Biological Stations at Roscoff and Naples are most like M. B. L.

SOME BIOLOGICAL STATIONS ABROAD

Dr. Gary N. Calkins
Professor of Zoology, Columbia University

Few people realize the remarkable character of the Marine Biological Laboratory here at Woods Hole. If we think about it at all in this connection we rather take it for granted that the laboratory here is merely a type of such stations all over the world. Such, however, is not the case. Woods Hole is unique. An association of biologists to provide equipment and opportunity for research in biology, conceived by biologists, developed by biologists, managed throughout by biologists, it is a striking illustration of the fact that men of the professorial type can be practical business men and make the venture pay, both financially and scientifically. They have recognized the value of research in science, but more than that they have realized the need of inculcating the spirit of scientific research and to this end have encouraged the development of courses of instruction preparatory to research. This development has not been free from a certain disadvantage which is bred of the very size of the institution and of the wide variety of interests of the collaborators. A social side has grown up, and for some younger individuals this side is a powerful incentive to come to Woods Hole. An overgrowth of this side is unfortunate and its disadvantage lies in the fact that investigators find that social distractions are not conducive to extensive work. Hence many of the old-timers hark back to former days when Woods Hole was simple and distractions were confined to forms of exercise necessary for continued mental work.

The marine biological laboratories of Europe are more of the type of Woods Hole as it used to be than as it is now. In no case, however, have men of diverse interests come together to found an institution for co-operation in research. Everywhere a need is felt for instruction in marine biology and upon living organisms and everywhere the need is recognized of an opportunity to do research on such forms. For the most part the laboratories have a paternalistic atmosphere and directed work predominates while most of them are financed with this end in view. Thus in the majority of them there is no corps of collectors to provide needed material for investigators, but, as one eminent zoologist told me: "It is much better for the investigator to find out for himself the habitat and modes of life of the forms he is working on."

We treat of these ecological matters in our course work for beginning investigators and feel that the research man's time is more profitably spent in experimental or other intensive scientific ways. The result is shown by the nature of the output abroad for it must be admitted that there is a preponderance of ecological and taxonomic work from these laboratories. But while this condition might indicate a pedagogic point of view I suspect that the real secret is the lack of financial support and not entirely the advantage of personal collections.

An army travels on its stomach, said Napoleon, but science travels on its purse and biological stations for pure research in biology are not particularly attractive to hard-headed men of affairs. Hence we find many of the marine stations in Europe (Continued on Page 9)
METHODS FOR EXPERIMENTAL EMBRYOLOGY WITH SPECIAL REFERENCE TO MARINE INVERTEBRATES

E. E. Just
Professor of Zoology, Howard University

Preface

These notes on methods for experimental embryology with special reference to marine invertebrates are published as the result of suggestions made from time to time by several investigators at the Marine Biological Laboratory, Woods Hole, Mass.

There is no inherent difficulty in handling the eggs and the sperm of marine animals. There are, however, some very simple methods that the worker unacquainted with marine metazoa ought to know in order to save himself time and to increase his chances of obtaining clean-cut results. Venturing the hope that these methods will serve both purposes, I here present them.

The notes deal with animals available for embryological work during the summer months at the Marine Biological Laboratory, Woods Hole, Mass.

Introduction

Some Precautions

Certain precautions should be taken if satisfactory results are to be obtained. Obviously, every utensil used must be scrupulously clean. Any cleaning fluid used must be thoroughly removed. I find that Boni's is excellent for cleaning glassware, leaving it bright and clear; it is superior to soaps and soap powders because more readily removed. Glassware should be of the best grade procurable. For some work, e.g., on sperm, I use quartz exclusively. Toxic reagents should never be put in dishes used for normal eggs. However, there is quite a difference in the degree in which glass absorbs various toxic substances. Thus, I have reared Platynereis embryos to sexually mature adults in dishes, borrowed from another worker who had kept Bouin's fixing fluid in them for several weeks. I had of course to wash the dishes thoroughly. Corrosive sublimate solutions, on the other hand, are more difficult to remove.

Many an observation has been ruined because some glassware previously used by a careless worker as a receiver for toxic waste has been used by an unsuspecting person without its being thoroughly cleaned.

Dishes from which eggs or sperm have been removed should never be directly washed with fresh water because of the danger of the cytolized cells sticking to the glass. The dishes should first be thoroughly rinsed with sea-water then washed with fresh water. I never use the laboratory towels for drying glassware because of the alkali that may still be in the sea-water is so frequently charged with gas as it comes from the taps. By the time that he is ready to use the sea-water, the gas bubbles have disappeared. When present they are a nuisance and perhaps even harmful. Sea-water should never be drawn from the tap directly into the eggs; they may be injured. Nor should eggs be taken up with a fine pipette, and in no case should they be forcibly ejected.

Hellbrunn's practice of drawing off in a large flask the sea-water which he is later to use in an experiment is an excellent one because the sea-water is so frequently charged with gas as it comes from the taps. The by the time that he is ready to use the sea-water, the gas bubbles have disappeared. When present they are a nuisance and perhaps even harmful. Sea-water should never be drawn from the tap directly into the eggs; they may be injured. Nor should eggs be taken up with a fine pipette, and in no case should they be forcibly ejected.

It is well to use some standard size of glassware. I find it convenient for most eggs, to use finger bowls which hold 250 cc. of sea-water without being completely filled. For the eggs from one ovary of Asterias, however, I use dishes that easily hold three thousand cc. of sea-water. Syracuse dishes are best for ten cc. suspensions because they are conveniently mounted under the low power of the microscope.

It is likewise a good plan to form the habit of using some standard concentration of eggs and sperm in sea-water, because the volume of sea-water employed is an important factor. Thus, many eggs, those of Asterias, for example, will neither mature nor on insemination fertilize in large numbers when highly concentrated in small volumes of sea-water. The worker should, therefore, settle on some standard of volume of sea-water, concentration of eggs, and concentration of sperm. This will help to standardize the results more uniform.

Now, as to optical equipment. Many workers seem to think that because they are working at the seashore they should use the most disreputable and obsolete microscopes and lenses. Nothing is farther from...
The University Students Form Dramatic Guild

After a winter of planning and organizing, conferences with Eva Le Gallienne, Winthrop Ames, Theresa Helburn and Robert Edmund Jones, and numerous searches for a suitable place for production, Charles Leatherbee, President of the Harvard Dramatic Club, and Bretaigne Windust, President of the Princeton Theatre Intime, announced, early this spring, the formation of a theatrical troupe, known as the University Players Guild, which would produce during the summer months, at the Elizabeth Theatre in Falmouth. This troupe was organized with the ideal that a group of students from many colleges, combining their talents, ideas and energies for dramatic expression and professional recognition would be a splendid adjunct to the modern theatre.

The company of twenty-two, made up of students from Harvard, Princeton, Yale, Vassar, Radcliffe and Smith take care of all the machinery of theatrical production—directing, acting, set designing and construction, costume making and business, even the cooking is done by a very able member of the company. The men of the company live on Mr. Robert W. Leatherbee's motor yacht, the Brae Burn, moored in Falmouth Harbor, and the girls live in cottages at Quisset, under the chaperonage of Mrs. Juliet Wells of New York City.

Other members of the company include Erik Barnouw, author of "Open Collars," the Princeton Prize Play for 1927, and co-author of next year’s Triangle Club show, Kingsley Perry, past president of the Harvard Dramatic Club, and other members of the Theatre Intime and the Harvard Dramatic Club. From Radcliffe are Helen Field, Sue Birnie and Margaret Cook, the last named the president of the Radcliffe Idler Club. Eleanor Phelps of Vassar and Elizabeth Schaufler of Smith, both members of the dramatic associations of their respective colleges, have played in productions of the Theatre Intime.

Beginning the season with A. A. Milne’s comedy, "The Dover Road," to be produced at the Elizabeth Theatre on Monday and Tuesday, July 9th and 10th, the company will present a series of plays of varying types. Eugene O'Neill's "Beyond the Horizon" will be produced the following Tuesday and Thursday nights at 8:30. Among other plays are Annie Meyer’s "Creation," Benelli's "The Jest" and George Kelley’s "The Torchbearers."

the truth. If one is seriously taking up the embryology of marine animals one must study the living eggs. The best optical equipment possible is therefore none too good. Accordingly use the finest apochromatic lenses and compensating oculars procurable—those made by Zeiss and Co. The Zeiss dark-field condenser and their small plankton condenser are valuable accessories for the study of living sperm and eggs. For measuring, I use the Zeiss screw micrometer with compensating ocular.

There should be at hand one or two good standardized thermometers. In view of the importance of temperature as a factor this suggestion seems superfluous. A record of the room temperature and that of the egg suspension should be kept. Whenever an observation on the eggs is made, it should be made on a fresh sample from the standard culture and not on a previous sample in a small quantity of sea-water, because the rate of development will be found to vary, the eggs in the smaller quantity of sea-water developing a trifle more rapidly.

Finally, the worker should learn all that he can about the animal whose gametes he uses. He should know what the normal animal looks like in order to be sure that he is using eggs and sperm from animals in best physiological condition. The normal development of the eggs which he is to use for his experiments he should also know, not through reading merely, but by careful and repeated study of each stage from fertilization through the larval stage.

ANIMALS AVAILABLE AT WOODS HOLE DURING THE SUMMER FOR EMBRYOLOGICAL WORK

Curiously enough too few workers realize how many more forms are available at Woods Hole during the summer for embryological work than the Arbacia-Fundulus-Asterias, trinity and the lesser lights: Nereis, Chaetopterus, Echinarcharias, Cumingia, Crepidula, Cynthia, and Ctenolaria. In addition to these and other forms commonly used which breed practically throughout the summer season there are several less familiar forms that are excellent for many lines of experimental embryology.

There are: Ensis, Mytilus, Mya, Macracte, Pecten, Thyone and Podarke. A brief account of these forms is given here.

Ensis. The eggs of Ensis resemble greatly those of Cumingia. They may be obtained in abundance in and outside the summer season. Animals kept one to a dish shed rapidly. It is more convenient to use smaller specimens placing them in finger bowls; larger animals usually shed more eggs but need larger dishes. The eggs are useless if taken from the ovaries. The animals are best kept in wet sand after collecting and should be protected from heat.

Mytilus. The eggs of this form can be obtained in very large numbers. They too resemble the eggs of Cumingia. For the worker who desires more eggs from one female than he can produce from Cumingia or Ensis there are the eggs of Mytilus used to cause a great deal of trouble in the old sea-water tank at the Marine Biological Laboratory. Larvae developed in such numbers that the mussels interfered with the water supply. This April, I found young specimens in my old diatom cultures of last season; these had developed from veligers.

Mya. The eggs of Mya are obtained by allowing the animals to shed. Eggs are plentiful during the summer.

Macracte. Unlike Cumingia, the eggs of Macracte are fertilizable in the germal vesicle stage, thus resembling the eggs of Nereis and Ascaris. This makes it an interesting form for work on fertilization and experimental parthenogenesis. For the latter point, especially see Kostanecki's paper, '04 and '08.

Eggs of Macracte differ from those of Cumingia, and of the other forms mentioned in still another way—they fertilize readily if taken from the animal. There is no scarcity of Macracte in the Woods Hole region. This is a beautiful egg admirably suited for experimental work.

Pecten. Pecten is monocious and in my experience at least seems to be self-fertilizing. Certainly, this is true; in battery jars each of which contained a single individual I have repeatedly found fertilized eggs which developed into veligers. With suitable food one could doubtless carry...
The Collecting Net

A weekly publication concerned with the activities of the Marine Biological Laboratory and of Woods Hole.

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Recapitulation
The Collecting Net is now entering upon its third year of activity; and it looks forward to a year of even greater usefulness than those that are behind it. Undoubtedly its two years of experience will make it demand more respect and have a wider era of influence and of usefulness. Formerly bewildered infant, it now emerges on its third birthday as an ambitious little boy —alert, confident,— and with its existence taken as a matter of course; with gratitude by most; and as a necessary evil by a limited few. We like to think that we have the wisdom of age and the enthusiasm of youth!

Financially we were rather successful last year. Over and above expenses we made $296.24. This enabled us to pay our deficit of $46.00 which was incurred during our first year of existence. Fifty-six dollars of the remaining sum was turned over to complete the sum of $500.00 to The Collecting Net Scholarship Fund. This leaves us with a sum of $194.24 on which to initiate publication this year.

With the splendid co-operation of our advertisers we are financially independent—and look forward to contributing an even larger sum of money to The Collecting Net Scholarship Fund at the end of the summer than we were able to last season.

Our Contents
The Collecting Net considers itself most fortunate in obtaining a series of articles on Methods for Experimental Embryology. Our contributor is Dr. E. E. Just, professor of zoology at Howard University. He is the acknowledged authority on the field which will be covered by this treatise. There is no one, we are confident, who is more competent to write concerning the technique of handling the various marine embryological material. The information presented in these articles has been accumulated by Dr. Just over a period of twenty years in his work at the Marine Biological Laboratory.

This series of articles will be published in the form of a manual which we will be able to sell for a small sum owing to the fact that the pages in the book will be a reprint of the material appearing in The Collecting Net.

It is a privilege to print in this number of the Collecting Net an article entitled "Some Biological Stations Abroad" by Dr. Calkins who is now head of the department of zoology at Columbia University. This article will serve as a general introduction to a series of individual articles which are being obtained directly from the various biological stations in Europe. One or two of these accounts will be published in the next issue of our paper.

We hope also to include articles on some of the biological stations in America.

The Directory
This issue of The Collecting Net contains a directory of the workers in attendance at the laboratory. In the process of its compilation it has been posted for corrections at the Mess Hall and at the Laboratory in the three stages of its development. Thus every possible precaution has been exercised to cut the number of errors down to the minimum. If, however, a few do remain, we ask those concerned to be indulgent and accept our apologies. Some investigators neglected to fill out the official application form and in these cases we have often had to depend upon other less accurate sources of information. The proportion of distinguished investigators falling into this group is large. It might also be expressed by the mathematical relationship: The likelihood of an investigator to fill out an application blank varies inversely as the square of his universe. Perhaps Professor Bernstein can further enlighten us.

Our Supplement
The "Loeb Memorial Supplement" of The Collecting Net will appear sometime in August. The original plan of publishing an extensive supplement during the winter proved unwise as well as impossible. We wish to express our appreciation to the Rockefeller Institute for the generous offer made by Dr. Flexner in a recent letter: "As the edition of your paper is not very large we propose to present the copy of the portrait with the compliments of the Rockefeller Institute."

The Division of Publication of the Rockefeller Institute writes that the heliotype reproduction of the portrait of Loeb was unsatisfactory and that they are now arranging for gravures which will be delivered to us during the first week of August. The supplement will appear shortly after that date.

Spiritualism
The Collecting Net, always attempting to present useful and authentic information concerning anything that directly concerns the workers at The Marine Biological Laboratory, takes the liberty of reproducing the advertisement below which appeared on the front page of the issue of The Falmouth Enterprise for July 5:

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To be of further service The Collecting Net may undertake to charter a bus to convey members of the laboratory to and from Hyannis. The proceeds resulting from this enterprise would then be turned over to The Collecting Net Scholarship Fund.

M. B. L. Mix-Up

(Continued from Page 1)

Those in the bleachers viewed the dance event with enthusiastic applause. In an interview with one of the leading biologists in one of the boxes, the following statement was officially issued, "The dance phenomenon, since it bears striking resemblance to the phenomenon of Brownian movement, may be safely and easily studied for purposes of analogy complete comparison."
**DIRECTORY FOR 1928**

**THE STAFF**
Jacobs, M. H., Director, prof. gen. phys., Pennsylvania.

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I. Investigation
Calkins, G. N., prof. protozool., Columbia.

II. Instruction
Martin, E. A., asst. prof., zool., C. C. N.

**PROTOZOOLOGY**

I. Investigation
Caldwell, C., prof. protozool., Columbia.

II. Instruction
Martin, E. A., prof. zool., C. C. N.

**EMBRYOLOGY**

I. Investigation (see zoology)

II. Instruction

**PHYSIOLOGY**

I. Investigation

II. Instruction

**BOTANY**

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Allen, C. E., prof. bot., Wisconsin.

II. Instruction
Bell, H. P., assoc. prof. bot., Dalhousie.

**INVESTIGATORS**


**ABBREVIATIONS**

Old Main Building............. O. M.

INVESTIGATORS


II. INSTRUCTION

Bennett, R., assoc. prof. zool., Missouri.

II. INSTRUCTION

Caldwell, C., prof. protozool., Columbia.

I. INVESTIGATION

Calkins, G. N., prof. protozool., Columbia.

II. INSTRUCTION

Martin, E. A., prof. zool., C. C. N.

PROTOZOOLOGY

I. INVESTIGATION

Caldwell, C., prof. protozool., Columbia.

II. INSTRUCTION

Martin, E. A., prof. zool., C. C. N.

EMBRYOLOGY

I. INVESTIGATION (see zoology)

ID. INSTRUCTION


PHYSIOLOGY

I. INVESTIGATION


II. INSTRUCTION


**ABBREVIATIONS**

Botany Building ............... Bot.

Brick Building ............... Br.

Lecture Hall ................. L.

Old Main Building............. O. M.

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Some Biological Stations Abroad

(Continued from Page 1)

financed as centers of fishery investigations. Many of them have been established in the interest of education as sea-shore laboratories of inland universities; others are financed through the activities of learned societies, and a very few by individuals who are interested in the advancement of science. The most conspicuous of the latter type is the Stazione Zoologica at Naples. Founded by Anton Dohrn as a private enterprise for the promotion of biological knowledge this became the international center for marine biology. In this venture Dohrn had a substantial subsidy from the German government and one from the Italian, while different countries subscribed for one or more tables. Annual subscriptions for some fifty of these tables helped to defray the expense of maintenance up to the time of the war. The elder Dohrn died before the new wing was in full operation some twenty odd years ago and his son, Reinhardt Dohrn, assumed the directorship. Since the war political and financial difficulties have made it hard sledding but the Station has withstood the many upheavals and is now well on its feet again with some forty-four tables occupied last year. Our country formerly subscribed for five tables but last year there were only three; two of the subscribing institutions having withdrawn their support as a result of the war. It is most unfortunate that this wonderful institution, this monument of self-sacrifice and altruism on the part of the Dohrns, should not receive more whole-hearted support from this country.

Coming into the Bay of Naples, Vesuvius with its endless smoke in the distance, the city stretches out in a lazy crescent. At the left horn is a great park bordered by a modern automobile-dotted boulevard quite different from the Naples of twenty five years ago when I saw it for the first time. Here and there a reminiscence cabby swears and cracks his whip at a pre-Fascist horse dreaming of the good old days when Naples was dirt and happiness. Happiness is still there but so much of the dirt is gone, that, relatively at least, Naples is clean.

Close to the park, surrounded by semi-tropical trees, the late sixty-four building of the Naples Station offers a welcome relief from the glare of the sun. Famous the world over as the one great outstanding international laboratory for marine zoology and botany it needs no detailed description here. A trained group of collectors provide material for all kinds of biological research; provision is made for special equipment for bio-chemical, bio-physical, physiological and morphological work. A great library of carefully selected biological works is well managed and easy to use and the private rooms are commodious, and amply equipped. It is, wholly, a research institution and, open throughout the year there is at no one time any suggestion of the aparian activity of Woods Hole. At the time of our short visit in May the winter workers had left and the summer ones had not yet come so there were only a few investigators at the Station. The genial hospitality of Dr. Dohrn pervades everything and visitors receive a cordial welcome.

Naples, however, is unique. By far the most numerous of the biological stations are financed by the universities. Where the universities are under a minister of education as in France the laboratories are indirectly financed by the government. The budgetary allocation for their support is always inadequate and the equipment is correspondingly simple. Could there be a pooling of interests through united and co-operative activity there is no reason why France should not have at least two great centers of biological research one for Mediterranean forms at Banyuls, the other for Atlantic forms at Roscoff. But individualism is traditional and deeply rooted in France and so far it has gone in this matter that the Sorbonne and the College de France intimately connected as they are in the University of Paris, have no less than five independent marine biological laboratories—one at Banyuls, one at Concarneau, one at Dieppe, one at Wimereux and one at Roscoff. Could they become affiliated there is good reason to believe that financial backing by the great international foundations would enable one or two at least to become much more important centers of biological research. This suggestion of scientific work being done at these smaller stations which, indeed, is usually excellent, but merely indicates a possibility which our French friends apparently neglect.

The coasts of France are dotted with biological stations, for practically each of the sixteen French universities has its particular marine laboratory, and, in some cases different professors of the same university have independent laboratories, each with his own group of assistants and students. Here in America we come to Woods Hole knowing that many of the men we wish to see will be here and we look forward with pleasure to the annual privilege of working together. But in France if we want to see Professor Bataillon we go to Céte; if we have mutual interests with Dr. Legendre and others of the College de France we go to Concarneau; to Dieppe to see Professor Herouard; and, in answer to our letter of greeting sent to the Roscoff station by the investigators at Woods Hole last summer and with customary French courtesy withheld his answering letter until we had come to Roscoff, when he asked us to be the first to sign it.

Eighteen years ago we spent one entire summer at Roscoff and I was much impressed by the spirit of isolation which seemed to invest every worker there; it was very different from the openness of Woods Hole. Today this has all been changed; there is a delightful spirit of frankness and camaraderie; biological subjects are broadly discussed and men from different institutions or from the same institution work together on the same problems. Classes of eighteen or twenty young people have daily instruction, daily or bi-weekly collecting trips, beach parties and picnics very much as we do at Woods Hole. The laboratory is spacious and with modern equipment and about it is a delightful old fashioned garden on which the windows of one side of the building are open. For a dormitory room an investigator pays three francs per day equivalent to twelve cents or eighty-five cents per week.

(Continued on Page 10)
Some Biological Stations
(Continued from Page 9)
At the time of our visit there were about sixty investigators and students at the laboratory; amongst the former were representatives of eight different countries and, altogether, of eighteen different institutions although the majority came from the University of Paris.

The private rooms are large and well-equipped; modern plumbing and running water are accessible and motor boats and other craft for marine collecting, an autobus and automobiles for inland trips, permit of a wide range of material. All in all any staunch supporter of the M.B.L. if transplanted to Roscoff, would feel at home there.

A different and a more typical illustration of the university laboratory is the station controlled by the University of Oslo in Norway. The University is in the center of the city and when I visited it just a year ago I was disappointed in not finding Professor Bonnevie who spent a year in New York some years ago. I was much pleased, however, to find Professor Ruud who will be remembered by many here at Woods Hole.

To be Continued in Next Issue

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There are many manifestations of the disease some of which are easily recognized, others more subtle. The social snob is perhaps the most common and most easily recognized. His malady is usually complicated by an inordinate tendency to climb and he becomes a specialized gymnast on the social ladder patronizing and even contemptuous toward those below him, obsequious to those above. In consequence he is scornd (Continued on Page 12)

METHODS FOR EXPERIMENTAL EMBRYOLOGY

WITH SPECIAL REFERENCE TO MARINE INVERTEBRATES

(Continued from Page 3)

these animals through to sexual maturity. This might well repay the effort.

Thyone. As far as I know, Pearse was the first to observe the shedding of eggs by Thyone in the Marine Biological Laboratory. I have during several seasons obtained eggs in optimum condition for fertilization by allowing the animals to shed. For many workers this may not be a good egg because of its opacity. It has nevertheless some interesting points. Thyone is extremely abundant at Woods Hole.

Podarke. Treadwell (01) has used the eggs of this worm. He collected them during the day and allowed them to spawn (at night). I have seen several hundreds of these worms swimming at the surface of the sea during the Neris runs. Because of their small size they are hard to handle when taken at night, and they are then shedding freely their eggs and sperm. If one wishes, therefore, to study fertilization, one should collect the animals during the day—from eel grass in the Eel Pond.

I have notes on other forms breeding during the summer. I give the present ones because they deal with animals from which the worker may obtain large numbers of eggs.

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BROWN

MICRO-SLIDE HOLDER

(Patent Applied for)

7071

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MICRO-SLIDE HOLDER, Brown (Patent Applied for), of aluminum, size 3x5 inches. hold four 3x1 inch micro slides.

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Fog
(Continued from Page 11)
for in reality he is lower than all.
Another type is the intellectual snob. He prides himself on his
condition; he seems the hum drum topics of daily life and converses
freely only with those whom he secretly believes know as much as
he does. He may tolerate the ordinary type of conversation but he
holds himself aloof from any part in it and as soon as possible gets in
to a corner with someone to whom he can demonstrate his great store
of knowledge. He is a bore.
The sporting snob is rather a
careless type and may outline his
disease. He must be doing some-
thing; tennis, golf, sailing, canoeing,
horse shoes and in inclement weather he must play bridge. Activity in
a physical sense is his obsession, for, if idle, there is the horrible
possibility that he may have to read or be caught in the act of contem-
plation and reflection.
The most insidious type of the
disease is manifested by the spec-
ialist snob. He is not uncommon
here at Woods Hole and can be easily detected by his superior
bearing towards those who are not
doing his own type of work. He is
interested only in his own line and
speaks sneeringly of work in other
fields. His friendly interest in others
is shown by remarks such as “Why
do you work in that subject, why
don’t you do something worth while”. His is the most dangerous
type of snobbery and the victims
should be avoided, particularly by
the young investigators, for there is
danger of loss of confidence and of
aimless wandering in the domain of
research.
All of these types are in the fog-
they can’t see beyond a few feet
from themselves; they huddle to-
gether in like groups and come to
believe that the world is bounded by
their special horizon. When you
hear the fog horn sonorously filling
the air, it is sometimes Nobska.
Let in the sun of humanity which
will soon dissipate the fog. Look
for something good and interesting
in everybody and everything; smile and be a human being worth
while. Don’t be a snob!—G. N. C.

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Wishes to call your attention to two items of interest.

1. A new and much enlarged Biological Red Book
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or a student of biology, you can have a free copy
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2. An exhibit of Turtox material will be on display
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come and see it. The exact location of the dis-
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ator. It is no longer necessary to bother with
two tubes. We shall exhibit it at Woods
Hole this summer.

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Through Professor Ruud I met Professor Schreiner who has made as excellent a record in anthropology as he originally did in cytology, and whose charming personality made a lasting impression.

While looking for him whom should we run across in the hall but Professor Harrison of Yale! With Professor Ruud as guide we boarded a small steamer and went down the fjord of Oslo for about twelve miles to Drobak where the small laboratory is located. Here Professor Brock, the Director, and his small staff of assistants gave us a cordial welcome. Their work is mainly on plankton but the instruction given is in histology and to complete the laboratory. Equipment is simple and not suitable for a variety of work. Life here is about the same as at other biological laboratories; thousands of eggs were treated show that the death rate depends on the intensity of the X-ray beam and on the length of exposure. Within physiological limits they demonstrate the Rumsen-Kroese law. This is true whether the eggs are exposed to both long and short rays together. Radiologists have long sought some kind of cell or tissue which will be affected by X-rays in such a way that it can be used as a measure of dosage. The eggs of Drosophila are well suited for this purpose, for by their death rate they show very clearly the strength of the dose to which they have been exposed. This criterion of effect is perfectly definite and cannot be mistaken. Experiments in which many thousands of eggs were treated show that the death rate depends on the intensity of the beam if the time of exposition is known. Several tests have shown that the method is practical.

Biological Research
More Centralized in America than Abroad

SOME BIOLOGICAL STATIONS
ABROAD
Dr. Gary N. Calkins
Professor of Zoology, Columbia University

First Evening Seminar Presents
Results of Biophysical Research

Packard finds fly eggs equally susceptible to soft and hard X-rays; Dr. Harvey describes the physiological effects of ultra-sound waves; Dr. Cole presents his work on the impedance of egg suspensions.
Biophysics Work Presented at Evening Seminar

Measurement of X-Rays (Continued from Page 1)

This method can be used in comparing the intensity of X-ray and gamma ray beams. For the dose of gamma rays, expressed in milligram—or millicurie-minutes, which kills 50% of the X-ray dose which kills a like proportion. Whether this comparison is strictly accurate cannot be finally decided until some way is found to measure these two radiations with the same open ionization chamber. Thus far, this has been impossible.

REVIEWS OF PAPER
BY DR. PACKARD

Comments by a Biologist

Dr. W. C. Curtis
Professor of Zoology
University of Missouri

The effects of X-rays and other radiations upon organisms have been the subject of a steadily increasing volume of investigation within the medical field since the original discovery of the X-radiations by Roentgen in 1895. In view of this growing interest by medical investigators, and the results obtained, it is surprising that such investigations have not assumed a corresponding importance in the general biological field until recent years. Interest was aroused by the early discovery of the selective action of X-rays and radium upon certain types of cells, but failure to obtain results of seeming importance to the biologist, resulted in failure to appreciate the possibilities inherent in the use of such a technique. During the predecade interest has been revived by certain spectacular extensions of our knowledge concerning the effects of radiations, notably those with ultra-violet in its clinical applications, and a new impetus has been given by the immediate returns that have followed the wider extension of work with radiations in other branches of biological science. To cite but one example, the work of Muller, in producing what appear to be gene mutations in Drosophila, has aroused the greatest interest and bids fair to open for genetics new means of attack at a time when geneticists seemed to be reaching a point of diminishing returns, despite many triumphs within the past dozen years.

What seems more important than any special piece of investigation, is the use of irradiation as a technique in biological research. Problems that we have never solved conclusively by previous technical means can perhaps be solved by this new method. If it is possible to reach within the nucleus and change the genes without lethal injury to the organisms, or to destroy certain types of cells completely while other parts main to all appearance normal, or to destroy specific chemical compounds at critical wave lengths, all of which can be done by irradiation, it is probable that much can be accomplished by such a method once it has received its full measure of refinement.

