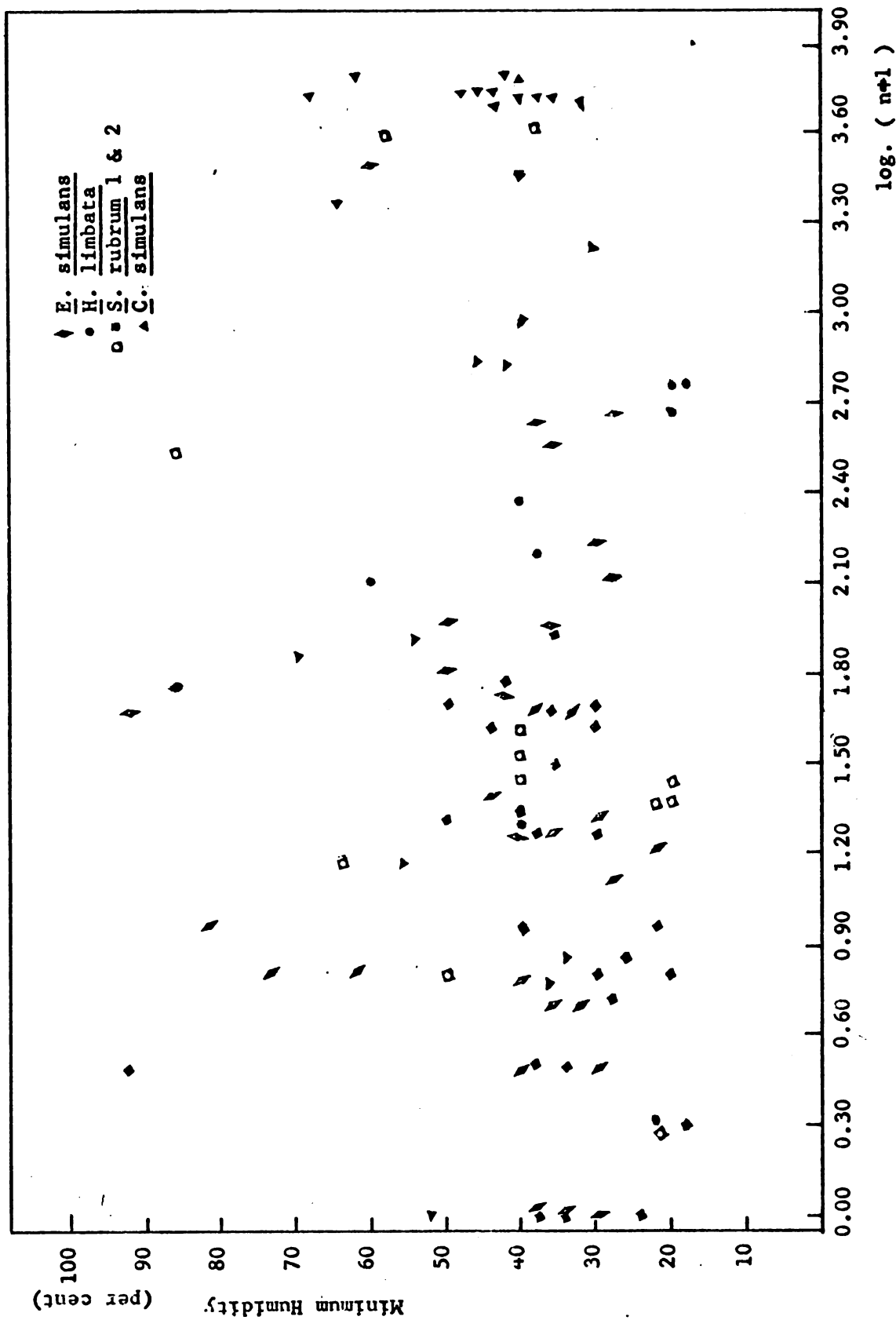
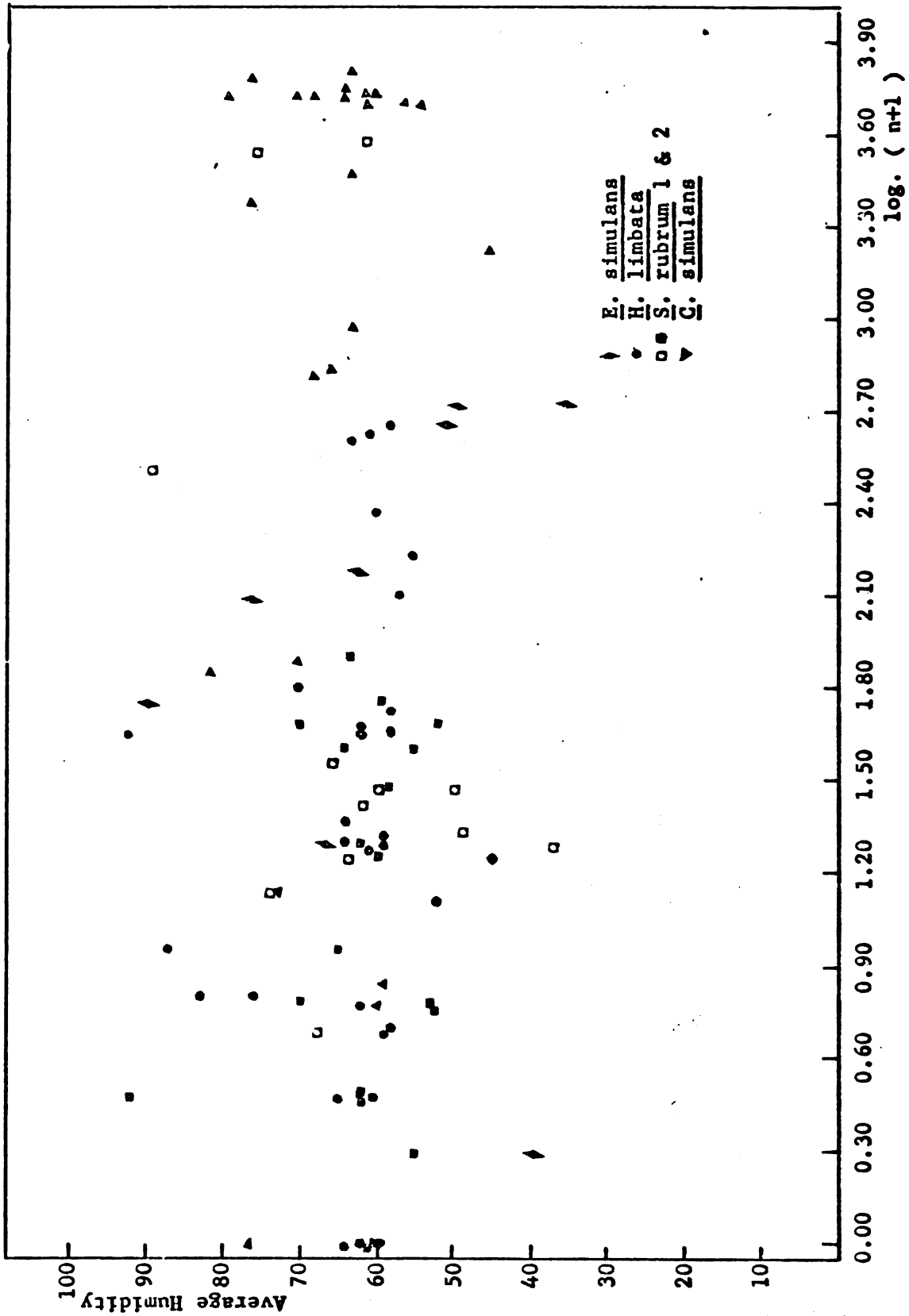


Figure 11.-- Scatter diagram showing the absence of any correlation between log. catch and average humidity for May through August, 1967.



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