The work of Dr. Packard is particularly significant to biologists, because of the increasing interest in the effects of all kinds of radiations upon organisms, and the lack of accurate methods for measurement of exposures with X-radiations. The data obtained in clinical medicine, despite painstaking investigations, must be unreliable because of the complexities involved. The differences of opinion among clinicians after years of study and practice show how little progress has been made. Professor Williams will discuss the physical aspects of the problem of measuring X-ray exposures. What can be said here is that the biologist must have more accurate methods of determining X-ray exposures than have been available, if such radiations are to be used for exact experimentation. These have been given us by the work of Dr. Packard. New technical methods need refinement before they can yield their full returns. The refinement Packard gives us seems the most important one that could be offered to students of the effects of X-rays at the present time.

Comments by a Physicist

Dr. S. R. Williams
Professor of Physics, Amherst College, Amherst, Mass.

Investigators of biological problems repeatedly express their appreciation of the methods and technique of the physical sciences. Dr. Packard has placed on the other side of the ledger a biological method and technique for testing the intensity of a beam of X or gamma radiations.

The beautiful way in which Dr. Packard repeats his results indicate the precision with which he works. In listening to this paper one experienced a feeling akin to that which one has in looking at the work of an artist.

There are four fairly well known methods which radiologists have used for the purpose to which we have seen the fruit fly eggs led as sheep to the slaughter. These are: (1) Measurement of heat produced by absorption of X or gamma rays; (2) Photographic and fluorescent effects; (3) Chemical effects such as discoloration of pastilles of various alkaline salts or the liberation of iodine from a 2 per cent solution of iodoform in chloroform; (4) The ionization effect whereby a gas is made a temporary electrical conductor by the passage of X or gamma radiations through it. The latter is the most widely used of all.

The method consists in measuring a small electric current which will be a function of the intensity of the radiation. It is highly sensitive, but, like all of these methods, there is the need of a skilled technician to make the measurements with success. Of what we wish we had is a small indicating instrument, which, when placed in the beam of the X or gamma rays, would move its pointer to the number indicative of the intensity of the radiation.

In order to use Dr. Packard’s method one must be supplied with a large number of the eggs of the fruit fly, Drosophila, at a proper age. When a definite amount of radiation either from an X-ray tube or from a radium applicator is turned on the eggs, a very definite percentage of the eggs will not hatch. The empty egg shells are easily differentiated from the unhatched eggs. One has only to count the unhatched eggs and the percentage of the total gives at once the intensity of the radiation. It seems very simple. There are reasons to suspect however, that not a few physicists will be prejudiced because they will not have the technique for feeling sure that the eggs are in the proper condition. This is not a criticism of the method, but rather a commentary on the inertia of the human mind, an “anti” for which has not yet been developed.

Electrical Impedance of Suspensions of Arbacia Eggs

Dr. Kenneth Cole
National Research Council Fellow
Harvard University

Ohm’s law states that the potential difference between two points of a conductor is proportional to the current in it. For direct current the factor of proportionality is called the resistance, for alternating current, the impedance. The impedances of stirred and aerated suspensions of Arbacia eggs in sea water were computed from vacuum thermocouple measurements of the potential differences and resistance at zero and high frequencies. The impedance of a suspension is constant, but as the frequency is increased the impedance decreases until at high frequencies it again becomes constant. The impedance of the sea water is constant for the frequency range covered, so portion of the egg acts like a capacity in that its impedance decreases as the frequency increases.

A general equation for the impedance of a suspension of conducting spheres having static capacity at their surfaces gives the function

$$S = \frac{(z^2-2) / (r^2-z^2)}{C_0 \pi r_0 w}$$

where $z$ is the observed impedance; $r_0$ and $r_00$, the extrapolated resistances at zero and infinite frequencies; $C_0$, the capacity per unit area of the sphere surface; $a$, the radius of the sphere; $r_2$, its internal resistance; $w$, 2n times the frequency. From this equation it is found that $C_0$ for Arbacia eggs varies as the inverse square root of the frequency, whereas it would be independent of the frequency if it were a static capacity such as has been found for red blood cells. It seems probable that there is a polarization capacity at the egg surface. This type of capacity usually has associated with it a polarization resistance which varies with the frequency so that the phase angle of the combination is zero or less constant. The phase angle of the egg suspension was not measured and the phase angle of the egg surface is not known. Without knowledge of either of these two quantities it has not been possible to calculate either the capacity or resistance of the egg surface.
REVIEWS OF PAPER
Given By Dr. Cole

Review

Dr. S. C. Brooks,
Professor of Zoology,
University of California

Like every advance in physical knowledge, the rapid development of alternating current methods brought about by the demand for radiotelephony provided biology with new weapons. To devise apparatus and methods suitable for biological experimentation has demanded much careful study, but the interpretation of experiments has been even more difficult and treacherous. Dr. Cole's paper has the double virtue of presenting new facts and carefully pointing out the limitations to their significance.

Electrical methods can tell us much about the freedom of movement of ions in and around living cells, and hence yield information as to their permeability to electrolytes and their ultimate structure. Furthermore, if alternating currents are used and attention paid to the reactance as well as the resistance, we approach more nearly an answer to the problem of the existence of the hypothetical plasma-membrane.

Until the last decade any flow of current through cells was tacitly assumed by most biologists to prove the permeability of cell surface or the "plasma membrane." But it suddenly became apparent to a number of workers that alternating currents, especially of the higher frequencies, could flow through a membrane without ions actually passing through it, that is, by a capacitance at the membrane. Subsequent workers have tried to eliminate the capacitance by using properly tuned circuits, or have studied the capacitance itself, or, as in Dr. Cole's work, utilized the combined effect of resistance and capacitive reactance as material for further analysis.

A survey of our present knowledge might include the following significant points. A direct current, reversed twice a minute to prevent injury, gives evidence that erythrocytes are probably slightly permeable to ions. (McClendon). Alternating currents up to several kilocycles yield data which support this view, although this interpretation has been disputed by Fricke and Morse. Other cells seem to be more permeable than red blood cells. Osterhout's data on Laminaria at 60 and 1000 cycles, Phillipson's data on various tissues, and the work just reported by Dr. Cole at higher frequencies, and many other lines of experiment all suggest or at least are compatible with a more or less restricted permeability of living cells to ions.

Finally we have what may prove to be a most significant deduction to which Dr. Cole has barely referred; namely that if the most plausible necessary assumptions are chosen, we deduce that a surface film on an Arabidopsis egg would show the observed effects only if it were less than half a carbon atom thick. Such a film being obviously impossible we would then have to look for other hypotheses as to the nature of the "plasma membrane," which could be called a "membrane" only by courtesy.

Thus electrical methods have given us many clues, pointed to significant probabilities and enticing possibilities; but they have not yet given us rigid proof of the things we most want to know.

BIOLOGICAL

Effect of Ultra-sound Waves
(Continued from page 1)

1. For this purpose Loomis has constructed a special device which can be attached directly to a microscope and operated by an oscillator of relatively low power, but which must be accurately tuned to resonance with the quartz crystal. The entire oscillator is very compact and weighs only eighteen pounds. It takes current directly from the 110 volt A. C. lighting circuit and employs a 75 watt tube (Radiotron 852) with two small transformers (one giving 8 volts for the filament, the other 1,100 volts for the plate). The microscope with quartz crystal on its stage is set up about three feet from the oscillator and connected through a shielded lead so that movements of the operator will not materially vary the capacity and thus the frequency. On each side of the crystal are two electrodes of tin foil with a hole cut in the centre to admit light to the material under examination which is placed directly in the crystal disc. Two controls which connect with the oscillator are operated from the microscope, one varying the plate and filament current and the other the frequency. Two frequencies have been used 400,000 and 1,200,000 vibrations per second.

Observing under a high power microscope, it has been possible to follow the progressive destruction of frog blood corpuscles. The oval cells at first become warped and twisted. Strained areas appear and the color fades, leaving a pale distorted shad-ow. Individual bacteria can be studied, but while they can be violently agitated, we have not yet been able to observe their destruction under the microscope.

If a fine emulsion of oil is examined, an individual droplet of oil can be singed out and made to rotate rapidly in either direction at speeds that can be accurately controlled by varying slightly the frequency of the oscillating circuit.

An excellent material to illustrate the effects of these waves is a leaf of Elodea, which his two cell layers thick. The protoplasm with suspended chloroplasts forms a thin layer about the cellulose cell wall enclosing the vacuole of cell sap. High frequency sound waves of low intensity passed through these cells cause the protoplasm to rotate very much as in the normal rotation or cyclosis of Elodea. Increasing the intensity increases the movement until the whole cell is a rapidly whirling mass of protoplasm, fragments of which are torn loose and rotate as small balls in the vacuole. The effect is very striking and might almost lead one to conclude that the normal cyclosis of this plant was caused by high frequency vibrations.

The normal protoplasmic rotation of Elodea is stopped by the waves unless they are of very low intensity. Rotation begins again provided the raying has not been too strong. Sugar plasmolysed Elodea cells are affected in the same manner as are the unplasmolysed ones, the whole protoplasm rotating rapidly, until, with increasing intensity, the mass finally bursts and the chloroplasts, still whirling, throughout the cell. Nitella cells when rayed have the chloroplasts torn from the walls of the cell and whirled rapidly, leaving a clear area which had originally been a uniform green color.

This stirring of the cell contents is one of the most characteristics effects of supersonics. The smaller the cell, the more difficult it is to stir but we have observed the rapid rotation of the chloroplasts in moss cells whose diameter averages 12u.

The phenomenon is not connected with living cells but may be observed in Elodea, killed by heating or by chloroform, although a greater intensity is necessary since the protoplasm is coagulated on death, and the coagulated mass only churned with some difficulty.

No effects of the waves have been noted that could be clearly traced to an influence on chemical processes in cells, although it is known that high intensity waves influence certain chemical substances in suspension. (W. T. Richards and A. L. Loomis, J. Am. Chem. (Continued on page 9)
in a motor yawl for an hour and a half to see the islands and the general environment. It was not yet sunset when we finally took a motor bus at ten o'clock back to Oslo.

Still another type of marine biological station is financed through the activity of commissions or scientific societies. This is the situation of most of the laboratories in Great Britain. The Sea Fisheries Commission for example, under the advice and direction of Sir William Herdman built and equipped the Liverpool biological laboratory at Port Erin on the Isle of Man in 1892. It is also the case at Plymouth where, largely under the influence of E. Ray Lankester the laboratory was established in 1884 as an institution of the Marine Biological Association of the United Kingdom, and only property leased by the government. This is the most widely known biological station in England and is and has been the favorite seashore laboratory for English biologists. Although Plymouth itself is beautifully situated the white stone building of the laboratory, surrounded as it is by buildings, walls and stone-paved streets, is not very imposing. A public bathing pavilion is within a stone's throw, and it is not more than a good golf shot from the Hoe or public esplanade, stone-paved and with a hand sand, where the people of Plymouth meet to chat or read. Nearby is the bowling green where Drake is said to have been bowling when the Spanish armada was sighted, and here the old Eddystone Light is maintained as a monument, having been set up here when the modern lighthouse was built.

Inside the laboratory the scene is different; here is a working institution under the direction of Dr. E. J. Allen who is a fountain head of information and is always ready to help. There is a good library of some seven thousand volumes; running water and a fine equipment generally. It was a real surprise to see one of the investigator rooms labeled Columbia Room, and on inquiry I learned that it was the gift of Professor T. H. Morgan. Some people practise the injunction not to let the left hand know what the right hand is doing!

The same type of organization underlies the marine biological station at Millport in Scotland. It is the Laboratory of the Scottish Marine Biological Association and is situated on Great Cumbrae Island about two hours by rail and boat from Glasgow. Originally founded for the investigation of the fauna and flora of the Clyde Sea Area it has become, under the able directorship of Mr. R. Elmhirst, a favorite working place for English and Scottish biologists. The laboratory is a small stone building artistically situated across the bay from the town of Millport. Here the genial Director may be found pursuing his statistical studies on plankton, or repairing and oiling the pumping machinery, or installing an electric lighting system, or, as we found him, rescuing a stranded goat on the rocky ledges above the laboratory. In short, he manages and runs the entire plant and has time to do scientific work as well. But there were only four investigators, two of whom were off on an extended collecting trip, while Dr. Needham and Mrs. Needham from Cambridge were at the laboratory working on a biochemical problem in development, with apparatus largely devised at the Station. As might be expected the library facilities are limited and the Director would be grateful for reprints or other scientific works.

In general, and always with the exception of Naples, the biological stations of Europe do not impress one as institutions of independent or individual importance. The exaggerated big-scale operations so characteristic of American institutions is never in evidence. The stations that are associated with the universities, are active, like Woods Hole, only during the summer months. Most of them are closed at other times although at Roscoff, as at Woods Hole, workers can be accommodated in winter.

Governmental and society-financed marine stations are usually open throughout the year and the directors are on duty all the time. There is no particular invasion during the summer months and large numbers never become a problem to the management. At Plymouth in July last year there were not more than half a dozen investigators. Dr. Punt in whom most of us will remember at Woods Hole had just left; Professor Watson had just arrived. Dr. Holson and Dr. Wells, who has also been at Woods Hole, were actively at work, but no others were in evidence. At Naples in May there were not more than a dozen workers. Professor Zeleny had just left; Professor Heider was on the eve of leaving. At such stations work is possible at all seasons of the year and one is always sure of a cordial welcome.
Our Classes

The art of class news-getting becomes more and more of a gamey sport in Woods Hole. In the old days each class would have its own reporter who, from close association with his or her prey, was well equipped to make careful observations on their habits and to write a short "paper" of their to a brown list in time to catch the press. Today, however, a lone leather-stocking rounds up his assorted game, trails them to their hidden lairs in the Brick Building, stalks them from behind the tables at Mess, and using a bathing suit as a blind, tracks them down at the beach. After the "kill," the vital information is carefully extracted, mounted and shipped in huge packing cases to the printer. The worst of it is that there is an editorial injunction against excess levity—this column is to be more or less serious. So bear with us!

The Botany department at the moment of this writing is beginning to alter almost imperceptibly from a rather set of color to a brown study. The three collecting trips to date have been most successful, both barns and buckets coming up to specifications. Dr. Taylor started off the course with lectures on the blue-green and brown Algae. At the present time Dr. Poole is lecturing on the greens. Two important botanical events are scheduled for this week. The first is the arrival of Dr. Lewis on the fifteenth and the second is the famous Cuttyhunk trip which will take place this Tuesday.

The Protozoologists all seem unanimous in declaring that there is no news. These are to be recognized as the people who come to mess late and weary with a red face from too close an attachment to the ocular. On the day that we interviewed the staff there were low groans proceeding from the laboratory. It seemed that Dr. MacDougall was passing down the aisle collecting twenty-five dollars from all the registered Columbia students (of whom there were several, it was said to sound!). Dr. Calkins, when asked if there were any special lectures, said there were none for advertisement. It was our own fault, because, it seems, we had put him in the difficult position of confiding which of his own lectures he considered special and which, not so special! He did say later, however, that he was saving the special lectures for the last week of the course, "to leave a good taste," as he put it.

"To leave a good taste," as he put it. After the "kill," the vital information is carefully extracted, mounted and shipped in huge packing cases to the printer. The worst of it is that there is an editorial injunction against excess levity—this column is to be more or less serious. So bear with us!

The Physiologists, for those new to these parts, are the people who are lectured at, just at swimming time, and can be seen emerging dry and erudite from the old lecture hall while the rest of the world drips and sloshes by. The lectures of the first week of the course were on the subject of diffusion and were delivered by Dr. Jacobs. During the second week Dr. Michaelis lectured on oxidation and reduction potentials and the properties of membranes. This coming week Dr. Harvey will lecture on oxidation, respiration, and luminescence in cells.

The last in our account are the embryologists. It might be well to state here that the order in which the classes are listed is neither alphabetical nor hierarchal in any sense. It is simply a chronological order based on the time of capture. The embryologists are most elusive at this season. The class lectures have been given by Dr. Goodrich, Dr. Packard and Dr. Plough who have covered respectively the embryology of the fish, cell lineage in the Mollusca and Annelids, and the embryology of the Coelenterates. A special lecture was given by Dr. Clark on the development of the vascular system. In connection with this lecture the technique of the study of the tadpole tail and the rabbit's ear was demonstrated, the latter by Dr. How. Other special lectures were delivered by Dr. Stockard, on the twinning of Fundulus, and Dr. Just on fertilization, Dr. Swett on the transplantation of tissues, and on Tuesday Dr. Lillie lectured.

The class work of this half of the week concerned the later stages in the development of the Annelids and Molluscs, with Dr. Grave lecturing. On Thursday and Friday afternoon Dr. Rogers lectured on the Echinoderms. The only social mention of the many physiologists seems to have been the Nerelie run, which was handicapped more or less by the competition of the Episcopal party and a heavy rainstorm.

Laboratory Workers are Guests of Church

Members of the Episcopal church of Woods Hole entertained M. B. L. workers and members of the Fish Commission at their annual social and dance, held in the rectory parlor on the evening of July 5th. The guests who have for many years enjoyed and appreciated the sincere and generous hospitality of the members of the church and their pastor, Dr. Bancroft, were first entertained with a delightful epicurean pastime of strawberries, ice cream and cakes, followed by two hours of dancing.

Kingsley Perry, Harvard '28, a member of the University Player's Guild gave a clever exhibition of ventriloquism during the intermission. His little act was loudly applauded by young and old alike.

The flood-current begins to run southeasterly in the Woods Hole passage, from Buzzards Bay to Vineyard Sound, one hour before it is low water at Boston.

A NEW DARK FIELD ASSEMBLY
FOR THE MOST CRITICAL WORK

DARK FIELD ASSEMBLY, for the most critical work. The 1925 model cardiod condenser supplied with this outfit was specially designed for the dark field observation of aqueous solutions and preparations, particularly living bacteria, and for the ultra-microscopic examination of colloidal solutions.

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The new model is a reflecting condenser and has, therefore, the advantage of being perfectly achronic. It also has a good spherical correction and therefore a high light transmitting capacity. To secure the full benefit of its optical correction, the condenser should be accurately centered with respect to the viewing system. For this reason the new model is provided with its own centering device.

While this condenser can be used satisfactorily with the incandescent micro-lamp, the use of the arc lamp as a source of light results in more complete utilization of the advantages offered in the new model.

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Cable Address: "Balancl," Philadelphia.
We want THE COLLECTING NET to serve as an agency for publishing news and information as well as a local biological magazine which can publish material of a specialized character, the limited interest in which might not make it available for publication in a magazine of more general circulation. The value of some of this material to workers at this laboratory could not easily be over-estimated. Further, the paper should give an opportunity to serve as a medium for the expression of one's thoughts in other fields through letters, essays and articles of a literary nature which we sincerely hope will be contributed by workers at the laboratory, and by those in Woods Hole and the immediate vicinity.

Again we ask for suggestions and assistance from the readers of THE COLLECTING NET.

Our Advertisers

Probably few people here realize the extent to which the general welfare and financial integrity of THE COLLECTING NET is dependent upon its advertisers. They enable us not only to issue a substantial paper—but allow us also to turn over a sum of money each summer to THE COLLECTING NET Scholarship Fund. In addition they have made it possible for us to employ a paid business manager which removes much work from the shoulders of the editorial staff. Those firms which have contracted for advertising space the value of which is $80.00, or in excess of this amount are:

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Looking Forward

During the past two summers we have been somewhat surprised at the limited number of individuals who submit material for publication in THE COLLECTING NET. Probably ninety-five per cent of the material that we have published during our brief span of life has been written at our suggestion. This situation is contrary to our wishes. Someone has suggested that the reason more material is not submitted is that people do not realize our columns are open for their use. We would particularly like to initiate a correspondence department which would be used for members of the laboratory to give free expression to their opinions concerning any subject on which they care to write.

Once we were officially told that we must not be too biological! And we do not want to be. We do not want THE COLLECTING NET to become solely a trade journal for workers at the laboratory: it can contain much of interest that does not fall directly in the field of biology. Anything contributed by a member of the laboratory is certain to be of interest to other workers. THE COLLECTING NET should be not only a paper that the biologist feels is his duty to read in his laboratory: which he would stick in his pocket and carry home to read after his evening meal, in an arm chair, before an open-wood fire. We should like to have these two attributes which are rarely found in one publication, and we believe that our unique environment ought to make such a combination of diverse characteristics possible without having the whole lacking in unity.

Fogg, Jr.
The Class Trees which have been an essential part of the Club’s activities in the past, will be continued this season and will be held as usual in the Club House on Friday afternoons from 4 to 6. The Invertebrate and Botany teas have already been given and on Friday, July 20, the Physiologists will be hosts. Following this in order the teas will be given by the Protozoology and Embryology departments, Investigators and the Bureau of Fisheries. It should be emphasized that, while the various groups alternate in giving these teas, they serve merely as hosts (alternate hosts, one might say), and the presence of every one at the Laboratory and the Bureau of Fisheries who is interested in these informal functions is earnestly desired.

It is planned to continue the Saturday Evening Session in the Club House throughout the duration of the courses. These are open to members: and non-members may dance upon the payment of fifty cents.

Membership dues in the Club are $1.50. They may be paid either at the Main Office of the M. B. L., or to the Chairman of the Membership Committee in the Club House on the evenings of the dances.

The honorary degree of doctor of science was conferred upon Samuel Robinson Williams, professor of physics at Amherst College, by Grinnell College on June 5. Dr. Williams is spending the summer at the laboratory carrying out experiments in biophysical research.

The velocity of the current in the Woods Hole passage during high course tides is six knots an hour; during the low course tides its velocity is four knots an hour.

**DIRECTORY ADDENDA**

**CHEMICAL SUPPLY ROOM**

Bently, Jr., J. H., stud., Wesleyan.
Haas, Dorothea, stud., Holyoke.
Halse, J. B., stud., Oppenheim.
Keel, Elia M., grad. ass't. biol., Brown.
Mast, Louise R., stud., Roland Park.
Roth, E. M., stud., Evolutions.

Richards, O. W., ass't. prof. biol., Clark.
Stockard, Marie Louise, stud., Washington, N. C. Y.
Strong, O. S., assoc. prof. neur., Columbia, Director.
Tilley, Betty, Betty, grad. chem., Pennsylvania, ass't. Director (abrupt 1928).

**MECHANICAL DEPARTMENT**

Boss, L. F., mechanician.
Larkin, T. E., ass't.
MacBeth, B. J., night engineer.
Steele, F. L., fireman.

**INVESTIGATORS**

Carey, C. L., instr. bot., Barnard Bot.
Chase, A. M., ass't. biol., Amherst.
Clowes, G. H. A., Dir. Lilly Res. Lab.
Mawson, R. D., prof. biol., West Virginia Wesleyan Col.
Morgan, Lilian V., (Mrs. T. H.), asst. exper. zoology. Br. 313.
Natsurajni, C. V., grad. public health, Hopkins School of Hygiene.
Rowe, Charlotte, grad. zool. New York.
Williams, S. C., inst. zool., Brown.

**STUDENTS**

Holman, Katherine K., grad. Dalhousie. Emb.
Methods for Experimental Embryology

With Special Reference to Marine Invertebrates

E. E. Just
Professor of Zoology, Howard University

In the preceding article I pointed out that there are very many more forms with large numbers of eggs, available at Woods Hole during the summer season for different lines of work in experimental embryology, than those most commonly used. There is certainly no dearth of various embryological material at Woods Hole. Most beginning investigators nevertheless will doubtless prefer to make their studies on the more popular forms like Fundulus, Cynthia, Arbacia, Echinarchus, Asterias, Nereis, and Cheltophorus, etc. It may be worthwhile, therefore, to detail some methods for obtaining their eggs and sperm in the best physiological condition. I consider this step of the utmost importance for successful and uniform results.

Permit me to say at the outset that in my experience the variability of the eggs from a female of a given species is not nearly so great as some workers seem to think. Take the eggs of Nereis, for example: if removed from a freshly collected female they exhibit after insemination a most remarkable uniformity with respect to the time of polar body extrusion, cleavage, and of trophectoderm formation. This is likewise true of the eggs of Arbacia and those of Asterias even. With the latter, though many workers claim to have difficulty, I have repeatedly obtained not only a uniform rate of development but also over 90 per cent. bipinnaria. These results depend largely upon the animals being in optimum condition when the worker gets them. The proper collecting and care of the animals after collecting are therefore essential for embryological work. The collector is as important as the investigator himself, and his importance increases with the number of investigators he supplies. The success of a marine laboratory in the greatest degree thus rests with the collecting staff.

Let us assume that the worker gets freshly collected animals in optimum condition. He must now procure the eggs and sperm by methods that will assure normal development. It will be most convenient to discuss the methods for handling eggs and sperm of each of a few animals in turn, the order being that of their importance as determined by the extent to which they are used. Arbacia, therefore, comes first.

**ABBACIA.**

The worker may obtain eggs and sperm of Arbacia in optimum fertilizable condition by one of several methods: (1) allowing the animals to shed; (2) cutting carefully around the peristome, without injury to the gonads, or removing the spines, either of which stimulates shedding; and (3) cutting around theequator of the test and removing the ovaries to 250 cc. of sea-water, the testes to a dry watch glass.

(1). Freshly collected ripe Arbacia readily shed their sexual products. Indeed, this may be a nuisance if the worker has, among several such animals in a tank, one that starts shedding. I have frequently observed an animal on the side of a tank begin to shed; next, the adjacent one sheds and so on around until soon from every ripe animal eggs or sperm stream forth. Similarly, I have found thick mats of eggs lodged among the spines of females on the bottom of the tank. Elsewhere (Just, '23) I have commented on the fact that I have taken perfectly normal eggs in various stages of development from among the spines of living females. I have also collected Arbacia from the piling of the wharf opposite the Crane Building, that shed before I could get them to the laboratory, a distance of about one hundred yards.

These shed eggs are of optimum fertilizability except toward the end of the breeding season (Just, '23). Since one could scarcely depend solely on shed eggs for one's experiments, one must use other methods for obtaining eggs in optimum condition. I therefore suggest either of the other methods.

(2). Eggs shed as the result of stimulation through injury to the animal, e.g., by cutting carefully around the peristome—without puncturing ovaries—or by removing their spines, are by no means inferior to eggs normally shed, as their per cent. and normality of development reveal. The animals thus stimulated should be placed aboral surface down in clean dry Syracuse watch glasses, and the eggs so obtained ("dry eggs"), free from perivisceral fluid, if from intact ovaries, should be removed as exuded to 250 cc. of sea-water. Sperm thus obtained ("dry sperm") should be kept undiluted and covered until immediately needed for insemination. This is important because Liible ('15) has shown very beautifully how the fertilizing power of Arbacia sperm suspensions falls off with dilution. Likewise, Cohn ('17) has made an important study of the relation of activity and ferti-
Methods for Experimental Embryology

(Continued from Page 7)

...fertilization capacity. A slight accidental puncture of the ovaries means contamination by the body fluid, which seeps into the ovary and through the genital pores with the extruded eggs. In such an event the eggs must be washed free of the perivisceral fluid which inhibits fertilization. One should therefore make trial inseminations on samples taken from eggs suspended in 250 cc. sea-water. If 95-100 per cent. of the eggs fertilize as shown by the number that separate normal membranes, they are good. If the per cent. and quality of membrane separation be low, the worker should wash the eggs again and make another trial insemination on them. This procedure should be repeated during not more than an hour after first suspending the eggs in sea-water, until normal fertilization in close to 100 per cent. of the eggs is obtained.

The inhibitory action of the perivisceral fluid to the fertilization of Arbacia eggs was first clearly established by Lillie. The reader should consult his book, "Problems of Fertilization," for references. I have confirmed Lillie's findings on eggs of Arbacia and those of Echinarchnus not only for fertilization but also for experimental parthenogenesis. Cf. also my paper on Nereis, (Just, '15).

'1) I daresay that the most common practice of obtaining Arbacia eggs is that of removing the gonads directly to sea-water. By this method the eggs most certainly suffer contamination with blood inhibitor. One may rid them of the inhibitor as follows:

Open the animal with a circular cut carried barely through the test, slightly above the equator. Discard the oral part of the animal. Now invert the aboral part and so drain off the perivisceral fluid; next, either place it in a clean dry Syracuse watch glass so that the eggs exude through the genital pores, or carefully remove the ovaries to 250 cc. of sea-water into which the eggs will fall freely from the ovaries. In the latter case, strain the eggs free from debris by putting them through cheese cloth, previously thoroughly soaked in running sea-water after having been washed in fresh water.

If necessary, wash the eggs four times by decanting the sea-water above them as soon as they settle, adding very gently, fresh sea-water in an amount equivalent to that removed. Again the washing should not take more than one hour. After each washing, test the eggs by trial insemination on samples. If after the fourth washing the trial insemination does not yield close to 100 per cent. fertilization, discard these eggs and use the eggs from another female that yield practically 100 per cent. fertilization.

I find it worthwhile to open several females, selecting the eggs from the best. And in general, I never mix the eggs from several females. One point the worker must remember: Arbacia eggs are not "c. p." chemicals that give the same results day in and day out. Too many variables enter: the time in the breeding season, the freshness and vigor of the animals—which depends upon the length of time they have been in the line cars, after having been collected—the fullness of the gonads—which depends to a great extent upon the collecting grounds from which they come during a given lunar period—the abundance of the blood inhibitor present, temperature, et cetera.

ASTERIAS.

Next to the egg of the Arbacia, that of Asterias is perhaps the most popular at Woods Hole. This is a most beautiful egg for many purposes, when properly handled, but unfortunately is greatly maligned by many workers. This is not the fault of the egg. The first essential is to get good animals with ripe gonads.

When fully ripe the animals are heavy, their skin is soft and their arms bulging. I determine the ripe animals by roughly estimating their weight, rejecting the lighter ones with firm brittle skin and narrow arms. Frequently, I have been able to select the ripe animals so exactly that when using eggs only, I have taken but one specimen. The ovaries of a large ripe female will fill a 200 cc. graduate.
Biological Effect of the Ultra-Sound Waves

(Continued from Page 3)

SOC. 49, 3086, 1927). The phenomena in living organisms, apart from temperature rise, are connected with mechanical effects, the most striking of which might be best described as "intracellular stirring." 2. In certain biological studies where great intensity is desired, and where it is not necessary to observe under the microscope, a high powered oscillator is required.

Using such an oscillator and placing the material to be treated in test tubes which were subjected to the vibrations. Wood and Loomis caused the rupture of filaments of Spirogyra, the tearing of Paramecium and the laking of red blood corpuscles. This latter effect is very striking, deglittered mammalian blood corpuscles in physiological salt solution laking completely in one minute before the average temperature of the fluid had risen to 37°C. They also noted the killing of small fish and frogs but the cause of death was not determined.

Using the same high powered oscillator we have taken small organisms like Euglena or Paramecium and enclosed them in capillary tubes sealed at the ends. When one end of such a tube is subjected to intense vibrations the organisms are thrown in piles regularly spaced (about 2mm. apart, depending on the diameter of the capillary) along the tube, from which they are unable to swim. These piles represent nodes of transverse vibrations set up in the capillary. It is not that the organisms swim into these nodes but that they are passively carried into the nodes and fortunately, so, for between the nodes they would be subjected to mechanical tearing that would disintegrate them. Thus, red blood corpuscles in a capillary tube are thrown into the nodes and quite unformed by ten minutes raying whereas the same corpuscles in a test tube, where convection currents carry them about, are laked in one minute.

Even luminous bacteria and particles of gamboge form striae in capillary tubes but colloidal particles of (OHs) do not.

An emulsion of luminous bacteria in sea water in a test tube, rayed until the temperature rose from 1.5° to 21.5°, luminesce considerably less brightly than control a tube heated from 1.5° to 21.5°. The turbidity is also less in the rayed tube, indicating that some of the bacteria have undergone cytolysis. Control experiments showed that the dimming was not due to the electric field. The luminescence of a mixture of Cypridia luciferin and luciferase was unaffected by raying in any way that could not be accounted for by rise in temperature.

One might expect that high frequency mechanical vibrations carrying as much energy as they do, would be capable of stimulating muscle or nerve tissue. All attempts to demonstrate a stimulating action have failed. The sciatric nerve of a frog connected with the gastrocnemius muscle may be touched (nerve or muscle) to a test tube violently oscillating or be immersed in a salt solution in such a test tube without stimulation and without injury. Both nerve and muscle are later found to be quite irritable to electrical stimuli. The high tension field is unable to stimulate because of its high frequency. A bull frog's heart mounted in Ringer's solution in a test tube touching the oil and connected with a heart lever for recording movement, shows no peculiarities of the contraction, but an irregularity and usually a slowing of the rate, despite the rise in temperature that accompanies the raying. Further observations will be necessary to analyze these peculiarities.

Review

Dr. Samuel E. Pond, Assistant Professor of Physiology, University of Penn, Medical School

The characterization of high-frequency sound waves (or super-sonics) as the "ultraviolet of sound" is an indication of the relationship which these bear to the sound-waves we more frequently encounter. The two departures from the ultra violet—to spoil the analogy as early as possible—must not be lost sight of. They do not pass thru a vacuum which emphasizes their chief relationship to ordinary sound waves and apparently they do not stimulate specialized tissues like muscle and nerve. In this latter respect they differ from certain bands of the electromagnetic spectrum (e.g. radiant energy and electricity). But one wonders whether some sensitization will not be effective so that it is possible to stimulate sensory tissues, ere the task is done.

In the frequency gamut of 200,000 to 2 millions cycles it would seem as though the order-difference were ample to discover whether specialized protoplasm will react to high frequency displacement, the superharmonics of mechanical force or stress. That Dr. Harvey and his associates have failed to affect nerve and muscle so far is indicative of the limited band of frequencies to which nerve and muscle and many other sensitive tissues will respond.

Hence an analysis of displacement effects, particularly sine-wave, continuous, and extremely rapid translation will nevertheless be of interest. In part, we look forward to a clearer statement of what stimulation is when the experimenters with super-sonics can tell us why these high frequencies do not evoke a protoplasmic response. And further, it may be anticipated that the work will lead to a clearer explanation of the aural stimulation by resonance and vibrations of the lower orders. A basic interpretation of stimulation which takes into consideration harmonic motion as well as polarization, physical as well as chemical effects, may thus grow out of this newer undertaking.

It is of some considerable significance that many clear-cut positive results with super-sonics have been secured. The laking of blood, the rupture and disruption of a variety of eggs without the apparent stirring of the protoplasm, and the cyclical-like effect in Elodea are examples. (A view of the disturbance in Elodea by the high frequency exceeds the thrill of any biological circus yet staged.) Yet these appear to be free of temperature effects and un-related to chemical disturbances. To some of us who

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The Zoological Station at Wimereux

MAURICE CAULLERY,
Professor at the Sorbonne,
Director of the Station of Wimereux

Wimereux, a resort on the strait of Pas de Calais (English channel) is 5 km, from Boulogne. The zoological station is a mile and a half beyond the Pointe-aux-Oies, at the entrance of the dunes.

It was described, such as it was in 1910, in the well-known book of Ch. A. Kofoid on the European biological stations; it has since undergone a few changes in its equipment which may make this article interesting.

A. Giard, professor at the Faculté des Sciences de Lille, founded the station in 1874; later it became part of the Université de Paris. From 1874 to 1899 it occupied only a small summer house on the banks of the river Wimereux, near its estuary. The equipment was most rudimentary, but in spite of this fact important work was accomplished. This was published in the "Bulletin scientifique de la France et de la Belgique" and in "Les Travaux de la station zoologique de Wimereux." Let us recall the beautiful research of J. Barrois on the development of the Bryozoa; those of Giard and J. Bonnier on the Epacrides, etc. It is at Wimereux that Giard has discovered and characterized the Orthonecides; he has published numerous biological and systematical notes on the flora and fauna of the Boulonnais.

Since 1899, the station occupies a special building on the sea-shore, sheltered by a dyke. The aquarium are in the basement; the main floor is the laboratory proper; an upper floor has bedrooms for the workers. Besides this building is a pavilion residence of the director, and a wing to the south remains to be built to house the collections.

The laboratory consists of a large common room with 12 desks equipped especially for microscopic work; a room for physiology and chemistry, a dark room, and a library. It is a small institution but its equipment is quite complete now. During the last few years the station was provided with electricity, which permits the use of motors, centrifuges, autoclaves, etc. We also have gasoline gas for ordinary uses, fresh water and sea water. The latter has been installed recently and we may keep live material for experimentation and observation. Sea water is sucked directly on the beach at high tide through a special filter placed in a wooden tank. (Foot note No. 1.) This water is brought by a centrifuge pump for decantation in reservoirs of a capacity of 80 cubic meters, from into which it is forced into an upper reservoir to be distributed then under a 5 meter pressure to the aquarium.

Combining the beach from the rocks of the fort Heurt, south of Boulogne to Cap Gris Nez, furnishes the current material. The marine fauna and flora of the coast are well known. We go out to sea for plankton in a small motor boat, the "Orthonectide." The coast near the station is so abrupt that it is impossible to have a larger boat. Occasionally dredging is done by a steamboat from the port of Boulogne.

Between April and October 1st about 60 workers come each year, 15 of whom pursue original research. The results are published in different journals: "Le Bulletin biologique de la France et de la Belgique" is the regular publication of the station, which occasionally publishes "Les Travaux de la station zoologique de Wimereux."

The laboratory of Wimereux has only limited possibilities because of its position, its size, and limited budget. It is, however, the center of uninterrupted activity, which the recent perfecting of its equipment will help increase. The workers also have every convenience in respect of living accommodations, and the common life they lead there has its charm. Wimereux and Boulogne being very near, the students may indulge in tennis or golf. The station is freely open to foreigners and has already had several American zoologists.

I shall be glad if publishing these few lines in The Collecting Net will give to others the idea of coming.

(Foot Note) Cf. M. Caullery, La Station Zoologique de Wimereux; les progrès récents de son outillage, Bull. biol. France Belgique, t. 61, 1927 (pp. 500-511).

Biological Effect of the Ultra-Sound Waves

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have been totally immersed in the biological aspects of polarization and the exclusive society of ions it is more than a thrill. Let the agitation proceed!

But apart from the simple explanation that smallness is synonymous with rigidity why are bacteria in the realm of the unscathed? Is it because the energy is reflected or transmitted? The reviewer judges that the energy is not absorbed by the bacteria and the small cells which give negative results when rayed. Otherwise they would not escape destruction when exposed to the intense fields of force applied. They could transmit and reflect the energy and thus exhibit the natural independence much as glass is unaffected by certain portions of the visible spectrum, as a galvanometer is undisturbed by an external electrical field when enclosed in a metal shield, and as a stretched string remains quiet in the presence of disharmony.

The apparent thermal effects which Dr. Harvey described (not upon protoplasm of the ordinary Woods Hole variety but the experimenter's own finger) raises another question. If the thermometer in the medium exposed to the high frequencies is not itself affected until the fingers close with some tension about the stem, does it not indicate that particles which themselves are set in motion become exposed to thermal energy—in the absolute sense—since they are in motion with relation to the medium in which they are viewed and rayed? Let us suppose that particles or cells in a protoplasmic fluid are in motion and the fluid remains at rest; then some thermal effect might be resident at the interface where friction arises (?). Presumably in the aqueous systems the high specific heat of the medium would diminish the temperature gradient, and thus tend to reduce the possibility of thermal stimulation (or destruction) of the moving cells by heat. Especially in media of different densities and co-efficients of friction, or where electrical fields of force are set up by moving particles, thermal effects would be anticipated.

Altogether Dr. Harvey's presentation was attractive and thought-provoking. In his audience were many who followed him through every turn and into the laboratory for a view of what the microscope could unfold when he "turned on the juice."
The Dover Road

"The Dover Road," the A. A. Milne comedy which opened this season for the University Players Guild at the Elizabeth Theater in Falmouth last Monday and Tuesday nights, proved to be not only a good summer evening's entertainment but an encouraging example of what the Little Theatre movement throughout the country is accomplishing. If the remaining seven plays in the Guild's program for this season are as well chosen and as excellently directed as the opener, members of the laboratory at Woods Hole may find there interesting relaxation from the rigors of biological research, or just another pleasant way of spending the evening, as the case may be.

The program on the opening night started auspiciously when the curtain rose promptly at 8:30, thereby removing the performance at once from the level of most amateur productions. The plot of the play, somewhat impossible in itself, centers about the stratagems employed by a wealthy bachelor in deterring young husbands or wives from eloping with new-found loves. The scene is laid in his home which is on the Dover road. It is to this home that the run-away couples are brought when they are about to embark on their new quest of happiness, and forcibly detained by such simple expedients as locked doors and unscalable garden walls until they have had time to see each other in a most unromantic fashion and to reconsider their proposed flight.

The action centers around the emotional difficulties of two couples who are unwilling guests of Mr. Latimer, the amusing old bachelor. Leonard, a strong-headed but not so strong-minded young husband, is eloping with Anne, a beautiful and charming young girl, while at the same time, unknown to Leonard, his impossible wife, Eustasia, is starting out to seek new romance with Nicholas. A week of Eustasia's unceasing baby-talk and perpetual solicitude proves enough to convince Nicholas that he doesn't want to go any further, and Anne loses heart in her supposedly romantic adventure with Leonard when she sees him, unshaved and uncombed, devouring a huge breakfast with animal-like gusto.

Absurd and trite enough are the situations, but the characters are well-drawn and the lines clever. And the acting, too, was carried off with admirable case and charm in all the roles, with Elizabeth Fenner, a Vassar graduate in the part of Ann, and Kingsley Perry of Harvard as Mr. Latimer giving the best individual performances in a well-directed cast.

Great credit is due the members of the University Players' Guild for the production. Every detail connected with the series of plays is being handled by the college students who are members. The staging, which was particularly good in "The Dover Road," the publicity, acting, and directing are all managed by members, and they have certainly approached professional finish in their first undertaking.

Author - Scientist
Here From Russia

(Continued from Page 1)

Dr. Sokoloff arrived in America last March and during the few months of his stay here he has met most of the important political and literary personages of the country, including Herbert Hoover, Mrs. Woodrow Wilson, Norman Davis, George Baker, editors of most of the important literary magazines, and lastly, Theodore Dreiser, the most intense, the most honest of American writers, whom Dr. Sokoloff accompanied to Woods Hole.

Besides his scientific work, Dr. Sokoloff has published about fifteen books of fiction in Czechohoslovakian, French and English. His first book of fiction to be published in America is entitled, "The Crime of Doctor Garine, and other stories," and is expected to appear in October, from Covici's.

In an interview with Dr. Sokoloff concerning the laboratory, he said: "I consider the Woods Hole Laboratory remarkable because of its organization. European scientists, I think, would profit considerably by visiting it, and by observing the extreme intensity with which American research workers carry on their experiments."

Dr. Sokoloff also expressed enthusiasm for the way in which American women scientists are able to carry on their work with the same enthusiasm and intense concentration as their masculine co-workers.

New Apparatus Exhibited

During the past week the Kny scheer Corporation has held an exhibit featuring some of their new apparatus and supplies. An electric incubator, the temperature of which can be set with a minimum difficulty, aroused much interest. This is done simply by turning a regulator knob until the indicator on the dial points to the desired temperature on the scale. It will then be maintained automatically at this temperature. Their representative, William G. Lebowitz, was in charge.
ROOMS AVAILABLE THIS WEEK IN WOODS HOLE

Louise and Elizabeth Mast

To satisfy the demand for up-to-date information concerning available rooms The Collecting Net will conduct a bureau of information. A corrected list of rooms will appear weekly in this column. Detailed information may be obtained from the editors or at The Collecting Net office.

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Fifty-Six Colleges and Universities have Adopted

A TEXTBOOK OF GENERAL ZOOLOGY

BY

WINTERTON C. CURTIS AND MARY J. GUTHRIE

University of Missouri

The Curtis-Guthrie Textbook of Zoology has already made a definite place for itself in introductory college courses. Coming out in September of last year after most teachers had made their selections this book was promptly adopted in 46 schools and colleges. With the opening of the spring term, this number has grown to fifty-six. Many teachers, who for one reason or another could not use it last fall, have indicated their intention to do so this fall.

Few college textbooks have received such superlative comments as has "Curtis-Guthrie." Here are two worth quoting: "It is indeed a pleasure to find a book written for college students, whose authors have maintained standards instead of yielding to the popular demand for simplification to 'fundamentals and a minimum of technical terms,' which generally means 'simplicitas ad nihilum.'"

"These teachers have achieved the remarkable feat of preparing an excellent college textbook and at the same time discarding many of the threadbare conventions of textbook writers; thus producing not only a teachable book, but a readable book bristling with stimulating points of vital human contact. Curtis and Guthrie’s "General Zoology" is delightfully clear and up-to-date, and is the first notable example of modern educational developments effectively applied in biology textmaking; it combines scope, perspective, unity, interest, and reliability, and is a valuable contribution to the pedagogics of zoology."—Clyde T. Reed, of the South Texas State Teachers College.

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Marine Station of the College de France, Concarneau, Finistee

DR. R. LEGENDE, Director
Translated from French by Marie L. Haruly

Brittany is, in France, the paradise of the naturalist. The three large Paris institutions for research and teaching have marine laboratories which share in the study of the coast: the National Museum at Saint-Servan, the Sorbonne at Roscoff, the College de France at Concarneau.

The marine laboratory of the College de France at Concarneau is the oldest of them all; it was founded in 1859 by Coste, professor of embryology in the College de France, member of the Institute and the first general Inspector of marine fishing, especially for the study of pisciculture and oysterculture.

As soon as opened, it attracted biologists the world over, and for a long period remained the only center of studies on the sea shore. It served as a model for the other stations of the same nature, in France as well as in other countries.

Its situation is well chosen at the entrance of a picturesque and very active fishing port, the most important in France for sardine and tuna fishing, where thirty factories prepare the canning of these fish, and where the movement of fishing boats is most extensive. It opens on a vast bay, calm, and lined with algae, where animals are abundant.

(Continued on Page 3)

M. B. L. Calendar

Saturday, July 21
Tuesday, July 24
8:00 P. M.
Research Seminar, I. Dr. I. F. Lewis, professor of biology, University of Virginia. "Floristic Succession in the Dismal Swamp of Virginia."
2. Dr. W. F. Taylor, professor of botany, University of Pennsylvania. "Algal Flora of the Western Atlantic."

Wednesday, July 25
Steamship New Bedford
Breaks Steering Gear
In A Narrow Channel

The schedule of the New Bedford, Martha's Vineyard, and Nantucket line was seriously disrupted by the breaking of the steering gear on the steamer New Bedford as she was leaving the Nantucket pier and approaching the narrow jetty entrance at 1:30 P.M. Saturday evening. She was forced to return to Nantucket for repairs.

The New Bedford with many passengers aboard docked at Nantucket nearly an hour late and pulled out an hour and a quarter later. As she rounded Brant point, Pilot Charles Leighton, who was at the wheel, noticed that something was wrong with the steering apparatus. Captain Francis J. Marshall immediately called down to Chief Engineer Schrader that the steering gear was out of order and they could not proceed.

(Continued on Page 3)
Dreiser Discourses On the Biologist

(Continued from Page 1)

gence may arrive, and so man may win at least a part of the secret of his descent and his being—

Marvellous! Beautiful! The most honorable and respectable employment of man; his greatest, most admirable distinction—that he can thus employ himself; that he has the urge and the equipment to do. Positively, when I consider the average man with his unformed definite reactive mental response to what is; his worse than petty interests, his indifference to the vast and mysterious universe in which he finds himself—and then out of all the millions, the billions even—contemplate this self-selected, knowledge-absorbed group which would like to know and is willing in this fashion to work and to sacrifice in order to know. I am visited by an elation of spirit such as does not ordinarily befall me. In truth, I am reminded of men who go forth to fight a battle, or who, courageous and yet poorly equipped, venture into a strange and difficult land in search of gold; or, I vision a group of cast-aways upon an unexplored island who have chanced upon a mighty house of many chambers, every one silent and locked—yet, since their need of aid is great, with the urge and the necessity to explore but with no implements or keys save of their own devising. Yet, the room so various, so vast, so mysterious. Their self-devised keys so inadequate: yet to be tried and altered and re-altered or abandoned and others made and tried, while many die, until at last one with more skill, patience or endurance than another may unlock at least one door, only to observe beyond it many, many doors which in due time must be unlocked if further progress is to be made. The strangeness! The wonder of it all! Indeed, you, each of you is like the figure in the Grecian fable who kneels before his Gordion Knot, but without a knife, or the permission to use one. Or again (and there the poorest of my similes), like a hunter who stalks game, a trapper who sets traps or gins, a cat that sits without a rat or mouse hole and listens and waits in the hope that from it will emerge and be seized that which to it at least is a need.

A profound and impressive spectacle to say the least; a great and most admirable and honorable labor—something that, as set over against the ordinary interests and business of my fellow-men, makes of them colorless and tawdry beings, they and their interests scarcely worthy of the thought, alone the rewards, gauds and adulatations with which as yet an unthinking world is all too ready to bestow upon them.

My compliments to the workers of the Marine Biological Laboratory of Woods Hole! A profound and reverent obsequy.

Theodore Dreiser

Service of Glass Blower Available

Mr. J. D. Graham, in charge of the Glass Blowing Service at the University of Pennsylvania, has been engaged as glass blower, and will be available at the Marine Biological Laboratory from the middle of July to the first of September. Part of this period will be devoted of the thought that, in order to be added to the stock of scientific apparatus and for the making of such equipment or for repairs as may be required by investigators working at the Laboratory. For the present a portion of the machine shop has been equipped for this work and a stock of both soft and pyrex glass is on hand.

The following work can be undertaken during this year: blown-glass forms not requiring molds, seals, stop-cocks and stop-cock grinding, drilling and cutting of tubing and plate, and the fusing of glass and quartz apparatus of the more complicated set-ups located in the Laboratory rooms.

Detailed sketches and description of the apparatus required may be left for Mr. Graham’s attention at the Apparatus Room or the Chemical Room during the summer. A charge is made to cover the cost of the work.

Mr. Graham may be available at times for both teaching the technical technique of glass blowing and for such bench work as individuals may require for their own use away from the Laboratory. For this service a charge will be made for the actual material and labor, and arrangements should be made directly with Mr. Graham.

Exhibit of Optical Instruments Closes

The final presentation of the Bausch and Lomb Optical Company’s apparatus was made on Wednesday afternoon. For ten days the apparatus has been on display in the Old Lecture Hall. Microscopes and their accessory parts, microtomes, projection apparatus, photomicrographic cameras, field glasses and other such research equipment was used in the demonstration.

TEMPERATURE REGULATION

Summary

Dr. H. C. Bazett
Professor of Physiology, University of Pennsylvania

Temperature changes of a considerable size are not limited to cold blooded animals but are also the rule in the peripheral areas of warm-blooded animals such as man. This has been clearly recognized in the past by the leading investigators such as Liebermeister and Claude Bernard, but has not received much attention recently.

The work of Stadie, Austin and Cullen and their co-workers has emphasized the profound effects on the chemical equilibria of blood when the temperature is changed, and the complexities due to variation in the degree of dissociation of water itself. Their data have demonstrated that, when mammalian blood is cooled in vitro without loss or gain of CO₂, the hydrogen and hydroxyl ion concentrations are both reduced, but the former very much more than the latter. The blood therefore is rendered more alkaline, and they have noticed this change is mainly dependent on variations in the dissociation constants of the acid groups of blood proteins with temperature. The change in these constants with temperature is greater than that in that of carbonic acid, so that, on cooling the blood, proteins bind less base, setting some base free to combine with carbonic acid.

There is usually assumed (on data reported by Joffe and Poultair) to be no interchange between blood corpuscles and plasma with change of temperature, and in consequence in almost all blood studies centripetal dissociation has been performed at room temperature. The data presented by Austin and Cullen (1925) and by Stadie, Austin and Robinson (1925) on human blood show different changes in pH for constant CO₂ content in separated serum and whole blood. Such a difference is incompatible with the above assumption, and further work is necessary to clear up the discrepancy.

Data were presented on the effect of local temperature changes produced on the blood within the hand veins by immersion of one forearm in hot or cold water, and on the tensions of gases in the tissues. The blood in vivo becomes more alkaline on cooling, and the CO₂ tension calculated from the blood data agree with those observed in the tissues if the pH measurements on separated plasma are regarded as representing whole blood. These changes are less than the changes in the isoelectric point of the proteins reported by Stadie, Austin and their co-workers, so that base should be bound by protein at the lower temperatures. This contrasts with the changes observed by Austin in alligators, where the pH of the blood varied considerably with temperature, but always in such a manner that the base bound by protein showed little change.

The effects of the combined pH and temperature changes on the dissociation of hemoglobin greatly alter the oxygen tension even when the oxygen saturation undergoes little change. Calculation from the blood data again agree well with observed oxygen tensions.

These chemical changes are great; the hydrogen ion concentration may vary with temperature under normal conditions five times as much as it differs in arterial and venous blood at the same temperature, and the CO₂ tension also varies greatly. It seems likely that the changes in acidity or CO₂ tension may be responsible for some of the vaso-motor changes to temperature, which may be initiated reflexly but be maintained by chemical means. Certainly after nerve degeneration they can even be initiated chemically. Some data on the parallelism of acidity and hyperemia in reaction to stasis at different temperatures support this hypothesis. The variations in oxygen tension may prove important in causing modifications in muscle metabolism, either during work or in tetany. Preliminary experiments, however, do not lend support to the theory that tetany is due to low oxygen tension within the muscle.

Review

Dr. N. B. Dreiser
Lecturer in Pharmacology, McGill University

The present task was undertaken at the request of THE COLLECTING NET some ten days after the lecture was delivered, as those who had originally consented to undertake to write a review found that stress of work did not enable them to do so. The author’s summary appearing in this number contains most of the items stressed by the lecturer. In his introductory remarks Professor Bazett pointed out that the general physiologists are devoting much time to the study of tempera-
Steamship New Bedford
Breaks Steering Gear
(Continued from Page 1)

were experiencing difficulty in keeping
the boat in her course. Under
slow speed the boat proceeded but
soon the wheel jammed solid and
Pilot Leighton was no longer able
to steer. The two long lines of
jetties with an opening of some 200
feet were dead ahead. Fate permit-
ted a safe passage and the trouble
located between the
steering engine and the pilot house.
A strong wind was blowing
from the southwest and the sound
was rugged, so the boat was turned
toward Nantucket wharf. The
steamers were kept in her course by
orders sent through the speaking
tube to the engine room as to the
direction in which the rudder should
be turned.
The New Bedford was scheduled
to leave New Bedford for New
York Sunday night to transport
1,000 troops down to Fishers Island.
The troops were sent by train due
to the accident.
The steamers Nantucket and
Marlins Vineyard were pressed in
to service during the night and the
following day to care for the pas-
senders and to keep the regular
schedule.

Marine Station of the
College de France
(Continued from Page 1)

protected from the open sea by an
archipelago, les Cléanans, where
the laboratory has an annexe, l’ile Cigogne, for other workers.

Concarneau is known the world
over for its port. The old city, built
on an island walled by ramparts of
the 14th century is surrounded by
the port full of boats of all colors,
and its beauty brings artists from all
countries.

The laboratory is built on a rock
on the sea shore, between the jetty
and the fish market, on a square near
an old chapel of the 15th century.

The ground floor is an aquarium
and there are pools, 300 meters
square, in the surface, communicating
with the sea. On the first floor
there is a large dissecting room and
smaller rooms for zoological studies.

On the second floor, just built, is a
large physiology room, a room for
chemical studies, a scale room, and
a dark room for experiments in
physics. All the rooms have fresh
water, sea water, gas and electricity.

An important library contains
a number of old and rare works, and
the algae herbarium of the Crouan
brothers.

Today, the laboratory is directed
by a group of Natural Science pro-
fessors of the College de France.
The personnel consists of an inter-
esting director, (author of this article)
an assistant and two sailors. For
dredging and collecting we have a
sail and motor boat, the “Nereis”
and several small skiffs.

It is difficult to mention here all
the scientific discoveries that have
been made in this institution. We
mention only names of some who
have died, let us recall Gerbe who
came here to study the birds, Van
Beneden and Puchet the Cetaceans,
Kainvier the torpedo ray, Marx
the swimming of fish, Barrois the
echinoderms, Puchet plankton, Giard all the fauna and particularly
the Balanoglossus, Robin and his
pupils the multiple questions of
Comparative Anatomy, Laguessa
the pancreas of fish, etc. Chabry,
real forerunner, invented micro-
infusions and discovered the action
of salts, questions that are being
studied now. Most of the natural-
ists and their generation have come
here also. Robin has done research
here. Fage and I practiced fishing
with lights which showed so many
crises of epitoquique and lunar rythms,
and I wrote here “The concentra-
tion of hydrogen ions in sea water.”

About fifteen workers come every
year to the Laboratory of Concar-
nneau to do research.

Since it was founded, technical
problems have been studied which
would enable the development of
marine resources to help out in the
numerous crises which occur in the
world of fishermen.

Coste had founded the laboratory
to study pisciculture and oystercul-
ture. If marine pisciculture today
applies only to a few species such
as mullet and turbot, if the raising
of the lobster is only beginning, on
the other hand oysterculture has be-
come in all countries an important
source of wealth. Its methods have
entirely come out of Coste’s works
and have not changed since. When
in 1907 accidents of typhoid pre-
vented the sale of the same oysters,
it was again in the Laboratory of
Concarneau that Mr. Fabre-Domer-
gue found the solution which could
prevent the epidemic—in stabling
in the carrying out of which I am
glad to have collaborated.

Most of the studies on the sar-
dine and its fishing have been made
in the same laboratory, whether it is
a question of new weapons in the
struggle against predatory enemies,
or of research on temperatures or
other physical conditions of fishing
on the food, on the growth, seasonal
variations, or migration of this fish.

The first experiment of marine
pisciculture, after Coste, was made
by Fabre-Domergue and Biértix
who obtained the complete devel-
opment of the sole and determined
the conditions for raising young fish.

In the last few years research has
been made on the oils of fish, the
canning of crustacea, artificial
sea water, alteration of light
metals, etc.

Among the directors who have
succeeded each other since 1859,
two deserve particular mention:
Robin and Puchet; they were the
friends and guides of a whole li-
terary generation: Flaubert, Mi-
chelet, About, les Goncourt, Taine,
Mérimeé, Céard, etc. Puchet
brought Flaubert to Concarneau
where he wrote “La légende de St.
Julien l’Hospitalier.” It is one
feather the more for our laboratory.

Beyond the Horizon
If Eugene O'Neill were less of an
artist; or if the University Players
were less skillful actors, this week’s
performance of Beyond the Hori-
zon, would have proved a sordid af-
fair. As it is, one comes away im-
pressed with the excellent manner
in which the difficult, intensely emo-
tional roles were acted, but wishing
the Guild had offered a somewhat
lighter and less pessimistic play for
a summer evening’s entertainment.

Next week’s performance of George
Kelly’s farcical comedy, The Truth
bearers, will be a welcome contrast.

Beyond the Horizon; the Pulitzer
Prize play of 1920, is a tragedy of
misfit characters, of mistimed love,
and drudgery. But throughout you
have the feeling that the tragedy
is not entirely necessary and has
been superimposed on the charac-
ners by events somewhat within their
control. It is not the finer tragedy
of Hardy or of Conrad, where the
characters are caught in a tangled
web of circumstances with which
they cannot cope and which drives
them surely and unrelentingly to
their own destruction. Here the
tragedy lies in the inability of the
characters to rise above the sordid
circumstances resulting from a mar-
rage based on fancied love without
true understanding.

Even had Rob not given up his
sea-voyage to marry Ruth, he would
probably have been the same man.
His temperament, a deplorable misfit on
the farm, would probably have led
him about for years in the quest of
happiness which he was not likely
to find. But for Ruth the marriage
was a real disaster, for she realized
three months later that she despised
Rob, and had then nothing but a life
of the hardest drudgery—possibly
that of a woman on a poorly-man-
aged, badly-paying farm, with no
one to sympathize or even to under-
stand the bleakness of her life.

(Continued on Page 12)
RESEARCH SEMINAR

At the Tuesday evening (July 10) Research Seminar three papers were presented in the field of genetics. The two by Drs. D. E. Lancefield and Whiting, with their accompanying reviews, are printed below. The summary of Dr. Bridges' paper entitled "The Chromosomal Complex of Drosophila Melanogaster" will be printed next week together with a review by Dr. Metz.

"Crosses of two races of Drosophila obscura of nearly the rank of physiological species."

D. E. LANCEFIELD
Associate Professor of Zoology,
Columbia University

A second race of Drosophila obscura Fallén has been found, which can be distinguished from the first morphologically only by the difference between the Y-chromosomes, and behaves quite differently in crosses to it. The genetic results are such that the two races may be regarded as "physiological species" if one prefers. The previous genetic work has been done with stocks which are here designated as race A, and the new stocks of different type may be called race B. Crosses between the two races are made with more difficulty than are the intraracial matings. The nature of this difficulty depends on failure of mating, and is attributable to the females. The F₁ males are sterile, but differ in the two reciprocal crosses as regards the size of the testes. The males are very much reduced in size in the F₁ individuals of one cross, but are not reduced in the reciprocal cross, although the males are sterile from either cross. The F₁ hybrid females from either reciprocal cross will occasionally produce offspring if crossed to males of either race. There is about the same amount of difficulty in obtaining offspring here as in the original crosses, namely, about half the males have reduced testes in the F₁ individuals of both reciprocal crosses. The nature of the offspring produced by backcrossing the hybrid females differs according to the nature of the cross. The most striking features in the results may be mentioned briefly. They concern deviations from equality in the sex ratio; occurrence of various sizes of testes, ranging from very tiny to normal sized ones; and marked reduction in amount of crossing over in certain regions of the X-chromosomes.

The nature of the sex ratio obtained depends on the direction of the cross. If the F₁ female is backcrossed to a race B male, about twice as many females as males are obtained. If a race A male is used, the males may exceed the females but the result is more variable. These ratios are not brought about through the presence of an ordinary sex-linked lethal. In either backcross of the F₁ females, about half the males have small testes and the other males generally have testes of normal size. This seems to depend on which X-chromosome was obtained, and can be determined by means of sex-linked characters. Whether males receiving the race A or race B X-chromosome have small testes depends on which race their father belonged to. Thus, if the hybrid female is backcrossed to a male of race A, the sons receiving the race A X-chromosome will have normal testes, and those receiving the race B X-chromosome will have small testes. The reciprocal backcross would reverse the conditions in the sons.

The chief alteration consists in a great reduction in crossing over in long regions at both ends of the X-chromosomes in the hybrid female, as compared with values in either pure race, while a long middle region is little changed. This low value of crossing over continues indefinitely in females backcrossed to males of either race provided that the regions in question have come from different races. In the case of one autosome tested, no significant change in amount of crossing over was found. The reduction in crossing over between the two different X-chromosomes may be due to two inverted sections in the X-chromosome of one race as compared with the other.

The conditions found in the two races of Drosophila obscura somewhat resemble the results reported by Sturtevant (1920-1921) in the interspecific crosses between D. melanogaster and D. simulans. The F₁ hybrids obtained in this cross are completely sterile, but one generation is enough to enable testing of allelomorphism of mutants in the two species. The possibility of obtaining offspring from the hybrid D. obscura females gives this cross a certain interest. It would seem that the two races in D. obscura represent (Continued on Page 5)
The Genetic's Seminar
(Continued from Page 4)
a case where evolution has not progressed as far as in the case of D. melanogaster and D. simulans. The two races of D. obscura occur in the same localities in Oregon and Washington. It seems probable that the two races do not naturally interbreed to any appreciable extent, if at all, and thus the association of the two races would not necessarily prevent their further differentiation and divergence.

REVIEW
Reviewed by Dr. P. W. Whiting
Assoc. Prof. of Zoology University of Pittsburgh

Dr. D. E. Lancefield spoke Tuesday evening on "Crosses of two races of Drosophila obscura of nearly the rank of physiological species." The "Origin of Species" is a problem which has long perplexed theologians, philosophers, and scientists. There seems to be something distinctive in the nature of specific differences which does not apply to varietal differences. Since, however, taxonomists frequently err in defining specific limits, it appears that species as described are not as real as many suppose. Hybridizing experiments have shown that numerous so-called species are in no way different from varieties distinguished by one or more mendelizing factors. Thus Miriam Palmer's work on beetles of the genus Adalia which have been defined as separate species, shows them to be but mendelizing color forms; and Gerald's work with the clover butterfly, Colias, shows that at least two so-called species are likewise mendelizing varieties. On the other hand, Goldschmidt's genetic investigations with the gypsy-moth, Lymnaea dispar, demonstrate many local races, differing genetically to such an extent that hybridizing results in the production of irregularities characteristic of species crosses.

The problem of the origin of species cannot be understood until we know the real nature of specific differences. That these are not merely an accumulation of mendelizing mutations appears if we compare the great diversity of form and color which have arisen in Drosophila melanogaster with the resemblance of Drosophila melanogaster and simulans. Mendelizing differences sometimes play a role as specific characteristics, but it is questionable whether they have much to do with specific isolation. They are perhaps caught by chance in one group or another, becoming thus distinguishing marks of closely related species. They may also appear subsequently by mutation, producing phenomena of convergence and "mimicry." Analysis of the genetic relationships existing between incipient or closely-related species thus becomes of the highest importance.

Dr. Lancefield is dealing with forms which are becoming genetically isolated rather than with a mere varietal mendelization. The case is especially interesting inasmuch as the races look alike though differing in behavior, Race A being taken frequently from fruit while B occurs in the woods. A chromosomal difference exists between the two races, A having a rod-like Y chromosome while in B the Y is as long as the X. Reciprocal crosses may be made, but with some difficulty due to failure of successful matings. The F1 males are fertile, but the females which are slightly sterile may be crossed to males of either race. Sex ratios in back crosses are aberrant, but this is apparently not due to sex-linked lethals.

Three homologous mutants have appeared in the two races, and crossover percentages have been found much reduced at either end of the X-chromosome, while remaining approximately normal in the middle. It is possible that these phenomena are due to chromosome inversion. Some of the hybrid males have tests of unusually small size but in back-crosses males appear with normal-sized testes. Testes of small size appear when X and Y are from different races.

It is gratifying to see analysis of these irregularities of hybridity being attempted by one who is familiar with all the intricacies of mendelian phenomena. Dr. Lancefield's paper was a clear exposition of the problem and methods employed and results obtained in the elucidation of a difficult subject. The analysis has progressed far enough so that much is quite clear, though much still remains to be done. Results will be shortly in press. The presentation of this new material carried out well the ideas of Dr. Jacobs, who initiated these meetings for the presentation and discussion of shorter scientific papers still to be published.

Production of Mutations by X-rays in Haplobracon.

Dr. P. W. Whiting
Associate Professor of Zoology
Univ. of Pittsburgh

Genetic work on the parasitic wasp, Haplobracon, has been curiously handicapped by the scarcity of mutations. At the suggestion of Dr. H. J. Muller who has obtained by means of X-rays numerous mutations in Drosophila, wasps were treated similarly in the hope of obtaining new types. At first the same dosages as used by Muller were applied, but these proved to be too weak to induce either sterility or mutations. Subsequent work with dosages four or five times greater induced sterility, as well as mutations, both lethal and visible.

Intense treatment of actively laying females fails to kill the mature eggs. Four or five offspring appear in the first bottles, after which the mothers become sterile but continue to live a normal length of time. Treatment of less intensity causes variable degrees of sterility in the females. If females are mated previously to treatment, the spermatogenesis are destroyed much more readily than the eggs, resulting in male offspring such as appear parthenogenetically from untreated virgin females. Males are completely sterilized with dosages approximately four-fifths as great as those required to sterile females. Reduced fertility of treated males is evidenced by the small number of daughters which they produce when mated to untreated virgin females. Virgin females or males crossed

(Continued on Page 6)
Our Scholarship Fund

The Collecting Net Scholarship Fund was inaugurated to provide financial assistance to deserving workers at the Marine Biological Laboratory. The recipient of the scholarship, however, does not only receive the monetary reward, but a notable honor as well. In the case of the three research scholarships the Advisory Board, consisting of Drs. Chambers, Conklin and Woodruff consulted with perhaps twenty of the older investigators concerning those worthy of the award. The Board made its final selection after these recommendations had been thoroughly digested. The recipients for the two student scholarships were chosen by a committee consisting of the head of each of the five classes.

Last summer The Collecting Net, an edition of $500.00 for its Scholarship Fund. This amount was composed of the following parts:

Sum realized by motion picture and lecture on whaling ................. $319.00
Contribution by James Harvey Robinson ... 100.00
Dr. E. C. Cole .................. 10.00
M. A. N. Meyer ............... 10.00
Nickerson Hardware Store ... 5.00
$444.00

The Collecting Net ........ 56.00

This amount was sub-divided into five parts and the sum of $100.00 was awarded to five different workers at the Marine Biological Laboratory. The scholarships are awarded only to those who have previously worked at the laboratory enabling them again to carry on their biological work at Woods Hole during the following summer. The five individuals holding the scholarships for the present summer will be announced next week.

We ask everyone at the laboratory to assist us in accumulating an even greater sum than was realized this first time for apportionment next summer. Three one-act plays will be presented for the benefit of The Collecting Net Scholarship Fund on August 22; and the possibility of holding a dance for the same purpose in the Town Hall is under consideration.

A ROOM SERVICE

(Continued from Page 5)

to sterile males produce male broods. A few scattered females among numerous brothers indicate near sterility of the treated male parent.

Little constancy of sex-ratio obtained in "normal" bisexual fraternities, but mated daughters of treated wasps in some cases give only a few males among numerous females. This abnormally low male ratio, persisting, in some fraternities, to later generations, is taken to involve structure, Dr. Whiting believes that he has done the latter, since four mutations have arisen in a half million individ-uals not treated. Because he sought only to obtain new mutations for genetic studies, he was disappointed by the rigid controls which would have been necessary to prove the effect of x-rays.

REVIEW

Dr. A. FRANKLIN SHULL

Professor of Zoology, University of Michigan

Whenever the problem of evolution is attacked in a new way, or some old method is suddenly successful, a narrative of the results is assured an interested audience. The spectacular acceleration of mutation in Drosophila by Professor Whiting has led to renewed efforts by other biologists to effect similar changes in other organisms, and Drosophila has set a standard of performance in this respect, as in its natural mutation, which other animals will probably seldom equal. The wasp Habrobracon has hitherto shown disappointing results by comparison, though Dr. P. W. Whiting is convinced that it has responded to treatment. No effect was produced on this wasp by X-rays of the dosage used by Muller. Increased voltage and exposure unfortunately caused much sterility, especially in the male, but in the surviving offspring of treated wasps four mutants appeared. They were "small head," "short" and "miniature" wings (these two occurring apparently in one germ cell), and "white" eye, which is indistinguishable from "ivory" but has a different locus in the germinal material. These mutations are found associated with certain already known characters, independent of others.

Along with these mutations involving structure, Dr. Whiting believes that lethals were also produced. The evidence for them was the paucity of males in certain progenies. The effect of the supposed lethal in the egg was held to be neutralized by the normal sperm, so that females could be produced, while unfertilized eggs, from which males would develop, were inviable. A certain expectation that lethals would occur was created by the lethals arising in Muller's experiments. It must be said, however, that something less than proof of lethals in Habrobracon has been adduced. The scarcity of males may have been due to simple injury. Satisfactory evidence of lethals, derived from definite effects in later generations, and particularly from their unequal effect on characters linked with them, has not been supplied.

It is a little unfortunate that Dr. Whiting's paper discussed what is a subordinate feature of his work under a caption which suggested that it was his principal interest. He sought merely to increase the number of loci by which he could study the germinal architecture. His title indicated that he had set out to effect artificial evolution. Dr. Whiting believes that he has done the latter, since four mutations have arisen in a few hundred treated individuals, as compared with seven previous mutations in a half million individuals not treated. Because he sought only to obtain new mutations for genetic studies, he was disappointed by the rigid controls which would have been necessary to prove the effect of x-rays.
Methods for Experimental Embryology
With Special Reference to Marine Invertebrates
E. E. Just
Professor of Zoology, Howard University

METHODS FOR HANDLING EGGS AND SPERM.
(Continued)

Asterias eggs shed readily in the laboratory. In June 1927, for example, I had a great deal of difficulty because of this fact. The first normally shedding male and female I ever used were kindly turned over to me in 1910 by Dr. John W. Scott. Since then I have recorded many observations on animals shedding in the laboratory. Every one of these was during full moon, never during new moon. The average worker would hardly dare to await the chance of procuring normally shed eggs. This is indeed not necessary, since he can obtain eggs of optimum viability by removing the ovaries to sea-water.

In the interest of economy it is well to make a slight puncture in an arm close to the disc, and pipette off a few drops of cells from the ovary or the testis as the case may be. The animal is not seriously injured thereby and its sex may thus be ascertained. The animals are best opened as follows:

1. Snip off a small bit from the blunt end of the testis and place this in 200 cc. of sea-water. The sperm, contrary to the somewhat current notion, are highly active, though not as much so in concentrated suspensions as those of Arbacia.

2. If the animal opened proves to be a male, cut through one arm only. Snip off a small bit from the blunt end of the testis and place this in 200 cc. of sea-water. The sperm, contrary to the somewhat current notion, are highly active, though not as much so in concentrated suspensions as those of Arbacia.

I venture the opinion that workers experience difficulty in handling eggs of Asterias, even when they have animals in perfect condition. There are three main reasons. First, they crowd the eggs in a small volume of sea-water. Eggs placed directly from the ovaries in a very little sea-water often fail to maturate; this failure is an effect of CO₂. Butyric acid (R. S. Lillie, '15) and insemination also inhibit maturation. On the other hand, maturing eggs are highly susceptible to CO₂. Butyric acid, and elevation of temperature because all these agents initiate development. Shaking maturing eggs, as Mathews ('06) has shown, causes them to break down.

3. If the animal opened proves to be a male, cut through one arm only. Snip off a small bit from the blunt end of the testis and place this in 200 cc. of sea-water. The sperm, contrary to the somewhat current notion, are highly active, though not as much so in concentrated suspensions as those of Arbacia.

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In this last case my own observations indicate that CO₂ here plays a part. Secondly, workers too frequently contaminate the eggs with perivisceral fluid or tissue extracts because, they do not use sufficient care in opening the animals and removing the gonads. Asterias eggs are the most sensitive that I know. The worker will obtain infinitely more constant results if he treats this egg with respect. In addition, he would save time and the needless destruction of animals. Thirdly, the practice of chopping up the ovaries for obtaining eggs is fatal for a high per cent. of normal development. By this method many young ovocytes are released whose germinal vesicles are not stimulated to break down. In the last case of Arsichthys heteroclitus, some eggs are brought into sea-water. Actually one may often count more eggs with intact germinal vesicles than those whose germinal vesicles are breaking down.

The worker can prove to his own satisfaction that the method for handling Asterias eggs which I have outlined above is a good one. First, let him take shed eggs and inseminate them. Next, inseminate eggs from the ovaries of the shedding female as outlined above. Finally, let him now cut up the ovaries and inseminate the eggs. He will find that while the eggs of the first and second lots are about the same, as they reveal by their high per cent. and normality of development through the bipinnatul stage, the eggs from the cut-up ovaries are distinctly inferior in both respects.

Fundulus

Three species of Fundulus are used at Woods Hole—heteroclitus, majalis, and diaphanus. Newman (07 an '09) has described their nor-
Methods for Experimental Embryology

(Continued from Page 7)

nal processes of copulation and egg laying. If pairs of Fundulus, F. heteroclitus particularly, be isolated his observations may be readily confirmed. In order to observe copulation and egg laying by F. majorus in captivity, one should place three or four males with one female (Newman '09). I have made these observations on both these species but not on F. dia-phanus. These normally-laid eggs are the best to use. Eggs and sperms can also be obtained by stripping the animals. The stripping should be gently performed by applying pressure on the abdomen toward the anus. The eggs are best fertilized dry, i.e., the eggs and sperms are first mixed and then sea-water is added; this is generally true for teleostan eggs. Personally, I prefer to use normally-laid eggs.

Eggs of Fundulus are extremely hardy and the fish are easily reared in the laboratory. They are therefore excellent for many problems in experimental embryology. However, they do present to the observer one serious obstacle, namely, the chorionic membrane. This fortunately, at least in the later stages of development, can be removed.

Armstrong ('28) was the first to use the egg of Fundulus with its chorion removed. Practically, the viability of its development is not thereby impaired. And, as Armstrong's work shows, removal of the membrane is a most useful procedure for experimental work. I give his method in detail.

Armstrong removes the chorionic membrane at the stage of closure of the blastopore under a binocular dissecting microscope with dissecting needles and iridectomy scissors. "In removing the membrane, special precaution must be taken to avoid injury to the embryo. The following procedure gave uniformly good results: the point of a sharp dissecting needle was pushed into the membrane and the egg rotated so that the tip of the needle within the membrane could be held against the bottom of the dish at an acute angle. A second needle was then drawn across the under side of the first needle so as to make a slit in the membrane large enough for the introduction of the point of the lower blade of the iridectomy scissors. By this means the membrane was readily removed, without exerting any pressure on the embryo. The naked embryos were kept over night in sea-water; during this time a few embryos, which had been injured in the removal of the membrane, died. The mortality was usually 4 to 5 per cent."

ECHINARACHNIUS

The egg of Echinarchinus is one of the most beautiful in the Woods Hole region. It is larger than that of Arbacia and possesses very little pigment. En masse, the eggs are of a red hue because of the pigmented jelly hulls that enclose them; with this jelly removed they are a pale yellow—lighter than an equal mass of Asterias eggs. Their color is due to chromatophores which the worker may have some difficulty detecting. They can, however, be found with ease in the later stages of development. When he starts another lot of eggs the chromatophores can be identified in a little earlier stage. Finally, he can pick out the chromatophores in the unincubated egg. I mention this because in a later article I shall discuss some interesting problems for the experimental embryologist on the behavior of chromatophores in echinid ova. As a matter of fact, every cytoplasmic constituent plays an important rôle in development and deserves careful study.

In Lillie's beautiful work on Chaetopterus, the first clearly to show the effects of centrifugal force on development, (subsequently confirmed by Morgan and by Conklin who used other forms), and a classic like each of his other careful studies, Lillie ('05) says: "I shall make no apology for entering into details because there is no other explanation of heredity other than a complete account of development, and one cannot describe even a small part of such complex a thing without many words, unless one knows in advance what is essential and what is not." This is sound—unless indeed, the beginning investigator does know what is essential. I have traced the history of every visible cytoplasmic constituent during the development of both the normal and centrifuged ova of several species. In Nereis, for example, I have worked out in both the living and the sectioned egg what one might call the cell lineage of the mitochondria, the pigment, the oil and the yolk. Note also my paper ('27) on the history of the oil drops, in Arbacia eggs, erroneously described by E. B. Wilson as Golgi bodies. For some time I have been

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studying the mechanism of the water intake and output of cells (Just, '26); here certain cytoplasmic constituents play a definite role. Finally, there is Heilbrunn's very fine work on the membrane precipitation reaction in the egg of Arbacia (Heilbrunn, '27) which reveals one rôle of the pigment granules. Because the early work on egg cells was concerned largely with nuclear phenomena the cytoplasmic constituents have been too greatly neglected. One need not be a "mitochondriac" to appreciate their significance for vital phenomena.

Echinarchnus does not stand up well under adverse treatment. One should therefore be sure that one has animals in prime condition. Fortunately, this is readily ascertained.

Crozier ('16 et cæt.) particularly has studied indicators occurring in animal tissues. Echinarchnus likewise possesses a natural indicator. The normal intact animal is brownish red and discharges no color into the sea-water. If the animal be injured, the point of injury is changed to green, and the sea-water above it is turned green. One may prove this by scraping a part of the test of an animal in perfect condition. Very quickly as the alkaline sea-water penetrates, the injured spot turns green. If one pours onto an intact animal of normal color N/10 NaOH, it turns green, but if one uses N/10 NH₄OH instead, the animal takes on a purple hue. Only animals of the normal color should be used. I find that the red pigment in the egg is also a natural indicator.

The animals are best kept on the clean concrete sea-water table. I am using now such animals which I got about four weeks ago. Though I have used Echinarchnus throughout August, I prefer to work on them earlier because then they come to the laboratory in better condition. This is largely due to temperature; the animals are not at their best when crowded in the tubs after having been dredged from deep water during the warmer days. This is shown by the rapidity with which the sea-water in the tubs is charged with the green color. At all times freshly collected animals, properly cared for after collection, are best.

In passing I may note that I also use Echinarchnus to feed Arbacia, thus restoring the sea-urchins previously in poor condition to a high degree of excellence.

I have frequently obtained Echinarchnus eggs normally shed. As in the case of Arbacia the shedding may be induced by injury—cutting around the lantern or around the margin of the animal. For obtaining eggs of optimum fertilization capacity from the ovaries, these directions should be followed. Cut around the margin of the animal, remove and discard the oral portion. Place the aboral portion (with the outside down) in a clean, dry, Syracuse watch glass. If the animal is ripe, sperm (or eggs) will ooze from the gonads. Allow an opened male to remain until you are ready for inseminations. In the case of the female, very carefully pipette off the eggs to 200 c.c. of clean sea-water. The sea-water in which the eggs are suspended should be clear and not opalescent or milky through the presence of perivisceral fluid. Allow the eggs to settle. Pour off the supernatant sea-water and very carefully add sea-water up to the original volume employed. Now strain the egg suspension through clean washed cheese cloth wetted with sea-water. The eggs are now ready for use. If the time consumed in opening the animals and preparing the eggs amounts to more than one hour, open some more animals until you get a good male, discarding the others, in order to have perfectly fresh sperm. Inseminate the eggs as you would those of Arbacia.

Nereis

Unlike the forms that I have so far considered in this section, Nereis is sexually dimorphic. The males are bright red anteriorly with white posterior segments, the females pale yellow or light green.

The animals are caught after sunset on certain nights, with a few exceptions, during the "dark of the moon" in the months of June, July, August and September. The most favorable locality for collecting is the float stage in the Eel Pond back of the Supply Building. The worms appear swimming near the surface of the water about an hour after sunset. Attracted by the light of a lantern (or nowadays by an electric light because the float stage has been wired, and two electric plugs are to be found in a box attached to the boathouse) they are readily caught with a hand net. In general the swarming begins with the appearance of a few males swimming rapidly in curved paths in and out of the circle of light cast by the lamp. The much larger females then begin

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Methods for Experimental Embryology

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to appear, usually in smaller numbers swimming laboriously, frequently not coming to the surface of the water. Both sexes rapidly increase in numbers in the next fifteen minutes, and in the case of a large swarm hundreds of males may be in sight at one time. The females are less numerous, though on one night I caught enough females to fill a liter jar. A night's swarm lasts for an hour or an hour and a half. Each night from full moon to new moon with certain exceptions this scene may be re-enacted. And each night the females swarming are a new crop.

During the light of the moon, except for the first (June) run, when some animals may in certain seasons appear each night until the next swarming period (July, full moon), no Nereis worm. And in late September if the nights be cold, they do not swarm throughout the dark of the moon. With these exceptions the swarming of Nereis corresponds to the four lunar cycles during June, July, August and September. Each run begins near the time of full moon, increases to a maximum during succeeding nights, sinks to a low point about the time of the third quarter of the moon, then rises again to fall to extinction at or shortly after new moon. Thus, the curve of nightly numbers during a run is bimodal.

When a female appears, the males at once surround her, swimming rapidly in ever more narrowing circles. In a short time, they shed sperm so that the water is milky. The female sheds her eggs, shrinking in bulk, in so doing becomes a mere shred of tissue, sinks slowly from view, and dies. For further details on the sperm-shedding and egg-shedding reflexes, the reader should consult Lillie and Just, Biol. Bull., 24, 1913, where Lillie's observations are recorded.

The earlier work at the Marine Biological Laboratory on eggs of Nereis was done at night. The animals shedding when collected were placed in the same vessel, and therefore the eggs were fertilized then or soon after. For the early stages, one was obliged to begin one's observations at once.

Fortunately, Lillie discovered that the worms may be kept over-night without detriment. The animals should be collected singly, each female preferably placed in a separate finger bowl, three or four males in one finger bowl. If the animals are to be kept over-night for work the next morning, they should be placed in fresh sea-water, one female to a finger bowl; three or four males may be kept together. The sexes should never be mixed. The finger bowls are covered and placed on the sea-water table with water flowing around them. The practice of keeping the animals in a refrigerator cannot be too severely condemned (Just, '22).

The great beauty of the Nereis for experimental work is that every swarming individual is always sexually mature, and contains no immature sexual cells.

Directions for obtaining eggs and sperm are simple. To obtain eggs wash an isolated female by placing her in clean fresh sea-water, and snip her with sharp scissors. The eggs will pour forth quickly. Remove the cut animal, wash the eggs by pouring off the sea-water in which you placed the worm and add an equivalent volume of sea-water. I use 250 c. c. of sea-water. Now wash a male by placing him in 250 c.c. of fresh sea-water. Remove and dry it lightly and quickly on soft filter paper. Place in a clean dry Syracuse watch glass and make a small cut about half way between head and tail, along the lateral border to avoid cutting the dorsal blood vessel. This gives you clean "dry" sperm almost free from blood. For an insemination add one drop of dry sperm to 10 c. c. of sea-water. Of this sperm suspension, use two drops to the eggs of one female.

Because of its almost clock-like precision of development, one could scarcely wish for finer material than the egg of Nereis for experimental work. If one does not get a hundred per cent. fertilization and an almost perfectly uniform rate of cleavage, one's technique is at fault. The worker who believes in wide variability in the development of eggs from one female should study the eggs of Nereis properly collected and handled. Permit me to say again that generalizations on the variability among eggs from a female of a given species fail if one uses animals in optimum condition and handles properly their eggs and sperm. Nereis when caught are always in optimum condition. The worker's results therefore depend solely on the methods he employs after collecting the worms. I make it a rule never to use Nereis that have been in the laboratory more than three or four hours.

Dr. A. M. Keefe is President of the organization; Dr. Charles Packard, Secretary-Treasurer and Mrs. Eva S. Evans is librarian.

There is a possibility that the Imperial Russian Quartet will add two or three numbers to the Annual Program which will be given by the Choral Club during the first part of August.
Our Classes

The classes whose activities we described in some detail last week are still under careful observation, and we append the following addenda to our former report.

The botanists at the time of this account are collecting dimes for the purchase of bananas, oranges and other favorite fruits for consumption on the Cuttyhunk trip. By the time this report is published the trip as well as the bananas will be a thing of the past. Dr. Poole has been lecturing on the green Algae and Dr. Taylor will continue next week with lectures on the reds. Dr. Poole will long be remembered by this season's botanists as the instigator of the quiz system this year.

On the morning of the first quiz it was reported that one of the botanical inmates was spotted some time before six in the morning on the beach accompanied by a note book and wearing a strained expression.

Dr. Duggar and Dr. Lewis have at last arrived and it is a famous sight to see the grand-stand windows in the Botany Building once more filled with an admiring and enthusiastic tennis audience.

Dr. MacDougall reports that all is going well with the protozoologists, and that aspirants for the first "hundred" are doing some tall bug-hunting. It is interesting to note that this year an unusually large proportion of the class is taking the course for credit—with the result that the competition waxes some-what violent and the midnight oil reserve at the Supply Department is running low. Dr. Calkins has been lecturing on the kinetic and granular elements of protoplasm in the Protozoa and will continue next week with a discussion of Protozoan functional activities. Mrs. Calkins will be at home to the protozoology students and investigators for the three remaining Sunday afternoons of the course.

The invertebrates, according to Dr. Dawson, "are working hard and doing nicely, thank you!" The lecturer this week has been Dr. Martin on Annelids. Next week, on Monday, Dr. Bissonnette will give a lecture on Bryozoa. For the rest of the week Dr. Cole will lecture on marine arthropods. The invertebrates, who might be described as invertebrate trippers, have in this last week collected at Kettle Cove and have been dredging Davy Jones' locker at the bottom of Vineyard Sound. At the time when this goes to press this dredging trip is a thing of the future—and according to Dr. Dawson it promises great interest.

On July 25 the laboratory work in the afternoon will be devoted to the study of tow plankton. On July 28 there will be an all-day collecting excursion to North Falmouth. It may be of interest to other students a the laboratory that after the various collecting trips, demonstrations of living material are set up by the students under the direction of the Staff. These demonstrations may be seen at the less populous times of the day in the invertebrate laboratory.

The lecturers in Embryology this week have been Dr. Grave on the later stages of Annelid and Mollusque development; Dr. Rogers on Echinoderms and Dr. Heilbrunn who lectured today. Next week will be spent largely in experimental work such as centrifuging eggs and the production of artificial parthenogenesis. Dr. Grave will lecture on Friday.

Tissues Cleared by the Spalteholz Method

Among the interesting specimens to be seen at an exhibit in Old Lecture Hall are some of the preparations from the Spalteholz Laboratories in Leipsic. Included in the exhibit are to be foetuses at the seventh month of foetal life. Some are injected showing the vascular system, others just cleared and rendering obvious the cartilaginous growth of the bones, the centers of ossification and their radiations.

Well known, but rarely seen parts, such as Meckels cartilage, the thymus gland, inferior and superior vena cavae stand out conspicuously.

An injected placenta showing the vein and two arteries is cleared and the cotyledons are seen with their separate vascular supply.

An object of unusual interest is a temporal bone which has been cleared, the semi-circular canals and cochlea having been previously injected with Wood's metal, these in the preparation stand out as sharply defined objects in a diaphanous temporal bone and the planes of the superior and posterior semi-circular canals are obvious and clear. A human heart is exhibited and being cleared it shows the chambers, and, being injected the coronary arteries and veins.

Altogether there are some three dozen specimens being exhibited by the Clay Adams Co. of N. Y. C. who are represented by Mr. J. A. Kyle.
American Author Leaves On Monday

Theodore Dreiser, considered America's greatest novelist, and Mrs. Dreiser are leaving Woods Hole on Monday, after a three weeks' visit here. They will be accompanied by the Dreiser mascot, a huge white Russian wolf hound, called Nick.

Mr. Dreiser, who is intensely interested in present-day relations between religion and science, has spent his time since his arrival in talking with various scientists concerning their work, their aims, and their philosophies. He has that rare talent, developed in his earlier experiences as a Chicago newspaper reporter, of asking questions which require hours of enthusiastic monologue to answer. Silent scientists have burst into profuse verbiage at his questions, to explain themselves. Timid scientists with inferiority complexes have talked of biological ambitions for hours at a time. Ordinary, normal scientists have lifted their feet to the table, hunched themselves deep into their chairs and discussed pros and cons, past and future. Mr. Dreiser sits, profoundly interested, and listens.

Mr. Dreiser has returned recently from a two and a half months' official visit in Russia, where he was invited by the Soviet government for a critical inspection of the country. His book on Russia, entitled, "Mr. Dreiser Looks at Russia," published by Messrs. Boni & Liveright will appear in the late Fall. It is likely to be particularly interesting in view of the fact that both Soviet officials and Russian refugees will have read the book with regard to its authenticity previous to its publication.


Beyond the Horizon
(Continued from Page 3)

The play contains many scenes of high emotional character, calling for extremely careful acting to keep them from falling miserably flat on the one hand, or from being absurdly over-acted on the other. The members of the cast carried through these scenes remarkably well—in fact their acting was undeniably better in the big scenes than in those of lower emotional tension. Charles Leatherbee of Harvard, who played the part of Rob, recovered from a poor beginning in the first act to be the star of the evening. F. Kent Smith, also of Harvard, in the part of Rob's brother Andy, and Margaret Cook of Radcliffe as Ruth, both carried their parts not only adequately but with an admirable amount of delicacy and poise. Nor is any Special Honors list complete without mentioning Sue Birnie of Radcliffe and Elizabeth Schaufler of Smith in the roles of the two mothers.

On the whole, Beyond the Horizon was a difficult play well-presented. It called for much greater talent than its predecessor in this season's repertory, but the members of the Guild proved themselves amply able to meet the greater demands.

ROOMS AVAILABLE THIS WEEK IN WOODS HOLE

Louise and Elisabeth Mast

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The following people will have rooms vacant at the close of the courses:
Mrs. Peterson, Mrs. Romelink, Mrs. Pierce, Mrs. Nickerson.

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EXTENDS A CORDIAL INVITATION
To the Workers at the Marine Biological Laboratory to Visit Their Exhibit of Scientific Apparatus in the OLD LECTURE HALL
July 26—August 4
Five Workers Are Awarded Collecting Net Scholarships

Capacity for Original Research was Chief Determining Factor in Selection of Candidates

The five individuals winning THE COLLECTING NET Scholarships of one hundred dollars for the summer of 1928 are: Miss Catherine L. T. Lucas, Messrs. Ferdinand J. Sichel, Arthur K. Parpart, Kenneth B. Coldwater and Allyn J. Waterman. The recipients of the scholarships have not only received the monetary reward, but a notable honor as well.

Miss Lucas, who obtained the degree of Master of Science from London College, England, held a Research Fellowship at Yale University last year. This summer she is continuing her work on the study of the effects of certain environmental factors on some internal Protozoa of Periplaneta americana. At present she is investigating the effects produced on some of the species by the existence in the medium of an abundance of certain types of yeast.

Mr. Sichel, who was demonstrator in botany last year at McGill University, will take up his new position this Fall as assistant in biology at New York University. He is a candidate for a Ph. D. under Dr. Chambers. Mr. Sichel is beginning his major problem this summer at Woods Hole. This is a study of the pH changes in eggs on thermal coagulation. Micro-thermo-couples will be utilized in conjunction with the Chambers' micro-manipulator.

Mr. Parpart has been instructor in embryology at Amherst College during the past year. In the Fall, he takes up his new position in physiology as research assistant to Dr. Merkell H. Jacobs at the University of Pennsylvania. Mr. Parpart is at present working on the effects of various acids, and of various acid and salt mixtures, on the rate of the first cleavage of Arbacia eggs. If his work is successful, it is hoped, will serve to clear up several disputed points relative to penetration effects. In the case of Arbacia eggs the previous workers in this field used the activation period and the time to reach a given stage of development, e.g., 32-cell stage, blastula, or gastrula in their studies in these problems. He feels that by using one definite process, i.e., the rate of penetration, more accurate quantitative results can be obtained. This work is being carried out under the direction of Dr. M. H. Jacobs.

Mr. Coldwater, who was a graduate assistant in zoology at the University of Missouri last year has just been appointed instructor in zoology at this institution. Mr. Coldwater is taking the course in embryology at the laboratory this summer, and in addition, is carrying on preliminary work in the field of X-rays under the direction of Dr. Curtis.

Mr. Waterman will hold one of the Austin Teaching Fellowships in zoology at Harvard University. Last year he was instructing in biology at Williams College. Besides his teaching at Harvard he will carry on graduate work in embryology under the direction of Dr. Leigh Headley. Mr. Waterman is taking the course in physiology at the laboratory this summer.

The winners were selected with sagacity by competent committees. The recipient of the scholarship, however, receives not only the monetary reward, but a notable honor as well. In the case of the three research scholarships the Advisory Board, consisting of Drs. Chambers, Conklin and Woodruff, consulted with perhaps twenty of the older investigators concerning those worthy of the award. The Board made its final selection after these recommendations had been thoroughly digested. The recipients for the two student scholarships were chosen by a committee consisting of the head of each of the five classes.
ON SANTA DOMINGO TRAILS

SUMMARY
Continued from Page 1

tories in general some illustrations from the breeding habits of the Paracentrotus lividus, various forms of the local frogs were given. It was pointed out that the Red-backed Salamander (Plethodon cinereus) of the Woods Hole region in laying its eggs on log form the original larvae were modified for life in swift and swifter water. In an adjacent island, Jamaica, four species of Hyla occur, and these frogs resemble the Santa Domingan forms so closely that a visitor to the former island would have concluded that each of the Santo Domingan species had in past times made their way to Jamaica where they had diverged only slightly from the original forms. But the Jamaican species all lay their eggs in Bromeliad, epiphytic on jungle trees, and the larvae are modified for life in the water caught at the bases of the leaves of these plants. Hence it was concluded that the Jamaican species had evolved independently of the Santo Domingan forms. This conclusion was of interest for it lowered that identical modifications may arise independently in isolated stocks.

The latter part of the trip was devoted to working out the life history of the Rhinoceros Iguana. It was found that during the breeding season females selected localized areas in which to lay their eggs. This was very suggestive of how the making of communal nests may have evolved in the case of the related Central American Iguana. Females of the later species not only come to one locality to lay but deposit their eggs in a single hole.

REVIEW

Dr. C. H. Arp
Director of the Coffer Experimental Station, Haiti

“On Santo Dominga Trails” was a very delightful mixture of scientific information concerning tropical biological curiosities, and of stories of the scenery of the island. The fauna and flora of the island. Recent collectors have all reported new biological curiosities and species. Any scientist who may wish to visit this western portion of the island will find the American staff of the Department of Agriculture ready to assist him in any manner possible.

REVIEW

Dr. Edward Uhlenhuth
Associate Professor of Anatomy
University of Maryland Medical School

In this age where the environment of men has frequently become confined to a small laboratory room, or even dwindled down to a corner fitted with a desk, a piece of paper, a pencil and a slide, a student should know that the old pioneer squire has survived in at least some of us, compelling his possession to venture out into the fields and primeval forests and to seek that intimate contact with nature, which rejuvenates to new life, and inspires more than anything else a search into the mysteries of nature. Even the most inventive geniuses among our great artists had to leave their studio sometimes and gather fresh and live impressions from the mother Nature. It always be necessary for biologists to go out into nature in search of new objects and facts, for inspiration and elevation, lest biology become a stale and dead science.

How important an addition to our knowledge may be obtained through direct observation of animals in their natural habitat, was brought home to us in a lecture recently, and yet bearing a background of rich scientific knowledge, which Dr. G. Kingsley Noble, of the American Museum of Natural History in New York, delivered to us last Friday after his expedition into the tropics of Santo Domingo; the purpose of this expedition was to find and collect two species, both giant representatives of their kind, the giant tree-frog Hyla vasta, and the Rhinoceros Iguana, Cyclura cornuta. The search was made with the object of studying the sexual and social life and the breeding habits not only of these two species, but also of all the tree frogs of Santo Domingo. Listening to Dr. Noble’s lecture I was reminded of another lecture held in Woods Hole, some years ago, by Dr. Julian Huxley on sex instincts of birds. On that occasion I was highly impressed by the relative complexity of the psychology of birds. But still more one may marvel that in the lowest classes of animate animals, in the amphibians, the instincts surrounding the sexual activity could have reached such high complexity as they have in these Santo Domingan species. I was also reminded, in one of his papers (Annals of the N. Y. Acad. Sci., 1927, xxx. pp. 31-128) data on the sex instincts of numerous amphibian species; the object of his present expedition was to add new information to this already rich store of knowledge, and to find a clue to the development of some of these instincts. Incidentally, I think Dr. Noble has done a valuable service for students of human psychology, sociology criminology and the psychopathia sexualis. Although students of these phases of biology are concerned in the first place with instincts and mentality of man, a final analysis of the human mind will be impossible without digging into the primitive sources from which the human instincts are derived. Here is one more instance to show how deeply rooted in the constitution of the animal psyche f. i. is the instinct of constructing a protective shelter, at first for the offspring, later for the family, finally a permanent home, so essential a part of the social make-up of most of the human races. And ever and ever it crops out, even among the lowest groups of vertebrates animals, in a few isolated species of fishes, quite commonly among birds and here, again, among the tree frogs Hyla vasta, until it finally crystallizes into one of the most essential habits in man and completely modifies his life.

In his lecture, and previously in his papers, Dr. Noble emphasized the history of amphibians as an aid to morphology in determining relationships between different species. Among whole genera or even larger groups of amphibian genera highly specialized instincts are found just as closely and constantly associated with the species belonging to the group as are the typical morphological characters binding them into the group of relationships. The most striking example of this rule has been found among the tree frogs of Santo Domingo. The giant tree frog, Hyla vasta, lives in the same environment together with Hyla cyanophryns, and the other giant frog, and yet the former has preserved the habit of depositing the eggs into water, so characteristic for the Hylidae all over the world, while the species of the genus Eleutherodactylus, yet the former has adopted an entirely different breeding habit, depositing their eggs on land. Following this peculiar habit a whole army of adaptive characters has arisen exceedingly in the embryos of the Latter genus, the most conspicuous one being that the young do not hatch from the eggs as tadpoles but as fully developed little frogs.

Concerning the constancy of some of these instincts for species of whole groups, as contrasted with a considerable morphological variability, it is interesting to recall the constancy of certain incidental characters such as odor of the secretion between the Rhinoceros and a horse seems less than that between the Rhinoceros and an elephant, together with which the Rhinoceros was classified, for a time, into one common group, the Pachyderms.

Finally I should like to say that the hand-colored slides and prints presented by Dr. Noble, which showed amphibians and reptiles in activity in their natural habitats, were of rare beauty, and are fitted to become valuable records for future generations which may know these species only as a part of an extinct fauna of the past.
THE MARINE BIOLOGICAL STATION AT PORT ERIN

(Continued from Page 1)

"Fairy Shrimp," *Hippolyte varians,* obtaining results that have found way into the text-books. The late Professor Benjamin Moore worked for several years at Port Erin on the photosynthetic processes in marine algae and diatoms—this was pioneer work that also became known. With the close of the European war both stations experienced evil fortune: the Fisheries Laboratory at Fiel has been closed down by the Lancashire and Western Sea Fisheries Committee and all scientific investigations have been abandoned. A general lack of interest, in England, in marine biological research, on the part of non-professional men has led to difficulties at Port Erin and the policy of the British Government Departments, with regard to assisting marine investigations, has been productive of a state of some confusion: it is clear that biological investigation, in the future, must be the charge of private persons who are interested in it as a hobby and of the University staffs. State-aided marine research, especially in the British Isles, has been unsuccessful in comparison with the private work of the past.

The Port Erin Station is very pleasantly situated: it is much liked by people who go there; the Isle of Man is a very popular holiday resort and the rich antiquarian interest of the island with its curious old customs makes a stay there an attractive one. The Biological Station is fairly well equipped: there are the usual aquaria and museum which are open to visitors on payment of a small fee. Although quite a sizable part of the whole scheme of work, this public instructional side has been almost embarrassingly popular: evidently it meets a demand and has a certain sphere of usefulness.

**THE TORCHBEARERS**

The play selected for presentation this week by The University Torchbearers Guild was "The Torchbearers." The Torchbearers is a comedy by George Kelly and concerns itself with the difficulties of a certain type of Little Theatre group in the production of a play. The characters with one or two exceptions are very natural and indeed, anyone who has had any experience in the average dramatic club will easily recognize the principal types.

The play itself is a quick-moving piece of entertainment that depends as much upon the action as upon the lines. This does not mean however that the speeches lacked humour for that the whole play was supplied with abundant wit. The audience attested to this by their frequent applause and laughter.

The Guild showed their wisdom in choosing a play of this type, for while it served as a splendid antidote to the more serious and, to some, rather depressing play of last week, it at the same time gave them an opportunity to display their many sided capabilities.

The premier honours of the evening go to Miss Elizabeth Penner who took to perfection the part of a naive and somewhat girlish young wife who for a short time felt that her future was upon the stage.

Miss Helen Field showed high talent in her portrayal of Mrs. Pampinette, the totally misguided but very righteous and self-satisfied director of the group. Miss Field exploited to the very full element of humor in the character of this upliftier of the drama. In the parts of a conscientious though utterly incapable amateur actor was responsible for many of the laughs.

In fact the bulk of the work fell upon the above three actors and the way in which they developed their roles is worthy of great praise.

Miss Schaufler in the character of a three-times-widow gave just the right interpretation to bring off the full comedy of the play.

Mr. Quigley as the blase and hard-boiled young husband, Mr. Ritter, had a difficult part and rather unnatural lines. He filled his part and yet managed to make the audience laugh, however, and made his lines seem as natural as possible.

Messrs. Windust, Barnow, and Swope got the full complement of humor out of smaller parts.

Miss Birnie as Mrs. Sheppard struck just the right note and added a truly comic character to the play.

The leading role of the young wife is a part that appeals to many: Miss Phelps and Miss Cook and Mr. Harrington took minor parts very suitably.

The play apart from its more obvious comic elements is a real good burlesque and being full up to usual standard of the Guild both from an historic and a technical point of view, provided an excellent evening's entertainment and relaxation from arduous biological work.

**JULIAN P. SCOTT PROMISES EXHIBITION OF PICTURES**

Julian P. Scott now has on exhibition pictures of American Men and Women of Science, for the benefit of the Marine Biological Laboratory folk.

For years Mr. Scott has been traveling from university to university taking kodak pictures of scientists. His finished work is the result of patient accuracy. It has been possible only because picture-taking is his avocation, and his interest in good results has dominated him to such an extent that he is satisfied only with the best effects.

Besides giving us artistic pictures, Mr. Scott has been consciously filling a need in the scientific world. It is not difficult to obtain pictures of European scientists, but it is hard to secure those of American workers. Mr. Scott has a collection of some 2000 pictures.

Mr. Scott has a collection of some 2000 pictures.

He has, moreover, been doing it in a unique manner. He takes a directory and goes to picture a popular scientific lecturer, arranging them so that students and new faculty members can connect faces with names. This is especially convenient at a Research Station like the Marine Biological Laboratory where all new comers are endeavoring to become acquainted immediately.

The individuality expressed is not often found elsewhere, and especially in the pictures of the late James A. Ford, Sidney I. Smith, Irwin F. Smith and Hideyo Noguchi, Mr. Scott has secured strikingly characteristic poses.

Mr. Scott is planning an exhibition for the Entomological Congress at Cornell between August 12th and 18th at the request of Dr. E. F. Phillips, formerly a member of the Marine Biological Laboratory. Another exhibition has been arranged for at the Smithsonian Institute, United States National Museum, Washington, D.C., between September 22nd and 29th. Mr. Scott plans a trip.p to the British Isles next spring and give an exhibition in the British Museum.
Importance of Oceanography
Emphasized by Dr. Galtsoff

On Thursday, July 19, the U. S. Fishery Laboratory initiated its summer season of lectures on aquatic biology with a lecture by Dr. Paul S. Galtsoff on "Living Matter and the Chemistry of the Ocean." On this occasion the staff and investigators of the Marine Biological Laboratory were invited to attend the lecture, and afterward to join the workers at the Fishery Laboratory in a social hour, thus reviving the custom of providing on Thursday nights food for serious thought and opportunity for social contacts and entertainment. An unusually large number of persons responded and the lecture hall in the Fishery residence was filled to capacity.

During the course of his lecture Dr. Galtsoff pointed out that during the last seventy years the life in the ocean has been studied chiefly from morphological and taxonomical points of view. Numerous oceanographic expeditions organized by every civilized country have collected rich material representing the life in different parts of the ocean, and have accumulated numerous data regarding currents, distribution of temperature and chemical composition of sea water. Many efforts have been made to make a census of the total population in the ocean, and thousands of samples of plankton hauls have been examined quantitatively. It has been found that the population of the ocean undergoes regular cyclic changes; certain forms appear during definite seasons, reach their maximum and disappear giving place to other forms, and forms appear during definite seasons, reach their maximum and disappear giving place to other forms.

Dr. Galtsoff pointed out that during every civilization the role of oceanography has been studied chiefly from morphological and taxonomical points of view. Numerous oceanographic expeditions organized by every civilized country have collected rich material representing the life in different parts of the ocean, and have accumulated numerous data regarding currents, distribution of temperature and chemical composition of sea water. Many efforts have been made to make a census of the total population in the ocean, and thousands of samples of plankton hauls have been examined quantitatively. It has been found that the population of the ocean undergoes regular cyclic changes; certain forms appear during definite seasons, reach their maximum and disappear giving place to other forms, and forms appear during definite seasons, reach their maximum and disappear giving place to other forms.

The organisms that live in the ocean are different not only morphologically, but are chemically different. Living matter in the ocean is formed by the same elements that occur in the sea water, but they are present in the organisms in different concentrations. Thus, the difference is not qualitative but quantitative. Certain marine forms condense and accumulate different elements. We know organisms that accumulate calcium, silica, phosphorus, potassium, iron, magnesium, sulphur, sodium, barium, strontium, lacustrine, copper, zinc, lead, arsenic, iodine and bromine. The accumulated element may be the by-product of metabolism, possessing no physiological signi-
cyclic fluctuations of the marine organisms, which at present remain unsolved.

Following the lecture the spacious parlors of the residence were occupied by groups of guests engaged in animated discussion; refreshments were served and many enjoyed dancing.

REVIEW

DR. CHARLES G. GALTSOFF
Professor of Comparative Physiology, Oberlin College

For those who have been in doubt as to the significance of oceanographic work, the lecture by Dr. Paul S. Galtsoff at the Bureau of Fisheries last Thursday evening, must have been at the same time enlightening and reassuring. Dr. Galtsoff demonstrated, not only a wonderful grasp of information in this world-embracing field, but a real sense of the significance of the facts at his command—and an appreciation of the need for further efforts of skilled investigators.

DR. GALTSOFF LECTURES ON OCEAN CONTENTS

Dr. Galtsoff reviewed briefly the work of the Challenger expedition, and the work of Moebius, Hansen, Haeckel, Lohmann, and Murray and Hjort. It was pointed out that at the first, as in any other branch of science, there must be a period of fact finding. He called attention to some of the significant failures in the history of oceanography, particularly those of Hermann, Orton, and the Australian Commission. In each of these cases the failure could be assigned to a lack of appreciation of the problem and a misdirection of efforts, in part due to inadequate preparation for the particular studies involved.

Attention was called, by Dr. Galtsoff, to the composition of the sea water. Only a very limited number of analyses of the sea water have been made and most of these have been only partial. The need for complete analyses of samples of sea water taken from widely different stations was emphasized. Our present assumption, that sea water is uniform in its chemical composition, certainly rests upon very meager foundations. Particular care should be given to the determination of the substances occurring in "negligible" (?) concentration. We have learned within recent years of the extreme importance of the substances occurring in mammalian blood in only very minute amounts. Is there not reason to suppose that such minute traces of various rare elements in the water may be of great significance? The constancy of composition of the sea water is only relative matter after all. When it is remembered that there are in the order of $10^{18}$ water molecules to form a layer two miles in thickness over the whole globe, it will be apparent that the inflow of a single river is not enough to make any very great change in the total composition. At the same time let it be remembered that the sea water contains about 3 per cent. of salts of various sorts, and that these salts are ionized to the extent of about 90 per cent. It is evident that the sea water is a most remarkable complex of molecules and ions, and that local changes which may occur at any point upon the earth may serve to upset the molecular and ionic balances. Chemists and physicists have not yet given us any adequate idea as to the nature of such a highly complex solution as sea water. Add to this the fact that here and there the solution may, through the addition of finely divided matters, take on some of the characteristics of a colloidal sol, and the sea water becomes a complex, the exact nature and behavior of which we are not yet in a position to understand. Much investigation of a highly technical nature remains to be done.

Chemical analyses show that the sea water contains some 25 or more elements. These are, for the most part, elements of the lower atomic weights. Small amounts of elements of higher atomic weights occur, and it is to these that special attention should be given. It is perfectly clear that such a solution as Van't Hoff's, or any other solution less complete than the artificial sea water of Cleve-Legon, can hardly serve as an adequate substitute for sea water in experimental work.

The elements making up living matter are the same as those contained in sea water, though not in the same proportions. They are, of course, combined in entirely different ways. Living organisms serve as condensers and accumulators of various elements. Whether the accumulation be in the form of an absorption upon some organic interface or in the nature of a chemical combination, it serves to remove from the sea a certain proportion of the element involved. We have been frank to acknowledge the effects of the sea water upon living organisms, but we have given little thought to the effects of the organisms upon the sea water. It is a well known fact that certain organisms have the power to disturb the existing balance of various elements in the sea water. For example, diatoms, being added to the oceans by the rivers. The calcium balance is kept up by the resolution of a part of the calcium deposited. Numerous other examples might be mentioned but these are sufficient to call attention to the fact. A wonderful opportunity exists for the study of the interactions which surely occur between the marine organisms and their environging liquid.

Much has been said in the literature of biology concerning the carbon cycle, the nitrogen cycle, and some other cycles. May we not look forward to the time when we shall speak with as much assurance concerning the cycles of silicoflagellates, sponges, radiolarians, iron bacteria, etc., accumulate silicon; bacteria, Foraminifera and Desmidaceae accumulate iron; the protozoans Coccolithophoridae accumulate calcium and deposit it to the extent of millions of tons per day. The work of Clark shows that more calcium is being deposited by these protozoans than other elements found both in the sea and in living organisms. They certainly do not occur in the living forms as a matter of chance. They form a part of a living mechanism, and as such should be thoroughly studied. It has already appeared that fluctuations in the composition of the sea water are

(Continued on Page 6)
The Collecting Net

A weekly publication concerned with the activities of the Marine Biological Laboratory and of Woods Hole.

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Home Again

We have been forced this week to remove the place of printing THE COLLECTING NET from The Reynolds Printing Company to the Reynolds Printing Company toコレクティングネット from The Reynolds Printing Company to COLLECTING NET from The Universal Press which had re-established himself in a new home.

Mr. Gray was one of the owners of The Universal Press which has charge of the printing when THE COLLECTING NET began publication. In January it burned to the ground, and just recently he has re-established himself in a new printing shop on North Second St. in New Bedford.

The change has thus not been as serious as it might have been.

At our new press we are insured of obtaining prompt and courteous service. We are confident that we shall be better cared for in our new home.

Our Meals

A letter to the Editor on this page perhaps exaggerates somewhat the eating conditions at the mess; but we gave careful consideration to its contents and finally decided to print it. It is simply an expression of opinion by one of its readers, and its columns are open to them for this purpose.

We have heard a number of people comment on the fact that insufficient time is allowed for the consumption of a meal.

Mr. Green, the chef, has been known to be very strict about the time allowed for eating, and it is almost impossible to get a meal at the mess on time.

This is the condition of geometric progression and will continue indefinitely unless external factors intervene.

We are ordered to accelerate.

The eating hall of a scientific laboratory!

Capitain Handy finds freakish starfish.

(The Falmouth Enterprise)

Falmouth, July 24—Captain Reuben Handy, Scrampton avenue, is wondering whether the object he hauled up from Vineyard Sound is a starfish, for the animal has seven perfect arms, instead of the more common five, and an extra mouth.

Captain Handy, whose auxiliary sloop Sea Robin, is well known to Vineyard Sound fishermen or sailing, is disappointed with the weather because two weeks ago four fishing parties booked for the Sea Robin had to be cancelled on account of storms.

Fishing is reported good at present. Last week one party, in Sea Robin got 55 pounds of mackerel in a forecasten and another came home from a sail with 75 pounds of prospective filet of sole.

Dr. Galtsoff Lectures on Ocean Contents

(Continued from Page 5)

associated with cycles of plankton appearance in the ocean. These particular fluctuations have involved nitrates, phosphates, and organic compounds. Is it not entirely possible that fluctuations of other elements or compounds may have great significance in the distribution of various plankton forms, and therefore, of fish which feed upon them? As to these matters we can be of untold service to the human race.

Dr. Galtsoff also discussed the work of Wernsdorf concerning the rate of propagation of animals in an ideal environment. This author found, that under ideal conditions the rate of reproduction could be represented by the formula \( N = N_0 e^{kt} \), in which \( N \) represents the number of individuals produced in a given period of time, \( N_0 \) is the initial number, \( k \) is the rate of increase or decrease, and \( t \) is the time.

This is the condition of geometrical progression and will continue indefinitely unless external factors intervene.

We are forced to accelerate.

Dr. Fred W. Stewart has been investigating the problem of new living matter and its relation to the human race.

It is possible that an intelligent cooperation of human beings with nature might be of importance in any racial history.

It is possible that we may discover that creation of new living matter, as suggested by the experiments of Moore, is a possibility even now upon the earth? The work of Millikan, resulting in the statement that the net swimming-building population of plankton are continually going on about us, certainly leads us to wonder whether creation may not after all, be a continuous process in the organic realm as well. The development of the individual has been shown to be the result of a series of interactions between the egg and its environment.

It is possible for us to find that the development of a race is the result of a long continued series of reactions between the individuals of a given stock and a very slowly changing environment?

If the students of oceanography cannot exist in the solution of some of these questions their efforts will have been worth while.

COAST GUARD HAS BUSY WEEK TOWING

Three calls for assistance within four days were received by the Coast Guard Base in Woods Hole last week, all of them being requests for towing. On July 12 word was received that the sloop Lillian, bound for Woods Hole from Gloucester, was drifting a quarter mile from the beach at Gy Head with a lost propeller. The Lillian was towed to Woods Hole by a Coast Guard boat.

Two days later in a strong tide the schooner Miriam of Nantucket, bound for Woods Hole, ran aground on Great Ledge, and a Coast Guard boat was sent to tow her off the ledge into deep water.

Last Sunday the Gyda Elde of New York was towed from Quicks Hole in to New Bedford. The engine of the Gyda Elde had broken down and her call for assistance was received at the Base.

During the high winds and hard rains of last week-end several calls were received from nervous friends on shore asking the Coast Guard to tow their boats, but the outlook was never more than to be in danger. In all cases, however, the boats were found to be safe.

Dr. Benjamin Grave has recently been chosen Director of the Department of Zoology at DePauw University, and will go to his new post in the fall. Dr. Grave has been Professor of Zoology at Wabash College in Crawfordsville, Indiana, since 1920, and for the past several years has been a member of the staff of Instruction in Embryology here at Woods Hole.
Methods of Experimental Embryology
With Special Reference to Marine Invertebrates

E. E. JUST
Professor of Zoology, Howard University

Crepida

(Continued)

CHAPTOPTERS

The sexes in Chaetopterus are distinguished by the color of the sexual elements located in the parapodia: the eggs are orange-colored, the sperm milky white. The sexes should be kept separate, each individual being placed in a separate dish under a gentle stream of sea-water.

The eggs are removed by cutting up the parapodia containing them. The mucus present is removed by putting the eggs through cheese cloth. The eggs are then washed and set aside for about fifteen minutes or until the first maturation figure reaches the metaphase. If not inseminated, the eggs die in this stage.

Sperm are obtained by removing a posterior parapodium which is cut up in 10 c. c. of sea-water. If a drop of the sperm suspension examined under the microscope shows bundles of non-motile spermatozoa, spermatoctyes, and spermatoctyes, the animal is not ripe. Mature spermatoctyes exude freely and are highly motile. Insemination is made as in Nereis.

CUMINGIA.

Workers who use Cumingia are indebted to Dr. Gilman A. Drew, formerly assistant director of the Marine Biological Laboratory, for the method of obtaining the eggs.

The animals are collected at low tide, kept in mud, protected from rise in temperature, and brought to the investigator as quickly as possible. They are placed under running water for about fifteen minutes or until wanted. Each animal is now transferred to a separate dish — the females in finger bowls containing about 200 c. c. of sea-water, the males in dishes of about 50 c. c. capacity. I distinguish the sexes by the color of the sexual elements seen through the shells: females show a salmon pink, the males a dead white color. If the animals are not disturbed, in less than half an hour they set free their eggs and sperm. I pipette the eggs off as soon as they are shed. Insensations should be made from a thin sperm suspension. Polyspermy must be avoided.

METHODS FOR HANDLING EGGS AND SPERM.

Of the three Woods Hole species of Crepida — plana and fornicata, convexa-planal is most commonly used for embryological work. Conklin's classic studies were made for the most part on the eggs of plana.

The breeding season of C. fornicata in the Woods Hole region lasts from early summer to about the middle of August, that of C. plana begins somewhat later and lasts longer. The egg-laying season of C. convexa covers about the same period as that of C. plana. (Conklin '97).

The unfertilized eggs in all three species are laid in capsules. This fact guarantees normal eggs. To obtain the eggs one simply removes and punctures the capsules found beneath the sand. All eggs produced by one female are laid at about the same time. Development from egg-laying to the escape of the veliger is very rapid, taking about four weeks in the case of C. fornicata and somewhat longer in C. convexa and C. plana. (Conklin, loc. cit.). For problems on determinate cleavage this is an excellent egg.

The reader has doubtless noted throughout this section on handling eggs and sperm that I have emphasized the value of using wherever possible normally shed eggs and sperm. This may strike him as over-caution; but many years of experience has taught me that in the case of most forms, normal eggs and normal sperm are those naturally obtained.

Let me cite two striking examples. I have referred to Platynercis, an annelid that only lays inseminated eggs after copulation. Now, if we were to procure the eggs as we do those of the nearly related form, Nereis, by cutting up the female in sea-water we should find that no eggs fertilize. This can be shown to be due to the effect of the sea-water on the eggs alone and not on the sperm — since the sperm cut out of the male in sea-water retain their fertilizing power; a drop of such sperm suspension mixed with dry eggs gives a hundred per cent. fertilization. Or, if we place the head of a carefully dried female in a drop of sperm in sea-water she swallows the sperm and normal fertilization takes place in her body cavity. From this and other experiments I concluded that the uninsensated eggs of Platynercis in sea-water rapidly lose a substance necessary for fertilization. The cortex contains this substance, the fertilizin of Lillie, which in the normal insemination process the sperm must almost instantaneously fix, as the rapidity of copulation and egg-laying reveal, since only a small fraction of the time of these processes is covered by the insemination itself. It was only by chance observation after repeated failures to fertilize these eggs in sea-water as we fertilize those of Nereis that I discovered the rather bizarre type of insemination process in Platynercis.

The reader may however dismiss this as an extreme case and therefore
Methods of Experimental Embryology

(Continued from Page 7)

not admissible as evidence that one should where possible use normally shed eggs and sperm. Let me then cite the case of Amphitrite so carefully worked out by Scott. (‘09, ‘11).

Amphitrite, which is very abundant in the Woods Hole region, breeds “within two days of the new and full moon” during the summer months. Shed eggs are always free from admixture of coelomic corpuscles and are taken up by the male. Every egg laid is capable of fertilization, but if we cut up the animals to procure the eggs we obtain mature eggs, inactive eggs and coelomic corpuscles. This is one of the most interesting cases I know. It recalls the precision of the egg laying in Echinorhynchus where only fertilized eggs, among the fertilized and unfertilized which reach the uterine bell, pass outside the female. Again, Phaeoleptoplana eggs are best when laid. On one occasion only, in 1911, was I able to fertilize eggs obtained by cutting up the animals to procure gametes. Eggs and sperm thus obtained are mixed with innumerable coelomic corpuscles; shed eggs and sperm are not. Eggs of Cumingia, Mytilus and Ensis are, in my experience at least, incapable of fertilization when taken by cutting up the animals. Similarly, Fundulus eggs normally inseminated after copulation are superior to those taken by stripping. If the animals be freshly collected and in good condition they copulate readily in captivity.

On the other hand there are animals whose eggs and sperm may be taken in optimum fertilization condition by cutting up the ovaries and testes in sea-water; Arbacia, Astéris, Nereis, and Chaetopterus are examples. It is well that this is true for otherwise vast numbers of observations and experiments accumulated by embryologists on these forms would be useless. But here meticulous care in handling the eggs and sperm is imperative. I have familiarized myself with the breeding habits of every invertebrate that I could get at Woods Hole during the summer months and have compared the development of normally laid eggs with those removed directly from the gonads to sea-water. I know that only by exercising great care are eggs and sperm taken from the gonads of the forms mentioned equal to naturally shed gametes in viability and in normality of development.

One final word of advice: every possible precaution against accidental insemination should be taken. To this end the animals, instruments used and the hands of the worker should be thoroughly washed before the gonads are removed. For most sexually dimorphic forms washing in sea-water is sufficient. Arbacia, Astéris and Echinorhynchus should be thoroughly washed first with fresh water and then with sea-water. Lots of un inseminated eggs showing one accidentally inseminated should be discarded.

(To be Continued)

REVIEW—By Sidney Bliss

Dr. Morgulis presented some of his recent experimental results obtained in a study of the nature of the action of the well-known enzyme, catalase.

Tissue extracts have the capacity of liberating free oxygen from its combination in hydrogen peroxide, and the catalyst involved in this reaction has been called "catalase.' "The interest of the biologist lies in the action that any enzyme may have in rendering oxygen more easily available for the all-important oxidations that are inseparably associated with the liberation of energy in the organism.

Dakin, in his monograph (1922 2nd Ed.) on "Oxidations and Reductions in the Animal Body," states that, "within recent years it has been shown, repeatedly, that a great increase in oxidation, such for example as that which follows the fertilization of the sea urchin's eggs, is not accompanied by any comparable increase in catalase action (Amberg and Winterants)." This is in harmony with the fact that catalase liberates from hydrogen peroxide, oxygen which is in the inactive, molecular state.

Dr. Morgulis stressed the point that the catalase reaction is probably a complexity of processes. Dealing particularly with the destruction of the enzyme catalase, he showed that both heat and alkalinity hastened the destruction of the enzyme. It was found that over a pH range of from 6.0 to 7.0 the enzyme exhibits its greatest stability. At 65°C. the enzyme is completely inactivated, regardless of the pH.

Williams, investigating the problem of catalase destruction, believes that the destructive agent is the oxygen liberated from hydrogen peroxide, but Dr. Morgulis has shown by some very beautiful data that hydrogen peroxide is really the destructive agent.

A peculiar fact about the action of catalase is the temperature which is optimum for it. At 20°C. catalase liberates oxygen from hydrogen peroxide more effectively than at higher or lower temperatures.

The work of Dixon bears upon the probable significance that may be attached to catalase action. In studying the oxidation of purines, Dixon found that the catalyst, xan-

Continued on Page 10
part; while Miss Elizabeth Schauf-day and Tuesday evenings, July 30 and 31.

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A carrier pigeon flies only in the day-time.

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PAGE NINE

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THE JEST,

"The Jest," by Italy's most famous dramatist, Sam Benelli, vehicle in which Sarah Bernhardt and the Barrymores, John and Lionel, have made great successes, is the fourth play of the season, to be presented by the University Players Guild at the Elizabeth Theatre on next Monday and Tuesday evenings, July 30 and 31.

Bretaigne Windust, president of the Princeton Theatre Intime, is to play the lead "Giannetto," and is said to be admirably suited to the part; while Miss Elizabeth Schau-
The Reduction Potential of Cysteine

Dr. L. Michaelis
Resident Lecturer in Physical Chemistry
The Johns Hopkins University.

Cysteine is the simplest prototype of the sulphydril bodies, the most important representative of which seems to be glutathione discovered by Hopkins. All sulphydril bodies contain a SH-group which can be easily oxidized in such a way that two molecules detach the H-atom of this group, the two S-atoms being linked together. Due to the peculiar circumstances under which this oxidation takes place, the sulphydril bodies have been thought for a long time to be connected in some way or other with the process of respiration or even partly responsible for the establishment or regulation of the respiratory process. It had been known that the SH-bodies can be oxydized by molecular oxygen. It had been supposed for a long time that oxydized SH-groups are reduced by catalase, which is directed towards the problem of the amount of work that could be accomplished by catalase in any given time. It was assumed that catalase catalyzes the reduction of hydrogen peroxide, thus preventing the accumulation of this substance in such a concentration that catalase actually participates in the oxidation of known metabolites, and that the fundamental problems of tissue oxidation can be solved by noting variations in its concentration.

After many attempts to demonstrate that hydrogen peroxide occurs as an intermediate product in biological oxidations, it has been shown that the decomposition of hydrogen peroxide by catalase yields inactive, molecular oxygen.

Dakin states that, "The distribution and mode of action of this ferment are such that so far as we can see there is no evidence available suggesting that catalase is directly concerned with oxidation. It will be recalled that catalase only liberates inactive molecular oxygen when decomposing hydrogen peroxide, and so far it has not been shown to accelerate or participate in the oxidation of any known metabolite." Dakin further states, "Yet we are asked to believe that catalase is the enzyme in the body principally responsible for oxidation", and that the fundamental problems of tissue oxidation can be solved by noting variations in its concentration.

He concludes the subject with the statement that "The old idea that catalase may serve to prevent excessive accumulation in the tissues of injurious peroxide by converting it into water and inactive molecular oxygen seems to have a good deal to recommend it."

The view of Dakin is shared by Morgulis who, in his review of the subject, states that catalase content is not an index of metabolism. "It is not a true oxidizing enzyme but is apparently of value in the destruction of hydrogen peroxide, thus preventing the accumulation of this substance which is toxic when present above a certain concentration.

A great many publications have dealt with the catalase content of almost everything, but we are yet unable clearly to define the significance of this ubiquitous enzyme.
Our Classes

The Protozoology class seems to have entered on a whirl of social activity. About half the class at the moment of this writing have caught their “hundred” and are busily engaged in trying to keep slippery Stylonychias sticking to the cover slips long enough to be stained a deep, rich blue. This last week’s schedule has included a seminar on Monday, a theatre party on Tuesday, a picnic on Wednesday and a tea on Friday. Dr. Calkins announced the picnic as “The Annual Protozoan Frolic”—we can almost see the party written up in the Woods Hole Daily Protozoenkunde: “Many eli- liates of distinction were present, and the music was furnished by Irving Amoeba (himself) and his orchestra. The slide was as smooth as glass and the cover slip was beautifully decorated with festoons of algae and bacteria. Re- freshments were served by pip- ettes.”

The physiologists, hardly to be called a class at all, are still pur- suing the course of science over in the Old Main Building and great is the collection of glass- ware therein. This past week Dr. Hecht has been lecturing and will be followed next week by Dr. Redfield.

The botanists have altered the Navy slogan to “Join the Botanists and See the World”. On their Cuttyhunk trip they forsook the algae temporarily and made the Cayadetta do figure eights and double spirals chasing Portuguese Man-of-War. We think that the round thing with a hole in its midst is a “fried cake” (cf. work of Kuchenesser, Cent. f. d. ges. Brot. usw., 1693, 132, 1927) and that the lump taken out of the middle is called the “doughnut”. These, however, are in the minority.

According to the Falmouth Enterprise one of the largest yachts ever seen in Woods Hole Harbor was the “Warrior,” built, it is said, in Germany, which came in Saturday morning to permit her owners, the Harrison Williams of New York, to call on friends at Penzance Point.

The U. S. S. Phallarope under the command of Capt. Robert Veed- er took the first swordfish of the sea- son off Noman’s Land last Friday afternoon. It was nine feet long,
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LIMULUS
A Biological Verse
By Walter C. Kraatz.
Assistant Professor of Biology, University of Akron

Limulus the horse-shoe crab of scientific fame,
Lingers today in ancient ways the same
As long extinct Eurypterids of Ordovician times,
'Mong myriad species mostly all of modern lines
Protected in that great, concealing, rounded shell;
The type "has stood the test of years", biologists all know so well.
But though it saw the rise of man, and bird, and beast and classes many,
What, these many, many million years, have been its thoughts, if any?

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med. 2 single 2 1 1 12
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NEW MARINE STATION OPENS VIRGIN FIELD IN FRENCH INDO-CHINA

By Robert F. Weill
Assistant in the University of Paris, Naturalist of the French Hydrographic Mission of Indo-China (1927-28)

In connection with the articles which have been published here on Some Biological Stations Abroad, some information may be interesting concerning a Marine Laboratory which has recently been opened in a country in itself still unexplored by biologists.

The “Oceanographic Service of Fisheries in Indo-China” was founded in 1924 by the General Government of the Colony, upon which it still depends, administratively and financially. Its purposes are multiple: (1) research on the physical Oceanography of the Indo-Chinese coasts; (2) research in marine biology (zoology, botany, physiology, chemistry, planktonology); (3) research on the biology and distribution of fishes, oysters, pearl-oysters, etc., and on the industrial methods of rearing them and fishing; (4) research on the National preservation and utilization of marine products.

In comparison with what we see in Woods Hole, its activity thus embraces both those of the M. B. L. and the Bureau of Fisheries.

The Oceanographic Service includes the Marine Station of Cauda and the laboratory-trawler de Lécassin.

The Marine Station of Cauda is located in the gulf of Nha-Trang.

CURRENTS IN THE HOLE

At the following hours the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

A.M. P.M.
August 5 ... 7:42 8:08
August 6 ... 8:29 8:56
August 7 ... 9:18 9:47
August 8 ... 10:11 10:49
August 9 ... 11:06 11:45
August 10 ... 12:07
August 11 ... 1:01 1:07
August 12 ... 2:08

In each case the current changes six hours later and runs from the Sound to the Bay.

Dr. Cowdry Presents His Work on Invisible Viruses

Nature of Viruses is Subject of Active Study at Rockefeller Institute. His Microchemical Work Apparently Corroborates Dr. Murphy’s Recent Discoveries.

DISEASES CAUSED BY FILTERABLE AND INVISIBLE VIRUSES

DR. R. V. COWDRY

Professor of Cytology, Washington University Medical College.

From the Rockefeller Institute, New York.

Dr. Cowdry delivered a lecture bearing the above title on July 20. The author’s summary is given below. A review of this lecture by Dr. Dugger will be printed in a later number.

Interest always attaches to unknown yet potent disease-inciting agents. Some of them have the property of being filterable, that is to say, they pass freely through filters with pores so small that ordinary bacteria are held back. This means that they are extremely minute. It is also believed that they are small for the reason that they cannot be distinguished with the highest powers of the microscope. Such substances are called viruses, meaning literally poisons, for want of a better name. There are hundreds of them afflicting plants, as well as man and animals, and bacteria too. New ones are being discovered year by year. Probably many more exist for which we have no test, since some of them are certainly not pathogenic. Whether they are living micro-organisms or harmful materials produced by injured cells, we do not definitely know.

Among the diseases of man caused by viruses of this kind may be mentioned rabies, chicken pox, herpes, warts, smallpox, infantile paralysis, molluscum contagiosum and yellow fever. The various bacteriophages which affect bacteria that in turn prey upon man are also to be reckoned with. These were discussed in a lecture last year by Dr. Bronfenbrenner, and reported in The Collecting Net.

Yet the group is an ill-defined one, and the diseases in it are, as it were, on probation. Evidence has been found in the last few years that typhus fever (Wolbach and Todd, 1921), heartwater (Cowdry, 1925) and trachoma (Noguchi, 1927) are due to visible micro-organisms; so that these, with several others, have been removed from it. Conversely, the discovery that yellow fever is not caused by a leptospiro, but by a filterable, and as yet invisible virus (1928), has resulted in its classification again in this category of the unknowns.

The viruses affect living cells in different ways. They often give rise to conspicuous structures called inclusion bodies. These may occur in the nuclei, in the cytoplasm, in both, or may not be formed at all, as in some sarcomata (cancers) of chickens, and yellow fever in man.

Speaking generally, the cells are not immediately killed, but react for hours or months to the injury strictly in accordance with their modes of life and the kind of injury. Nerve cells do not proliferate, but epidermal cells often multiply even after the appearance of them in typical inclusions. Epidermal cells likewise provided with inclusions frequently phagocytize and digest other cells (vaccinia). The volume of the injured cells may remain approximately the same (rabies), or it may increase a million fold (lymphocystic disease). The formation of the inclusions may be paralleled by little visible injury to the cell, or by profound injury. Eventually the cells undergo solution (cytolsis), and there may be marked leukocytic infiltration.

The inclusion bodies, which may be regarded as the footprints of the virus...
viruses—because where they are seen, there, it has been proved, we must look for viruses—have been interpreted in different ways. On their discovery they were looked upon as protoplasm parasites. But this view has been generally abandoned on account of the steadily increasing information already referred to, showing that the active agents are in reality of much smaller size. They then came to be regarded as products of degeneration.

Some investigators even hold that they are half and half, in other words, ultramicroscopic microorganisms shriveling out of material produced by the cell in response to their penetration and multiplication in it.

After a review of the literature along these lines, certain experiments were described which, however, concern only a few of the major questions to be answered.

Last summer with Dr. W. Glaser the question was studied with what was thought to be of all the most favorable material, namely, the polyhedral virus of infects. Briefly stated, blood containing the virus of polyhedral was compared with blood free from it. Although both were studied repeatedly by many methods with direct and dark field illumination, no qualitative difference whatever could be distinguished between them.

Dr. Glaser even devised a technique by which the ultramicroscopically visible particles could be counted with a remarkable degree of accuracy, and still no difference could be made out between them. It is shown that the virus and blood proved to be free from it. In this case, if the virus is particulate, the particles are probably not larger than 1,000,000,000 of an inch in diameter.

Other experiments on the cytoplasmic inclusion bodies brought forth by the vaccine virus were reported. It was found that the inclusion bodies developed when this virus is placed upon the slightly injured rabbit's cornea are made up, at least in part, of material which can be detected within the cells before the virus is allowed to act, showing that in this case the inclusions are not simply the normal fibroblasts (or micro-organisms) taken in from without, but something largely of endogenous origin.

Special attention was paid, in another series of experiments, to the nuclear inclusion bodies of viruses. Borna's disease of horses, and Virus III disease of rabbits. Experiments were reported which were planned to ascertain, first, whether these are identical as had been hitherto supposed, and second, whether they can be regarded as masses of included micro-organisms.

Diseases Caused by Filterable and Invisible Viruses  

The results indicated that the inclusions called forth by these five different viruses are alike in so far that they are acidophilic and devoid of detectable amounts of iron in organic combination, as well as of thymonucleic acid. In a morphological sense they seem to differ in slight but important ways.

The fact was emphasized that such microchemical properties are rather at variance but not absolutely with the theory that the inclusions are composed in large part of the causative micro-organisms themselves. A parallel is not easily found of any micro-organisms which are so consistent under these reactions. Even the Rickettsiae of Rocky Mountain Spotted Fever, which approximate most closely to the inclusions, being also of distinct history, parasitic in masses within the nuclei, are distinctly basophilic. The absence of iron, which in detectable quantities is of such widespread occurrence in all living things, is significant. For, while Feulgen reaction of thymonucleic acid is also noteworthy. This substance, while not so ubiquitous as iron is nevertheless an essential constituent of all animal cells, including the pathogenic protozoa.

The remainder of the lecture was devoted to some sarcoma (cancers) which are virus diseases that are not characterized by the formation of inclusions within the injured cells. In so far as the nucleus is concerned, the virus is slightly acidulated. The virus was slightly acidulated. The virus then came to be regarded as exactly the same microchemical treatment.

Several comparisons of this kind were made. It was found that in all cases the nuclei of the malignant sarcomatous cells gave a much more strongly positive reaction than the normal fibroblasts. But for some inexplicable reason a similar difference could not be observed in the case of other sarcomatous, and of spontaneous and transplanted mammary cancers.

No theories were induced in, but attention was called to some observers, such a varia, which, however, could not be made out. It was found that the virus and blood proved to be free from it. In this case, if the virus is particulate, the particles are probably not larger than 1,000,000,000 of an inch in diameter.

NEW MARINE STATION OPENS VIRGIN FIELD IN FRENCH INDO-CHINA  

(Continued from Page 1)  

The south-east coast of the Indo-Chinese peninsula, in the kingdom of Annam (French Protectorate since 1884), and 12 hours by train from Saigon, the southern capital. (Saigon is reached from Hong Kong in three days, from Yokohama in fifteen.)

It is two miles from the city of Nha-trang, a rather important center, where also one of the three Pasteur-Institutes of Indo-China is located, with Dr. Yersin as director. This place has been chosen in consideration of its salubrity, its remarkable beauty, and the peculiar wealth of its fauna; at the foot of the great Rang Island, a horrid of miles along the coast, extend splendidly living coral-reefs; to biologists it does not need any commentary. The bay being sheltered on the open side by a string of islands, the plankton is very rich, the fishing abundant.

The Station comprises (1.) the Main Laboratory of three floors, fire and typhoon-proof, where are located the biological laboratories, as well as the virus and products required by current biological work (microscopes, spectroscopes, high-power centrifuges, sterilizing apparatus, drying-stoves, darkroom, workshops, etc.); there is also a special equipment for biochemical research on alimetal products of marine origin. As no pictures can be given here, the following comparison is made to give an idea of the place: the building is 267 feet long by 96 feet high, the height of the Scripps Institution (California), and is half as large again. The station also includes (2.) the library and the office; (3.) the supply department; (4.) the electric plant; (5.) the hall with the large engines for the industrial study of marine products; (one desiccator treating 4 tons of fish meal; one oil-extractor of 3 tons capacity; one colloidl grinder 'Kek'; four allos containing together 100 tons of fish meal; and many others; (6.) the supply department of the trawler; (7.) the five residences of the European staff; (8.) the dining hall overlooking about fifteen. All the buildings are fire and typhoon-proof.

The gas installation and the seawater circulation are in course of construction; in the immediate future, the extension of the collections becomes every day more urgent; also of a home for temporary visitors and foreign scientists, (at present there are no accommodations). A future special building for the aquarium is already provided for.

The European staff includes the Director, two Assistants, and the
THE BIOLOGICAL STATION OF FRENCH INDO-CHINA

(Continued from Page 2)

chief of the library and the office; the subordinate personnel is of about 30 natives, as preparers, janitors, secretaries, draughtsmen, modelers, mechanics, sailors, workmen, etc.

The possession of a ship was of course a necessity for the Station. The “de Lanessan” is a trawler of 750 tons, 150 feet long, specially equipped and acquired with a view to its purpose, which it fulfills perfectly. It is a real floating laboratory, and in its large central room five biologists can work in exactly the same conditions as in the best laboratory ashore. The ship carries all the apparatus for industrial or scientific fishing (big trawls, all kinds of big and small nets, dredges, apparatus for securing samples of water or of the bottom), for oceanography (deep-sea sounds and thermometers, apparatus for the measure of currents, of density, of salinity, a new apparatus for the automatic inscription of the nature of the bottom), and, in a special room, larger engines for oil-immersion treatment of fishes (oil-extractors, desiccators, big holding apparatus). Finally there are in addition: aquaria with running fresh and sea-water, a frigidaire, diving-apparatus, powerful submarine lamps (of 3000 ced. p.), two kinematographs, cameras, a wireless station, a motor-launch seating twenty and some smaller boats, etc.

The crew includes the Captain and the Chief-Engineer (Europeans), and about 30 natives.

The activity of the “de Lanessan” extends every year on the 1500 miles of the Indo-Chinese coast, from China to Siam, and also to the Great Lake of Cambodia, which is indeed one of the most important economic fishery regions. To the north, to the west, to the south, to the east lies the Indo-Chinese Province, remarkable for the great climatic differences between the North (Tong-king) and the South (Cochin-china) of Indo-China, the biogeographic differences between its north-coast, the coast of Siam belonging to the Malayan Province, and the east-coast (the Champa-Sea belonging to the Pacific Province), make it a biological field of rather exceptional importance.

The fauna of Indo-China is hitherto almost entirely unknown. If perhaps it does not offer to industrial fishing the resources which elsewhere are often supposed, chiefly because of the difficulty in preserving the products, it is for the biologist, of tremendous interest owing to the strangeness and the extraordinary variety of tropical forms (the very first inventory of fishes, by Challenger, 1882, has described 275 species). The greater part of the Indo-Chinese coasts are bordered with living coral-hefs. Finally the splendor of these tropical countries, —the charm of native life, strange races, —the impression of the ancient culture,—all this must incite even the passer-by to consider and often to discuss, from a practical point of view, some of the most important problems of human thought.

In spite of its very recent creation the Oceanographic Service of Indo-China is already now a scientific implement of the highest value. Its work has had, during the past few years, a remarkable influence on the economic life of the colony, where rice and fish are, for 19 millions of natives, almost the only food; and its scientific results, when they are published, will certainly call general attention to it.

The service has secured the collaboration of several specialized biologists abroad, chiefly for the systematic inventory of the Indo-Chinese Fauna and Flora. Finally, the short “Notes” (9 in number up to date) and more extensive “Memoirs” (2, up to date).

Only one Assistant is actually appointed, the biologist, formerly Assistant in the National Museum of Natural History in Paris.

The man who, in the midst of a country where no one can even imagine who is next to him, lives in unisonately with colonial, tropical and Asiatic life, had the talent to conceive, and besides his own research work, the tenacity to realize his idea. His name is Armand Chever, zoologist, former student of the late famous Professor Delage and a colonial for more than 20 years. It is really to him that I am indebted for the pleasure of the opportunity, here in the most remote station of biologists in the world, to tell about a work which every Frenchman may be proud, and every biologist a grateful admirer.

THE REDUCTION POTENTIAL OF CYSTEINE

Dr. K. C. Blanchard
Assistant Professor of Biochemistry
New York University

Dr. Michaelis gave a paper bearing the above title at the Research Seminar on July 17. A summary of his paper was printed in the last issue. A review of the paper is presented below.

In a recent evening lecture Dr. Michaelis presented the results of his attempts to measure the oxidation-reduction potential of the cytochrome system. The non-chemical biologist often asks, "Why are such potentials measured and what biological significance have they?" It is now necessary to review the underlying chemical concepts of oxidation and reduction.

Since the discovery of oxygen by Priestley in 1774 and the fundamental concepts of electro-chemical reduction by Lavoisier, three years later, a host of investigators have attempted to solve the problem of biological oxidations from the standpoint of structural chemistry—that is, the changes in molecular structures brought about by oxidation or reduction. Few, however, have attempted to introduce quantitative concepts.

With the discovery of anaerobiosis and the fact, with which tissues could reduce a number of organic substances, incapable themselves of yielding oxygen to the cell components, it became necessary to extend our concepts of oxidation and reduction. For some time it has been customary in inorganic chemical formulations to regard oxidation as the removal of electrons from atoms; conversely, reduction is the addition of substances interact in such a fashion that one loses one or more electrons which in turn are gained by the other, we say that the former substance has been oxidized and the latter reduced. Now a given material may in one reaction function as an oxidizing agent and in another as a reducing agent, being itself respectively either reduced or oxidized. For example, hydrogen peroxide, which is usually known as an oxidizing reagent, will easily reduce the silver oxide to metallic silver. Now, whether such a substance will interact as a reducer will be determined respectively by the ease with which the second component of the reaction will accept or lose electrons. It follows that in order to state quantitatively the oxidation-reduction potentials of a substance which will tend to be oxidized or reduced (i.e., oxidized another substance) we must devise some measure of the ease with which it would be oxidized or reduced. This is the so-called electron fugacity.

This may be easily accomplished by assuming the reducing (the reduced form) of a given concentration, the extent of the dissociation will determine the electrons concentration and hence the reducing power of the system. The higher the electron concentration of the hydrogen-ion concentration, the less the reducing power of the system. But how are we to ascertain this electron concentration? Just as we can enable the hydrogen-ion concentration of any solutions to be determined by means of a reversible hydrogen electrode, providing we know how the potential of the electrode varies with the hydrogen-ion concentration, we can also measure the electron concentration if we have available a reversible electron electrode—that is, one whose potential referred to a standard electrode is a function solely of the electron concentration. This is possible in the absence of oxygen, most of the noble metals will function as such.

From what has been said above, it should be apparent that the electron concentration of a solution may be determined by the relative concentration of the oxidant and reductant. Mathematically the potential difference between a metal electrode and a standard electrode immersed in such a solution is formulated as a simple logarithmic function of the ratio of the concentration of the oxidant to the concentration of the reductant. Since the measurable concentration of the reductant, i.e., will easily combine with electrons, it is necessary in measuring such potentials to correct for the hydrogen-ion concentration of the solution. This is done by adding to our equation a term which is a logarithmic function of the hydrogen-ion concentration, but at constant hydrogen-ion concentration the measured potential is a function of the relative concentrations of the oxidant to the reductant.

In his experiments with cysteine, Dr. Michaelis, like Dixon and Quastell before him, found that the potential developed at an indifferent metal electrode was a function not of the ratio of cysteine (the reductant) to cysteine (the oxidant), but only of the concentration of cysteine. Now, by the definition of oxidation-reduction potential, it follows that the potential developed by Dr. Michaelis is not a true oxidation-reduction potential. On the other hand, the fact that the measured potentials were reproducible suggests that in the solutions studied a definite physico-chemical state existed. The most obvious explanation of these results is that the concentration of the oxidant in the solution is always low; this implies that the solution is saturated with the oxidant and is in contact with either an excess of it or a substance which is irreversibly converted to the oxidant. If cysteine is not the oxidant, but may irreversibly give rise to it. A somewhat analogous state of affairs was found by
Dr. Mathews Lectures on His Theories of Blood Coagulation

The Use of Crotalus Venom in Analysing the Phenomena of Coagulation of Blood

Dr. Albert P. Mathews
Professor of Physiological Chemistry, University of Cincinnati

Dr. Mathews presented a paper at the Research Seminar on July 17. The author's summary and a review of the paper follow.

There are two main theories concerning the chemistry and physics of coagulation of blood. One of these theories is sometimes called, outside of America, the 'American theory'; the other is that which is predominant outside of America and may be referred to as the theory of Bordet, although it embodies many concepts which did not originate with him. The so-called 'American theory' is the theory of Professor Howell, which seems to have been adopted by the Council of Pharmacy of the American Medical Association, and has been made the basis for testing all substances introduced into medicine for the purpose of influencing the coagulation of blood in medical practice.

According to the theory of Howell blood does not coagulate in the body, because of the presence in it of an anti-coagulant. When blood is shed, cephalin is set free from tissues or blood plates. This cephalin unites with and neutralizes the antithrombin in the blood. The antithrombin being removed, or rendered inert, the calcium of the blood plasma thereupon converts a prothrombin, which is a protein in the plasma, into thrombin, which unites with the fibrinogen, also in the plasma, causes the latter to form fibrin—a crystalline, sticky stringy insoluble protein which thus clots the blood. The action of tissue extract in clotting blood is supposed to be due wholly to the cephalin in such extract. If a protein in such extract is also active, it is because it contains cephalin, and acts for this reason just as cephalin acts.

The theory of Bordet is that in the blood plasma there is a substance called serozyme, or its progenitor 'pro-serozyme'. This is a protein coagulating at 56° C. Blood does not coagulate in the body because it does not contain any, or sufficient, free cephalin. When blood is shed, or comes in contact with a substance to which it adheres, cephalin is set free if calcium ions be present. This cephalin unites principally from the blood platelets, but it is also derived in part from leucocytes and even from the other plasma proteins which are also cephalin compounds. The cephalin thus set free unites with the serozyme, if calcium ions are present, to make thrombin. This thrombin, by union with fibrinogen (the union taking place even in the absence of calcium), converts fibrinogen to fibrin. Bordet recognized that besides the cephalin there was also present in tissue-juice another accelerator of clotting, a protein compound called 'tissue fibrinogen,' concerning the method of action of which he was in doubt. This protein constituent is partially specific, acting most strongly on blood of the same species, as shown by Dr. Leo Loeb in this laboratory.

Mills, in my laboratory, has cleared up the action of this additional clotting factor, tissue fibrinogen, and has also shown the inadequacy of Howell's theory, and brought clear evidence in support of Bordet. Mills has shown that it is impossible to convert prothrombin to thrombin by the action of calcium alone, as Howell has supposed; but that always cephalin is necessary. If calcium alone appears to act, it does so only if there be some cephalin present. Prothrombin received of its cephalin cannot be activated by calcium alone, but requires cephalin also. The antithrombin of Howell is simply any protein which has a faculty of binding cephalin, for bound cephalin no longer acts. Mills and I showed that if serozyme were removed from the plasma, the addition of cephalin and calcium caused no clotting; but tissue fibrinogen clotted such plasma just as rapidly as before the removal of the serozyme. We cleared up therefore, the action of tissue fibrinogen showing that in the presence of calcium it united directly with fibrinogen to make fibrin and this clotting did not involve thrombin. There were two substances active in clotting in Morawitz' thrombokinase. One was cephalin, as Howell and Bordet supposed, but the other was tissue fibrinogen, a cephalin—protein compound. The latter is in many ways the more important factor.

The venom of Crotalus adamanteus, the diamond back rattler, may be used to analyse the phenomena of clotting. This venom has a remarkable effect in checking blood clotting. This action it owes to two enzymes of a very particular kind. One is a specific enzyme for fibrinogen. It destroys fibrinogen with very great speed, almost instantaneously in fact, so that the addition of even very small amounts of venom to blood plasma causes a very rapid loss of its fibrinogen. The plasma will no longer coagulate at 56°, the coagulation point of fibrinogen, nor loss of its fibrinogen. The plasma by the addition of salt. This en-
zyme either does not act at all upon the other blood proteins or acts so slowly that no appreciable change occurs in the serum globulin and serum albumin. This is sure proof of the essential difference of the fibrinogen from the other blood proteins. What is formed from the fibrinogen by the action of the enzyme has not yet been decided. The temperature of coagulation of some of the proteolysis however, appears to be near that of the two plasma proteins, namely, between 70 and 80 degrees.

The other enzyme in crotalus venom is a cephalinase. It has a very slight action on ordinary fats, but it destroys free cephalin with great speed. As Delezene has shown it splits out the unsaturated fatty acid, leaving the cephalin or lecithin in the form of a partially decomposed phospholipin, which he called "lysocithin," but which Levene called lyso-cephalin.

If now a solution be made of tissue fibrinogen, and a little crotalus venom be added to it, any free cephalin which is present is almost instantly digested by the cephalinase; so that any action of the mixture on the blood can no longer be attributed to free cephalin. The very interesting fact has been found that cephalin in such a compound as it is in tissue fibrinogen, although it makes almost 50% of the molecule, is not digested at all by the cephalinase, or is acted upon at a very slow rate. By centrifuging and washing the venom-tissue fibrinogen mixture, the tissue fibrinogen, which is in a coarse state of suspension, is thrown down, and the venom may be completely removed. There is left a suspension of tissue fibrinogen which, in the presence of calcium, clots a fibrinogen solution or blood plasma as well as before the venom was added to it, but which does not at all produce thrombin.

This experiment proves that tissue fibrinogen does not act in the same way as cephalin acts, and solely by its cephalin content, as Professor Howell supposes, in some other way, either by a direct union with the fibrinogen or as a contact substance—and almost certainly by the first method, as Mills and his co-workers have shown.

Crotalus venom is remarkable, then, not only for its extremely toxic action on vessel wall and nerve cells, due to its crotalin content, this action continuing unchanged in the boiled venom, but also because of these two very specific enzymes, fibrinogenase and cephalinase, both of which are destroyed by boiling. It has enabled us to obtain them some further evidence of the truth of the Border and Gengou theory of clotting.

REVIEW
Dr. Irvine H. Page
Presbyterian Hospital, New York.

Dr. Mathews and Mills have chosen a subject, interest in which is exceeded only by its intricacy. Intricacy of thought, nomenclature and procedure have characterized this branch of research. The lecturer knows the theory and laboratory practice well, having been probably the first to recognize and champion Wooldridge. What he knows of the clinical application is difficult to judge. Dr. Mathews presents what seems to be the most significant advance in the field of hemostasis since the work of Bordet.

The Howell theory, even more than that of Morawitz, makes use of a multiplicity of terms which presumably are meant to describe substances. Without proof of the existence of these hypothetical materials this does not seem altogether advisable. It is not inconceivable that some of these "substances" may essentially prove to be "phenomena." At times the rampant speculations have assumed the position of little more than a fantastic travesty, not unlike the inimitable caricatures of Rube Goldberg.

In short, a more detailed and careful characterization of the chemical moieties which induce the clotting of blood might possibly render clearer the nature of the fundamental elements. This reaction.

Dr. Mathews has made a significant advance in the recognition of the phospholipin-protein role. Whether the partial species specificity first noted by Dr. Leo Loeb is due to a variation in the structure of the protein molecule or the cephalin fraction has not as yet been determined. One would like to know whether the nature of the union with the protein-cephalin consists in. Probably it is an adsorption phenomenon, as Dr. Mathews himself suggests. This is a compliment to Dr. Mathews' sense of the value of reference to the Physiological Reviews, Volume 1, page 553, will show.

One of the most striking results he reports is that tissue fibrinogen extract when taken by mouth actively reduces the clotting time. This is indeed, unlike most protein complexes. The active splitting of proteins by erepsin and trypsin almost invariably renders this path unmanageable for exhibition of this type of therapy.

In the last two years, extracts of the plant Coeanothus Americanus have been found to be active coagulants when administered internally. For instance where such a drug fits into our present theories is difficult to see, but it is not too great a call on our already stretched credulities. Mills' report on blood clotting in hemophilus seems decisive, though one would have liked more data. If Mills is right, then Howell must be
An Added Service
The Collecting Net is now initiating another phase of work which we believe will be of value to a number of people. To state our plans briefly: we are going to serve as a free employment agency. We will keep on file in our office applications of those persons who are looking for positions. These will be available for consultation by individuals who desire to employ workers.

At the beginning it will be largely younger workers looking for positions as research assistants or technicians who avail themselves of our services. To them we would like to remark that already a couple of men will be on file in our office applications of those persons who are looking for positions. These will be available for consultation by individuals who desire to employ workers. We wish to express our appreciation to Mr. Thomas F. Morrison, for the assistance in helping us in many ways with the work of THE COLLECTING NET.

Mr. Morrison is instructor in physiology at Princeton University. So far as our welfare is concerned it is unfortunate that Mr. Morrison is leaving Woods Hole on Saturday.

Motion pictures of the salmon fisheries of Alaska (Finley-Nature Film) and of cooperative fish culture of the bureau were shown on July 26 at the Bureau of Fisheries.

The Reduction Potential of Cysteine

(Continued from Page 3)

Biilman in studying certain azo dyes. In the case of the oxidant and reductant equilibrium was established but the reductant was found to undergo a molecular (semide) rearrangement producing a reduced substance without influence on the oxidation-reduction potential.

Furthermore the recent work of Harrison, who found that both the aerobic and anaerobic oxidation of sulphhydryl compounds was definitely catalyzed by iron-free dithio compounds, suggests that the cysteine system is not by means so simple as heretofore supposed.

Finally Dr. Michaelis pointed out that if we accept his measured potentials as indicative of the reducing power of cystine, it would account for the marked reducing intensity of living amoebae observed by Cohen, Chambers and Reznikoff. To the writer it seems rather dangerous to lay much stress on this point until this apparent reducing potential has been checked by some such means as Conant employs in ascertaining the apparent oxidation-reduction potentials of interconnected systems. If such measurements a potential of the same order of magnitude is found, then more stress may safely be laid on this point.

Our Classes
This report will probably be the last one which we will be able to publish. It seems that the fauna of the various classes are a migratory band, whose range is limited in these parts, to about six weeks. After the first week in August it will be a rare sight to see these birds of passage skimming along the waters of the Hole in such numbers.

They usually leave in a more or less disorganized flock, most of them following the New Bedford boats to warmer climes. The botanists are finishing their book on the Collecting Net under the guidance of Dr. Taylor. There is a discussion at the moment of this writing as to whether or not the class will hold its annual track and field meet. The discussion is due to the fact that this is conspicuously feminine and apparently the staff does not believe in intercollegiate athletics for women. This week’s seminar was given by Dr. Poole who spoke on Mycetoma and Orchid. The seminar of the week before was addressed by Dr. Arndt, who spoke on Coffee. The entire class was more or less wide awake as a result of testing the various varieties afterward.

The protozoolists seem to have recovered from their week of social activities, and they can be heard questioning various alumnus of the course in this very week. When we break the course, did you study the lectures all through the course, or did you concentrate on them toward the end?

In the Embryology course, Dr. Plough is lecturing on the Tunicates and will continue until the end of the course. In this last week the embryologists have crowded both a picnic and a bowling trip, and seem to be acquiring more or less sea-sonal propensities, that may acquire the salty savour which is the boast of the botanists and invertebrates.

The invertebrates, after a false start, finally did get in their trip to North Falmouth, and collected enough material to keep them busy far into the night. They set up a demonstration of Woods Hole fauna afterward under the direction of the staff. Dr. Bissonnette and Dr. Young have been lecturing this week, and on Monday and Tuesday Dr. Bissonnette will lecture on the Corals.

The physiologist seems a puzzle to the inquiring naturalist, and his life-history is more or less clouded with obscurity. As far as we can make out, the nests are built in the midst of concealing glassware, and the call of the bird sounds something like “pee-sich, pee-sich” repeated over and over. This, however, requires more careful observation than we have been able to give. But the time this article is published, the annual migration will be about to begin and will continue for at least a week.
Methods of Experimental Embryology
With Special Reference to Marine Invertebrates

(Continued)

E. E. Just
Professor of Zoology, Howard University

METHOD FOR RAISING A DIATOM CULTURE

For many problems in experimental embryology it would be worth while to carry the eggs not only to the larval stage but through metamorphosis. Unfortunately the literature affords too few instances of marine animals reared from normal eggs to sexual maturity and still fewer of eggs that have had experimental treatment. In the latter case one thinks particularly of Delages' parthenogenetic starfish and the parthenogenetic frogs of Loeb and Parmenter. I once had young Echinarchinus six weeks old which I had reared from eggs caused to develop by treatment with butyric acid followed by centrifuging. Unfortunately for me, I poured out the whole culture because he wanted to use the glass container to wash Mytilus which he intended to use on a party.

The difficulty of rearing marine forms is largely due to inadequate or improper food. Most of the marine invertebrates suffer from diatoms. If therefore one could have at hand a rich diatom culture as a source of food, one could remove the chief obstacle to carrying hermaphroditic embryos through metamorphosis. Such a culture can be got with ease. In 1922 I published a successful method of culturing diatoms in abundance, which I used several years for rearing Platynereis larvae to sexual maturity. This method follows.

At the beginning of the season mud is taken from Eel Pond, near-by flats or scraped from eel grass, together with animal and plant life. This is placed in jars containing equal amounts of sea-water. The jars are then covered with glass plates and set aside in subdued light. In a day or so all metazoa—worms, crustacea, ascidians, etc.—are dead. After a period of purification, a culture of diatoms and a rich diatomaceous deposit of diatom cover are left. It is a good plan to start several such cultures at five to ten day intervals.

From the stock culture thus prepared diatoms only are removed, suspended in filtered sea-water, and strained through bolting silk. The diatoms that pass through the bolting silk are placed in the dishes containing the larvae. As the larvae increase in size and vigor food is added in greater quantities.

With this method I raised Platynereis embryos to adult worms in one-half-gallon Mason jars kept tightly sealed and never once opened during ten months.

My experience in rearing marine invertebrates from eggs—Asterias, Arbacia, Echinarchinus, Nereis, Platynereis, Pectenaria, Dipsodyra, Chaetopterus, and Mytilus—indicates that the most essential point is to know when to begin feeding. In general food must not be given until the larvae have used the oil and yolk present in the eggs. This is readily ascertained in all the forms named except the echinoderms, since the oil particularly is well defined. For the echinoderms a few trials will indicate the proper time for the introduction of food.

METHODS FOR REMOVING THE JELLY FROM THE EGGS OF ARBACIA AND OF ECHINARCHINUS.

For various kinds of experimental work the removal of the jelly enclosing eggs of Arbacia and of Echinarchinus is frequently desirable. This is generally accomplished by treating the eggs with HCl in sea-water. The jelly may also be removed by shaking. Both methods may be injurious to the eggs.

It has sometimes been stated that the presence of the jelly hulls around echinoda ova is necessary for the separation of the vitelline membrane during the early stages of development (McClendon, Elder and Gray.) Upon this statement theories of the mechanism of membrane separation have been fabricated. That the presence of the egg-jelly is not necessary for membrane separation has been abundantly shown by several workers, notably Harvey, Lillie, Just and Hobson. The fact that shed eggs which in some instances are devoid of jelly, on insemination separate perfectly normal membranes argues against any necessary role of the jelly in the process of membrane separation. Moreover, frequently through shaking the eggs lose their jelly but retain their capacity to separate membranes. Centrifuging removes the jelly without impairing the normal response of the eggs to insemination. What is true, therefore, is not that the egg-jelly is a sine qua non for this response but that the methods for its removal may be deleterious to the eggs themselves. This is eminently true of HCl in sea-water.

HCl in sea-water, employed to remove the jelly from eggs of Arbacia and of Echinarchinus, may be harmful to the eggs either because the concentration of the acid is too great or because the washing in sea-water subsequent to the acid treatment is not sufficiently thorough. The concentration is important because increase of acidity blocks fertilization. Accord-
Methods of Experimental Embryology

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ing to Smith the acid limit (of CO₂-free sea-water) for a ten minute exposure for eggs of Arbacia and Echinarchinus is about pH 4.4. That is, at this pH and below, the eggs are irreversibly injured.

If the worker insists on using acid-sea-water to remove the egg-jelly he may find the following directions useful.

Treat each of four to six lots of eggs from the same female, with 50cc of HCl-sea-water of pH ranging from 3.5 (eggs exposed for 5 minutes) to 5.0 (eggs exposed for 8 minutes). Wash the eggs thoroughly by carrying them over, with as little of the acid sea-water as possible, to 1000 cc. of normal sea-water in a large flat dish of 3000 cc. capacity. Gently stir the water with a circular motion when the eggs have settled, in order to bring them to the centre of the dish. Pipette them off and place square, round, rectangular.

At least one lot should show as many membranes as the untreated inseminated eggs—if no lot gives this result, the eggs have suffered from the acid treatment. If, however, one or more of the samples show normal membranes following insemination, take additional samples from the original lots and without insemination examine each in turn under the microscope for the presence of the jelly. When in a single layer eggs with jelly touch each other, eggs without jelly cannot. Or, if the eggs be placed in a suspension of Chinese ink, made by grinding up the end of a stick of ink in sea-water, particles of ink will be seen close to the eggs without jelly and as far away from each egg with jelly as the width of its jelly.

On the whole, I regard removal of the egg-jelly by means of acid sea-water as unsatisfactory. In order to be sure of success one must use several concentrations because of the individual and seasonal variations of the eggs. Under the most favorable conditions the washing subsequent to acid treatment is laborious and time consuming if one needs a large number of eggs.

Shaking will remove the egg-jelly, but in my experience is uncertain when the eggs are at their seasonal optimum. Toward the end of the breeding season the jelly is more easily removed; indeed, eggs then frequently lose their jelly on standing in normal sea-water without any treatment.

I find that the simplest and most effective method for removing the jelly from eggs of Arbacia and of Echinarchinus is to put them through bolting silk. In this way the eggs are in no wise impaired, as can be demonstrated by the fact that they separate membranes at the rate, of the quality and of the per cent. identical with eggs from the same female which possess jelly hulls. One merely pours the eggs onto the wetted bolting silk stretched over a finger bowl containing sea-water. There is only one precaution: one must not use pressure—e. g., by pouring eggs from a height greater than three or four centimeters. Eggs examined under the microscope in a suspension of Chinese ink in sea-water are found free of jelly. If some eggs still possess jelly they are put through the bolting silk again. I have used this method for several years now. After rather tedious comparisons with the other methods named, I can safely say that it is the best.

METHODS FOR REMOVING THE VITELLINE MEMBRANE FROM INSEMINATED EGGS OF ARBACIA AND OF ECHINARCHINUS.

A great deal of experimental work has been done on echinoid eggs whose vitelline membranes have been removed after their separation as the result of insemination or of treatment with butyric acid. As soon as completely separated the membranes are most readily removed. This is generally accomplished by shaking. But there is a great deal of evidence to indicate that at this time the eggs are very susceptible to shaking. Boveri and more recently Painter use shaking for the specific purpose of modifying the development of echinoid eggs. I should say that any experimental work based on eggs whose membranes have been removed, immediately after separation, by shaking or by similar methods, is of doubtful value.

The membranes can, however, be removed without the slightest injury to the eggs. For this purpose again I use bolting silk. The method is as follows.

Eggs from one female known by previous trial inseminations to be of optimum fertilization capacity, as revealed by the speed and quality of the cortical reactions induced by insemination, are used. About two minutes after insemination when the membranes are equidistant from the egg surface at all points—e. g., the vitelline space is of equal width throughout—the egg suspension is very gently poured onto wetted bolting silk. As the eggs pass through the mesh, they lose their membranes. A good plan is to put the eggs through the silk three times—at ninety, one hundred twenty and one hundred fifty seconds after insemination in order to allow for any individual differences in their insemination time. Practically one hundred per cent. of the eggs will thus be freed of their membranes. Eggs without membranes should never be crowded; they should lie in one layer well spaced in plenty of sea-water.

(To be continued)
The Behavior of Mutable Genes

An evening lecture bearing the above title was delivered on July 13. The authors summary and a review of the lecture follow.

Dr. M. Demerick

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In addition to genes which behave as very constant units there are genes known which change with a high frequency, viz. which are in a mutable condition. About fifty mutual genes have been described in plants and 5 or 6 in Drosophila. They determine different color characters (chlorophyll and anthocyan variegations in plants, and body color and eye colors of Drosophila virilis and melanogaster), different morphological characters (shape and size of leaves and flowers in plants, and miniature wings, in D. virilis), and also different degrees of sterility (in plants). The majority of known mutable genes mutate in all stages of the development in somatic cells as well as in the germ-cells. Mutable genes are known, however, with mutability restricted to a definite period of development.

The most restricted mutability known at present has the gene for reddish body color character of D. virilis, which mutates at the reduction division of heterozygous females only. The frequency of mutability of reddish is fairly low (1-10%) when compared to the frequency of mutability of other mutual genes. In the case of redu- dished females a rate was found to exist between the occurrence of reversions and the crossing over in the red-lib- dence region. In that region crossing over in the reverted classes is increased—from 6 to 132 percent as compared to the crossing over in the normal classes. A mutability almost restricted to the maturation division was also found in plants (Plantago, Pharbitis).

By a method developed by E. G. Anderson, the frequency of somatic mutability of color characters could be measured for several cell generations, and the frequency of relative mutability could be determined. The relative frequency of mutability is the frequency of mutability in one cell generation as compared to the frequency of mutability in another cell generation. The absolute frequency of mutability is the total frequency of mutability in all cell generations. The curves for the relative frequency of mutability of four genes of Delphinium and one gene of Maize indicated that one gene of Delphinium (pale green chlo-rophyll and rose flower color) the frequency of mutability was constant during five generations but increased in the sixth generation from fifteen to about forty percent; the increase in the mutability of the gene for variegated pericarp of maize (data of Anderson and Eyster) is pronounced in the fourth cell generation; the peak, however, is attained in the sixth cell generation; finally the gene for lavender color character of Delphinium has a very low frequency in the first five measured cell generations and a very high frequency in the sixth cell generation.

All measurements were made during the sixth generation toward the end of the development of the measured organ (leaf, petal, or seed.) In the case of mutable genes of Delphinium no genetic change in the relative frequency of mutations has been noticed.

The absolute frequency of mutability is very variable. In the case of color variegations, light and dark variegated lines can easily be established by selection. Selection was found also to be very effective in the case of mutable characters of Drosophila virilis. It has been possible by selection to increase or decrease in a small number of generations the frequency of somatic or germinal mutability of the miniature wing character. The results of different experiments indicated that the change in the mutability effected by selection was due to the isolation of different modifiers which stimulate the mutability of miniature. It has been found that the mutable miniature in a certain genetic environment behaves as almost constant. Two dominant genes were isolated, one of which stimulated miniature to mutate with a very high frequency in somatic cells only (producing mosaics) not affecting at all the mutability at maturation division (germinal mutability). The other gene stimulated the germinal mutability of miniature not affecting its somatic mutability. By combining miniature with the gene which stimulates somatic mutation of the line has been obtained producing one hundred percent of mosaic flies without giving any germinal changes. Miniature of that line duplicates the behavior of spotting in mammals.

The great majority of known mutable genes mutate in one direction only, viz. from the mutant to the wild type. In a few cases, however, it is known that the change in the opposite direction may occur also, but with a very low frequency.

In the case of miniature a constant miniature was obtained from the mutable one.

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In an attempt to explain the mutable condition of certain genes, hypotheses were proposed (Correns, Anderson, Eyster) which assume that these genes are complex structures composed of smaller genic units. The changes observed, according to these hypotheses, are due to the mechanical assortments of these small units. The evidence accumulated up to this time is more against than in favor of these hypotheses. An assumption that the frequent mutability is due to chemical liability of the gene could also account for all of the observed facts. Other hypotheses may prove useful.

**Review**

Calvin B. Bridges  
**Member of the Staff, Carnegie Institution.**

The highest interest in genes which mutate with exceptional frequency lies in the possibility which they offer of obtaining more information upon the nature of the mutable genes, and of genes as a class. It has been tacitly but rather generally assumed that the gene is the basic structure in the series of units concerned with heredity. The chromosome, the group of chromosomes (n), the nuclear outfit, (e.g., 4n) and the total cell have been recognized as higher units. Mendelian phenomena deal with living material at the level of organization of the gene, as chemistry deals with matter at the level of organization of atoms and the combination of atoms into molecules. But the physical properties below the atom, and deals with its properties as the outcome of definite internal structure of which the units are the nucleus and the peripheral zone, and these in turn are analyzed into positive and negative electrons, regularly disposed. Similarly, the properties of a gene and of different genes must be accounted for in terms of the internal structure of the gene.

The question at issue is how many levels of organization intervene between the gene, which is a living unit, and the chemical level of non-living atoms. Stated more specifically, is the gene directly concerned with the atoms, thereby existing as a single molecule, or is it one level higher, ranking as a molecular aggregate? In the first case the transformation of an original gene into a new gene, the mutant gene, proceeds in a way concerned with the kind of basic structure, the character of the radials and the atomic relations directly. In the second case mutation must also start from a point in the constitution of a molecule; but the observable mutative change in the organism may then be the result of a totally different process, namely, the change in the proportions of the original type of genic molecule to the mutant type of genic molecule. After the first step the gene consists of n—1 original type molecules and one mutant-type molecule. The different action of the one mutant-type molecule may well be seen by the standard action of each molecule. Presumably each molecule reproduces itself independently, but with a rate approximately the same for all, and within the limit imposed by the nucleus. The ratio of the transformation is in favor for a daughter molecule to be included in each of the daughter units of the next higher aggregate. Production should ordinarily maintain the original ratio, just as the different chromosomes of a group of chromosones are maintained in their original ratio during successive nuclear divisions.

But accidents might occur, which would throw both daughter molecules into the same chemical environment giving a slightly different ratio of mutant and original-type molecules in the mixture. The total molecules of that gene have meanwhile increased by one, but in the altered daughter molecule it has decreased by one. There would presumably be physical limits regulating roughly the size to which a gene might attain by change in number of constituent molecules and still be stable. If the ratio of two types of molecules might soon give a ratio in which the mutant type of molecule would produce an effect. The gene would then manifest itself as a mutant allelomorph. If the changes in ratio were relatively rapid, the gene would seem to be highly mutable, although the origination of the new type of gene element occurred only the once in the ancestry of the gene.

A mixed gene of this type would be expected to shift, mainly by chance, in the direction of a higher ratio of the original type of molecule or of the mutant type of molecule. As long as the sorting out of the gene elements has not been completed, mutants to more extreme allelomorphs or to less extreme allelomorphs would be possible.

In one of the strains of corn worked with by Eyster, the general color of the pericarp is an orange, deeper or lighter tone, the tone being determined as an increase or decrease in the red to white gene elements present. This orange background gives place to variegations by the appearance side by side of a red and of a white of different ratios and widths. In this case it seems clear that the two stripes would go back to a cell division which produced two daughter cells, one of which may be assumed to be identical with the parent and the other with the white genes. But this type of variegation seems to be the exception rather than the rule; usually the stripe repre-
THE CHROMOSOMES
OF DROSOPHILA
MELANOGASTER

(Continued from Page 10)

...through genetical behavior as possessing only one fourth chromosome.

For many years it was not perceived that there is a constant size difference between the two pairs of large V-shaped chromosomes, amounting to about 20 percent. Measurements give about 3.2 micra as the length of the longer V, 2.6 micra for the smaller V, 1.8 for the X and 2.0 for the Y, with the arms of the Y, 1.2 and .8 micron long.

Each of the large Vs has a marked constriction at its mid-point, which is also the point of spindle-fibers attachment. Rather recently it has been observed that the X has a marked constriction at a distance slightly less than a third of the way from the point of the spindle-fibers attachment. The proximal piece may even be mistaken for a separate chromosome, especially since the joining is not direct but is slightly offset. The proximal piece is smaller in diameter than the remainder of the X chromosome. There is another, less marked, constriction in the X. Each limb of the large V is likewise segmented into three parts, of which the proximal part is only about a fifth of the length of the limb. Most of the bending of the chromosomes comes at these constrictions. The metaphase split starts with the most distal section and reaches the proximal section last. In the Y and in the smaller pair of Vs, there is a sharp constriction and an angular bend at the point of spindle-fiber attachment, and fainter constrictions occur elsewhere.

Genetic and cytological studies have brought to light numerous modifications of this basic group; first by changing the number in which a particular chromosome appears, and second, by changes involving all or several chromosomes. These modifications have high theoretical value in showing that the effects of the chromosome aberrations can be interpreted in terms of constituent genes within the chromosomes. The triple-IV type was not found until after a portrait has been made of it by means of two X chromosome attachment between the two X’s or between the X and a part of the Y. In the attached-X condition, there seems to be only one spindle fiber for two chromosomes. The converse situation also exists, in which there are apparently two spindle fibers for the X-chromosome.

In one case the end of the second chromosome has become broken off and transferred to the third chromosome, where it is interpolated. Cytological examination of the type shows inequalities in the lengths of the arms of both the large and the small V, corresponding to a deficiency in the case of the large second chromosome, and to a duplication on the smaller third chromosome.

REVIEW

Dr. C. W. Metz
Carnegie Institution of Washington.

Unlike the other two speakers of the evening, who emphasized special aspects of current research, Dr. Bridges summarized the results of a series of investigations extending over many years—giving a bird’s eye view of the gross modifications of the chromosome group thus far investigated in Drosophila melanogaster. This series of modifications involved a wide range of conditions, from that in which one chromosome was lacking, through others in which whole chromosomes or parts of chromosomes were added, up to the triploid condition in which three chromosomes instead of the normal two of each kind were present. It also involved cases of attachment of chromosomes and modifications in chromosome behavior. The extent of the series, together with the fact that it involved the best known genetic material in the world and was reviewed by one of the leading students of this material, served to make the review of particular value, especially to those in other fields of work. On the other hand, the amount of ground to be covered necessitated an extreme brevity of treatment, with little emphasis on the experimental methods employed.

Dr. Bridges’ review brought out clearly the great value, not to say necessity, of combining genetic and cytological study in any attempt to analyse the processes of inheritance in an organism. It also gave an indication of the greater delicacy of the genetic method, as contrasted with cytological observation, in studying chromosome behavior. The latter feature would have appeared much more clearly had it been possible to consider the detailed methods used in the work.

In Drosophila there appear to be certain specific limitations to the viable chromosome combinations. For instance, the addition of one large autosome to the normal diploid group apparently produces an unbalanced condition fatal to the individual. In this respect some species of plants may be more favorable, but on the other hand, the Drosophila evidence is the more illuminating because of the exhaustive genetic analysis which forms the background of these particular studies.
THE JEST

An exciting melodrama is The Jest, the play by the Italian dramatist, Sam Benelli, which was presented this past week by the University Players' Guild in Falmouth. Each of the four acts is replete with threats, cruel moments, bitter scheming—factual in fact with all the proper harrowing action of the true melodrama. Certainly the play did not drag for a single moment, and the weary biologists who attended were not in danger of napping or of letting their minds wander to biological problems during the course of the action.

Without any doubt, The Jest is the most difficult play yet presented by the Guild. Each of the principal characters had a continuous succession of scenes in which he was called upon to enact the extremes of the varying emotions of love and hate and fear. And it must be said of these actors that they carried the exacting roles most excellently.

F. Kent Smith of Harvard who played the part of Neri gave a truly splendid performance. In the first act he was a perfect blustering, scheming villain, and later on, when he was trapped and chained, his anguish and fury were most convincing. But he was particularly good in the dungeon scene where he was being tormented by Giannetto, when he was trapped and chained, and when he simulated madness. The equally difficult role of Giannetto was taken by Breitaigne Windust, president of the Princeton Theatre Intime, whose stage manner and facial expressions were particularly notable. Unfortunately, his enunciation was not as clear as Mr. Smith's, and those in the back of the theatre at many times had difficulty in understanding his lines.

Elizabeth Schaufler of Smith was cast in the third principal part—that of the beautiful, wanton, and vain Ginevra—and beautiful and

wanton and vain she assuredly was. Equally as impressive as the acting was the stage-setting managed by Charles Leatherbee. The sets were extremely artistic and suggestive of a professional than of an amateur stage. The costumes, which were made by Mrs. Higgins Sullivan, were also beautifully done, those of Ginevra being particularly lovely.

Criticisms of the performance would be those directed against the play itself rather than against the production by the Guild. For instance, the realistic touch when Ginevra comes out from her chamber dragging the blood-stained sheet on which Gabriello had just been murdered, seemed not only entirely unnecessary and unlikely, but savoried too much of gory realism. As for the production itself, however, there is no doubt that it was excellently carried on, and The Jest provided for most people the best evening's diversion of any of the plays thus far presented.

V. L. T.

A SCIENTIFIC ALLIGATOR

Is it any wonder that even the animals imbibe the spirit of research when they live in an atmosphere like this?

At least Willie the Alligator does not think so for he began his education on the surrounding fields by crawling curiously about the tables in the Loeb Laboratory. When he grew bolder he assayed a fall to the floor and then ventured out into the semi-darkened hallway. He watched his opportunity like a true scientific adventurer and gained the wider experience of natural things that an evening on a grassy plot beneath a starlit sky has to offer. His investigations were finally brought to an abrupt ending by a two-legged seacher with a single bright eye, who had a definite rather than a generalized aim in his search.

ROOMS AVAILABLE THIS WEEK IN WOODS HOLE
Louise and Elizabeth Mast

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The following people will have rooms vacant at the close of the courses:
Mrs. Nickerson, Mrs. Pierce, Mrs. Rohm cling.

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PRINCIPLES OF PLANT PATHOLOGY

By C. E. OWENS
Associate Professor of Plant Pathology,
Oregon State Agricultural College,
Corvallis, Oregon.

This book has been planned for use in a one-semester course in Plant Pathology. It will meet the needs of undergraduates in schools of agriculture, and can be used with success in non-technical colleges and universities where applied courses in botany are offered.

The book is divided into two parts. Part I treats the general aspects of plant pathology. Topics covered include:—Historical
account of the rise and development of the science of plant pathology; definition, symptoms, and classification of plant dis-
eases; relation of plant diseases to the environment; methods of investigating plant diseases; sickle conditions; relation of insects to plant diseases; storage and transportation problems arising from plant diseases; and control measures, such as the
use of fungicides, disease-resistant plants, clean seed and nursery stock, and quarantine and inspection.

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Floristic Succession in the Swamp of Virginia

Dr. J. F. Lewis
Professor of Biology, University of Virginia

It has long been known that pollen grains are more or less distinctive and may serve as a precise basis of identification. The discovery that the exine of pollen resists decay under bog conditions is more recent. Vos Post of Sweden first worked out a method for analyzing, by the identification of subfossil pollens, the vegetation constituents of peat bogs at different levels. By this method it has been possible to trace floristic succession in the peat deposits of various European countries and to draw conclusions as to post-glacial climatic changes.

The method of pollen analysis applied to the "Great Dismal" near Norfolk, Va., shows that this area began its floral development as a great brackish swamp covered by grasses and sedges growing in the sand and mud. This was the condition when the peat now ten feet below the present surface was forming. Besides the dominant grasses and sedges there was a little Pine, Willow, Osmunda, and Polygonum.

At the nine foot level the meadow bog was becoming a savannah, with many new types appearing. Pine is now fairly abundant, willow is common, and there also occur ferns, water lilies, paw paw, club mosses, heaths, black gum, oak, and beech. It is evident that a forest type of vegetation was developing at this level on the higher and drier spots.

At or near the eight foot level there appears to have been a drying out process, perhaps accompanied by a great conflagration. At the same time there is a great increase in fungus spores. The sedges and grasses have now increased, and the forest constituents have begun to decline, although holly and alder appear as new types.

The trouble that developed in the orderly progress of the vegetation at eight feet became serious by the time the 7 foot level was reached, and assumed the proportions of cataclysm. At 7 feet most of the forest types are gone. The few remaining are greatly diminished. Even pine falls to a minimum of 5 per cent of the total, which indicates that the change for the worse was general throughout the swamp area and its environs. Oak, holly, alder, beech, Osmunda, club mosses and others are gone, while willow has increased, and fungus spores now form a surprisingly high (15) per cent of the total spores.

At 6 feet forest conditions are returning. Although fungus spores are still numerous, 5 forest types have returned, and 2 new ones have appeared (mosses and jessamine).

(Continued on Page 2)

M. B. L. Calendar
Saturday, Aug. 11
9:00 P. M.

Tuesday, Aug. 14
8:00 P. M.
Evening Seminar. Dr. A. C. Redfield, Assistant Professor of Physiology, Harvard Medical School. "Role of the Blood in Asphyxiation of the Spinal Cord".
Dr. W. E. Garrey, Professor of Physiology, Vanderbilt Medical School. "The Basal Metabolism of Cancer and its Physiological Variations".
Dr. E. K. Marshall, Professor of Physiology, Johns Hopkins University. "Structure and Function of the Kidney of the Goose-fish".

Wednesday, Aug. 15
3:00-5:00 P. M.

Friday, Aug. 17
1:00-6:00 P. M.
8:00 P. M.
Evening Lecture. Dr. A. N. Richards, Professor of Pharmacology, University of Pennsylvania. "Experiments of the Elimination of Certain Dyes by the Kidney".

THE OCEANIC PROBLEM
By Dr. A. G. Huntsman
Director of the Atlantic Biological station, St. Andrews, N. B.

Dr. Huntsman delivered the evening lecture bearing the above title on July 29. The author's summary and a review of the paper by Dr. Higgins follow.

The ocean presents a fascinating complex and ever-changing problem. If one takes any particular cubic metre of water in Buzzards Bay at a particular time, a host of questions may be asked about it. Why does it have its particular salinity, temperature, oxygen tension, nitrogen content, phosphorus content, character and intensity of light? Why are the animals and plants in it of particular species? Why are the individuals of each of a certain abundance, of certain size, of certain ages, in certain physiological conditions, and the seces in certain proportions? No matter which of these questions were taken, it would soon be found that but a very incomplete answer could be given on the basis of present knowledge.

Also, if one attempted to probe the manner or the particular question at all deeply, one would soon be involved in most of the other questions as well. The investigation could not properly be confined to a particular species, a particular depth, a particular time of the day, a particular season of the year, or even to a particular region. It is, therefore, correct to state that to the inquiring mind the ocean presents one problem.

Not only is it impossible to have a thorough investigation of one of these questions, and be limited in time, in space, or in matter, but even in order to visualize properly the existence of such questions, the importance of finding answers to them, or the means of doing so, it is necessary for one to have the stimulation of contact with the contrasts that the ocean presents. We are particularly fortunate in this part of the world in being able to obtain experience of remarkable contrasts in the ocean without having to make long voyages. The Labrador current brings icebergs, Greenland seals, polar bears, and a host of arctic forms south to the latitude of the State of Maine, and such arctic conditions can be studied in a very pure state in the Strait of Belle Isle, which is on the great circle or ocean highway between Montreal and the British Isles, and which has regular steamship service during the season of navigation. In that Strait in pleasant summer weather one can observe a treeless Arctic shore, incepting glaciers at the water's edge, floating ice, salt water, over one degree below zero, Centigrade, and a great wealth of arctic animals and plants. More than this, the Strait itself furnishes an attractive oceanographic situation in the ceaseless summer struggle between the ice-laden cold water entering from the Labrador current, and the warm water entering from the Gulf of St. Lawrence. The human population at each fishing place is vitally dependent upon the local outcome, but ignorant of it, except as shown in the presence or absence of the codfish which forms their sole source of livelihood.

For the other side of the picture we have the so-called "Gulf Stream" bringing tropical water, with floating Sargasso weed and an enormous variety of animals and plants, not only to the latitude of Cape Cod, but much farther north. This mixes with the ice-laden water of the Labrador current off the southern tip of the Grand Banks of Newfoundland, where the Titanic sank. The tropical, conditions thus brought northward can be readily investigated, from terra firma in delightful summer weather at all seasons of the year on the island of Bermuda, within two days sail from New York. There a broad pinnacle of (Continued on Page 2)
THE OCEANIC PROBLEM

(Continued from Page 1)

The problem of the ocean is to be solved in the well tried scientific fashion—observation of nature, the establishment of correlations, the formation of theories, and the testing of these theories by further observation or by experiment. Two states, Maine and New Hampshire, do not go far enough south along the coast. The latter is absent from the warmer waters that are frequented by the former. Can they withstand equally high temperatures? The very high tides of the region reach from New Hampshire to the southern exposure of Nova Scotia, and why are young herring concentrated in the Passamaquoddy Bay region? Why is the lobster so abundant at the southern exposure of New England? Why do herring concentrated in the Passamaquoddy Bay region? It is especially noteworthy that these are "practical" questions. Their solution has economic importance and shows how true ecology can yield rich dividends in terms of human prosperity and happiness. Yet they are worthy of careful attention as part of the oceanic problem, despite their practical bearings.

Dr. Huntsman, however, is not interested solely in the location of the schools of cod in the Straits of Belle Isle or in the fate of the eggs of herring in the St. Croix River. His oceanic problem is the discovery of those factors in the environment, both physical and biological, that limit vertically and horizontally the distribution of life. Why are young herring concentrated in the Passamaquoddy Bay region? Why is the lobster so abundant at the southern exposure of New England? Why do herring concentrated in the Passamaquoddy Bay region?

Dr. Huntsman employs direct experiment to check his method of attack are both intensive and extensive. He urges the study of the effects of these factors over large areas by means of frequent deep occupations by which the results of investigation are correlated and by which correlated results of natural phenomena may be made, but in addition to this he employs direct experimentation to check the conclusions drawn and to determine new relationships of facts. Indeed his employment of the experimental method is what distinguishes his work from the older methods of observational work. To him belongs the credit of having developed the methods of future investigators.

The proceeds of the sale will be used to support the studies of Dr. Huntsman and his associates, and the proceeds will be divided among the students at Woods Hole. The price is $4.00 a table or $1.00 an individual. The sales will begin August 15, from two to five o'clock. All members are urged to form tables or come individually.

M. B. L. CLUB ANNOUNCEMENT

An afternoo bridge will be held at the M. B. L. Club on Wednesday, August 15, from two to five o'clock. The price is $4.00 a table or $1.00 a player. The proceeds are to be used to support the work of the Club. All members are urged to turn out and play.

The M. B. L. Club can now furnish glasses, cups, and saucers, and a tea service for small parties, for the nominal charge of fifty cents.

FLOSTRIC SUCCESSION

(Continued from Page 1)

Continued progress toward a forested condition is shown at 5 feet with a decrease in grasses and sedges and fungi, and an increase in the forest constituents. At this point Sphagnum appears for the first time, so that if it is ever to be a Diatom Swamp it may be, as has been assumed, a Sphagnum bog. Birch also appears at this level.

The 4 foot level shows a second regression, indicating a period of favorable conditions. However, the great plague of fungi has subsided, and there are indications of better times in the increase of humus and ferns and in the return of club mosses and jessamine.

From 3 feet to the surface there is unbroken development of the forest, indicating increasingly mesophytic conditions. The pioneer pine diminishes and becomes the dominant type of the forest. The most characteristic is the beech, and the first lumbermen went through the region there was an almost pure stand of white cedar such as is now found in a great part of the swamp.

The results make a beginning in tracing changes in vegetation and promise to throw some light on climatic changes and on oscillations in land levels in this region.

REVIEW

J. M. Fogg, Jr.,
Instructor of Botany, University of Pennsylvania

One of the most interesting problems which the oceanographer has to solve is that of determining the recent past history of the vegetation of a given region. Through a study of subfossil remains, such as are often preserved under log or swamp conditions, the latest finds, remarkably accurate picture of vegetational succession may be pieced together. Such work acquires a double value and interest when, as in the present case, its results are in general confirmed by geologists working independently on problems of continental submergence and elevation.

The study of floristic succession in the Diatom Swamp of Virginia and North Carolina reported on by Dr. Lewis, leads to conclusions which are at variance with traditional conceptions of the developmental history of the region. It may well be questioned whether the revolutionary nature of these results be warranted by adequate evidence.

The results of the present method of studying microfossil remains may well have proved formidable, but now that it has been found possible to recognize the more or less perfectly preserved shells of pollen...
review
John M. Fogg, Jr.
(Continued from Page 2)

grains exhumed from relatively considerable depths in the soil, the ecologist is provided with an indicator system which, for sheer simplicity, nearly all geologists consider the ecological by which one measures the rate of recession of a glacier.

There is one serious difficulty, however, viz., the fact that any process by which vegetation is determined to be either a source or a sink of error. This difficulty would naturally be rendered negligible by the taking of a large number of samples. Despite the recognized limitations of work of this sort, it must be conceded that here are the most accurate and practical methods yet devised for studying the past history of natural areas and for gaining a real insight into the order of development of vegetation. The far-reaching significance of such studies and their influence upon allied problems of ecology, climatic and phylogenetic nature need scarcely be emphasized.

DESTRUCTION OF CATALASE BY HYDROGEN PEROXIDE

Dr. Sergius Morgulis
Professor of Biochemistry, University of Nebraska College of Medicine

Dr. Morgulis presented a paper bearing the above title at the Research Seminar on July 17.

The catalase reaction, which manifests itself in the liberation of oxygen, is the resultant of two antagonistic processes: (1.) the catalytic formation of oxygen from hydrogen peroxide, and (2.) the destruction of the enzyme catalase. By properly adjusting the experimental conditions it is possible to make either the first or the second part of the reaction predominant. The "destruction of the catalase" is a phenomenon fundamentally distinct from the "inactivation" of the enzyme. The destruction occurs only in the course of the catalase reaction. Consequently, it is under conditions entirely independent of the catalase reaction. The nature of the chemical alterations of the catalase which in both instances results in a loss of enzymatic activity is not known, but the two processes nevertheless can be easily differentiated. Thus, the destruction of catalase is a monomolecular reaction: it increases with temperature and apparently also with alkalinity. The destruction of the catalase is definitely related to temperature changes, this correlation being expressed by a sine curve. Finally, it has practically no effect on the latent period of the catalase reaction.

The inactivation of catalase, exemplified by loss of enzymatic activity caused by heat, is very intimately associated with changes in H-ion concentration, the heat stability being greatest at pH 6.0. Indeed, it does not seem improbable that the inactivation by heat is due simply to an acceleration of changes induced by H-ion concentration. At 65° C the liability of the catalase molecule to denature, so that the enzyme is instantly inactivated at all pH. The inactivation of catalase unlike the destruction reaction, follows a bimolecular course, which is proportional to the acid side of pH, 6.0 and, lastly, greatly affects the latent period of the catalase reaction.

Owing to the composite nature of the catalase reaction, its kinetic equations which are not directly by the law of mass action applied to the decomposition of the hydrogen peroxide, but must be formulated for each of the component reactions separately. It is obvious that a proper understanding of these reactions is an essential prerequisite for their correct formulation. Tasmakski developed an equation for the catalase reaction involving the following kinetic equations: (1) d[S] dt = k, E. (catalytic reaction) and (2.) dE dt = k2, E. (catalase destruction), in which E and S are the concentration of enzyme and hydrogen peroxide, respectively. Williams in a recent attempt to formulate the kinetic equation of the catalase reaction follows Tasmakski in the mathematical elaboration of the problem, but for the second equation he has substituted the expression: dE dt = k2, dS / dt2. In other words, whereas Tasmakski assumes that the H2O2 concentration is a factor determining the rate of destruction of catalase, Williams assumes that the latter is determined by the rate of decomposition of the H2O2. It is his opinion that the catalytically liberated oxygen, while still in nascent condition, destroys the enzyme.

From my earlier studies of the catalase reaction, I came to the conclusion that the catalase destruction is a function of the H2O2 concentration. Tasmakski's assumption of the latter is determined by the rate of decomposition of the H2O2. It is his opinion that the catalytically liberated oxygen, while still in nascent condition, destroys the enzyme. This follows the fact that catalase is a function of the H2O2 concentration, and the catalyst involved in this reaction has been called "catalase".

The interest of the biologist lies in the action that any enzyme may have in rendering oxygen more easily available for the all-important oxidations that are inseparably associated with the liberation of energy in the organism. Dakin, in his monograph (1922 2nd Ed.) on "Oxidations and Reductions", speaks of the H2O2 as one of the "principal oxidants of the body". He states that, "within recent years it has been shown repeatedly that great increase in oxidation, such for example as that which follows the fertilization of the sea urchin's eggs, is not accompanied by a comparable increase in catalase action (Amerger and Winternitz)." This is in harmony with the fact that catalase liberates from hydrogen peroxide, oxygen which is the ultimate molecular state.

Dr. Morgulis stressed the point that the catalase reaction is probably a complex process. Dealing particularly with the destruction of the catalase, he showed that both heat and alkalinity hastened the destruction of the enzyme. It was found that over a pH range of from 6.0 to 7.0 the enzyme is much more resistant to heat: At 65° C the enzyme is completely inactivated, regardless of the pH. Williams, investigating the problem of catalase destruction, believes that the destructive agents are not the oxygen liberated from hydrogen peroxide, but Dr. Morgulis has
DESTRUCTION OF CATALASE
(Continued from Page 3)

shown by some very beautiful data that hydrogen peroxide is really the destructive agent.

A peculiar fact about the action of catalase is the temperature which is optimum for it. At 2°C, catalase liberates oxygen from hydrogen peroxide more effectively than at higher or lower temperatures.

The work of Dixon bears upon the probable significance that may be attached to catalase action. In studying the oxidation of purines, Dixon found that the catalyst, xanthine oxidase, was destroyed during the course of the reaction. Hydrogen peroxide is formed during the reaction, and it is believed that catalase may function in the removal of this otherwise harmful hydrogen peroxide.

Frequent attempts have been made to demonstrate that hydrogen peroxide occurs as an intermediate product in biological oxidations. It undoubtedly does play a role as a transitory intermediate in some biological reactions, particularly in those oxidations where the occurrence under such conditions has yet to be shown to be related to biological oxidation, for the destruction of hydrogen peroxide by catalase yields inactive, molecular oxygen.

Dakin states that, "The distribution and mode of action of this ferment are such that so far as the writer can see there is not a trace of evidence available suggesting that catalase is directly concerned with oxidation. It will be recalled that catalase only liberates inactive molecular oxygen when decomposing hydrogen peroxide, and so far it has not been shown to accumulate or participate in the oxidation of any known metabolite." Dakin further states, "Yet we are asked to believe that catalase is the enzyme in the body principally responsible for oxidation, and that the fundamental problems of tissue oxidation can be solved by noting variations in its concentration. In the judgment of the writer it appears reasonable to reject the inferences drawn from these studies until unequivocal evidence is produced that catalase actually participates in the oxidation of known metabolic products, and until the quantitative estimations of the catalase are made under more exactly controlled conditions."

He concludes the subject with the statement that "The old idea that catalase may serve to prevent excessive accumulation in the tissues of injurious peroxide by converting it into water and inactive molecular oxygen seems to have a good deal to recommend it."

The view of Dakin is shared by Morgan who, in his review of the subject, states that catalase content is not an index of metabolism—that it is not a true oxidizing enzyme but is apparently of value in the destruction of hydrogen peroxide, thus preventing the accumulation of this substance which is toxic when present above a certain concentration.

A great many publications have dealt with the catalase content of almost everything, but we are yet unable clearly to define the significance of this ubiquitous enzyme.
Egg Differentiation (Continued from Page 4)

Strongylocentrotus at least, where a skeleton is formed, this was most often a single triradiate spicule.

In order to test the hypothesis of differentiation in the egg at the time of the first cleavage, which would explain these results, two additional investigations were undertaken. It was first verified that the first cleavage plane cuts close to the egg axis, and that the microsomes appear opposite the micropyle in over 95% of eggs. Echigögorgmers were separated into two parts in the plane of the third cleavage in the 8 and 16 cell stages. These showed—contrary to Driesch’s data—that the upper or animal hemisphere, giving one with and one without skeleton, and cut just before the first cleavage in the same plane indicated a similar differentiation at that time. The gut and skeleton-forming material are thus proved to lie in the vegetative hemisphere alone, at first cleavage. These latter observations confirm those of Horstadius recently published.

Von Ubisch has shown that the first cleavage plane may make any angle with the future axis of the larval body, although it most often coincides with it. The work thus indicates that the skeleton-forming material probably lies in an eccentric position in the ventral hemisphere of the egg, with apparently some bilateral differentiation. The first cleavage plane may separate the right and left portions of the skeleton-forming material—giving two incomplete blastomeres—or it may separate both from the remainder of the egg—giving one with and one without a skeleton. The tendency appears to be for the material forming the skeleton to develop as it would have done in the normal egg, but such blastomeres have a certain amount of regulative capacity.

Comments on Dr. Plough’s Paper

By Dr. E. G. Conklin
Professor of Zoology, Princeton University

Dr. Plough’s work on the potency of isolated blastomeres of the eggs of different species of Echinoderm is of particular interest because it shows, by the use of more exact and scientific methods than those previously employed, that the distinction between “mosaic” eggs and “regulative” eggs is less sharp than was formerly supposed. At the same time it indicates that there is no ground for the assumption of Driesch that every one of the first four blastomeres is typically totipotent, but rather that there are already present at the first and second cleavages differentiation of these blastomeres which limit their potencies.

There is a widely accepted body of data concerning the structure and behavior of central bodies in animal cells. It is assumed that the central body of a cell grows and divides into two, each daughter cell receiving one of them during mitosis. They are thought of as maintaining genetic continuity from cell to cell. Hence they are regarded as a self-perpetuating permanent cell component. They are spoken of as the “dynamic” centers of cells, or as “division centers,” since they are supposed to be the formative foci about which cells arise. It has been known for a long time that individual blastomeres of the 2, 4 and 8-cell stages are not totipotent, even in the case of annelids, mollusks and ascidians, but echinoderms were generally supposed to be typical examples of such totipotence. Plough’s work shows that Echinoderm eggs are not in this respect fundamentally unlike those of the other phyla named; in all of them differentiations begin as early as the first cleavage, though the degree of differentiation, and the capacity for regulation may vary in different forms.

Upon the supposed totipotence of the blastomeres of Echinoderm eggs, Driesch based his first proof of vitalism, in that, as he said, it was inconceivable that any machine could be fragmented in the three dimensions of space and the fragments still be capable of giving rise to a perfect machine. He therefore assumed the presence of a non-causal, vitalistic factor, his “entelechy,” which was entirely beyond the reach of science. This abandonment of science and the scientific method is now shown to have been premature.

Dr. Plough’s experiments refer only to stages of development at the time of the first cleavage and later. At earlier stages there is good evidence, as shown by Tennent and others, that any portion of an Echinoderm egg is totipotent. Consequently it is necessary to suppose that in the period between fertilization and the first cleavage a significant amount of embryonic segregation and localization occurs. This conclusion confirms many observations on eggs of echinids, mollusks, annelids, ascidians and amphibians, and it indicates that while the visible materials that are localized at this period may not be in themselves “organ-forming” they do represent a process of differentiation. Some one ought now to see, by methods as exact as those used by Plough, whether centrifuged eggs, in which these visible materials are abnormal distributed, really do produce larvae complete in every respect.

The so-called Central Bodies in Echinoderm Fertilization

Henry J. Fry
Assistant Professor of Biology
New York University

I. The So-called Central Bodies in Echinoderm Fertilization

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They are supposed to play an important role in fertilization. The sperm’s central body is assumed to give rise to the sperm aster. At least the central body of the sperm aster is regarded as having some kind of genetic continuity with that of the sperm, and as later dividing to form the two centers of the cleavage aster. A full presentation of these facts is given in “The Cell in Development and Heredity”, by E. B. Wilson, 1925, especially Chapters 1 and 9. There is much confusion concerning terminology. The term central body is here used in its broadest sense, in the same way that it is used by Wilson (25, pp. 30 and 673), it designates any differentiation at the center of aster, other than the inner ends of the rays and the possible presence of nuclear structures. The most constant element is a minute, deeply-staining, period-like granule called the centroline, about which may be a structure having various degrees of complexity called the centrosome. The term centrosome includes both centroline and centrosome, either of which may occur without the other. They both show modifications in various organisms.

A period-like centroline is not described in echinoderm fertilization by most investigators. All, however, picture a mulberry-like body appearing about it. If they are not periodically appearing and disappearing about it. If they are not found at any stage it is suggested that possibly they have become indistinguishable among the cytoplasmic granules, or have lost their staining power, or have become submicroscopic.

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ATTENTION: "M. E. S."

To the Editor of The Collecting Net:

M. E. S. has apparently not taken seriously the boast of the M. B. L. that it is run not only for scientists but by scientists. The fine spirit of cooperation and mutual helpfulness so characteristic of the Laboratory is extended by the older investigators with few exceptions to that very essential part of the M. B. L. known as the Mess. Some of them understand the situation through previous experience.

You who are here for the first time should consider certain facts. First, the Mess provides you with three substantial meals for a dollar: and limits only the number of descents you may have! See how far your dollar will go in Woods Hole. Secondly, the Mess is crowded due to increase in the number of students and investigators without a corresponding increase in kitchen and dining hall space. It could easily dispense with those who prefer a restaurant. Thirdly, most of the dining room force is made up of students and investigators. For three and a half hours of hard work—more if people come at the last minute—you receive the equivalent of one dollar. Fourthly, individual attention can obviously not be given to each of the 28 to 35 people served at two tables all arriving during the last ten minutes. Certainly not all of them are detaine by experiments until that period. Fifthly, the meal is not over for those who are earning their board until the tables are reset. Delay in the dining room means more delay in the kitchen.

Sixthly, for the benefit of M. E. S.—those who arrive at the beginning of the meal are not the ones who complain of lack of time for conversation. After all a really important discussion could be adjourned to the laboratory. Lastly, the Mess has tried to accommodate the increased number at the Laboratory by putting resets at nearly all the tables. Consequently a few people at each table will have to leave in about twenty minutes if their fellow investigators are to be served. It is more keeping with the tradition of the M. B. L. to turn away those who are unable to get here at the beginning of the season or for us all to suffer a very slight inconvenience until more adequate accommodations can be provided.

E. C.

BIOLOGY AND THE BIBLE

The following letter was recently addressed to the Editor of The Scientific Monthly:

Dear Sir:

In The Scientific Monthly for June 1928, on page 535, in an article "Can we live longer?" by ColonelHarry Vanderbilt Wurdemann, mention is made of Methuselah, who is said to have lived 969 years and when he died; but Colonel Wurdemann holds that a year in those days meant a lunar month, and therefore that Methuselah passed on when he was 73 years old. Those are told in Genesis 5, 21, that Enoch was 65 years old when he begat Methuselah, and that Enoch lived to be 365. If in the time of the patriarchs a lunar month was reckoned as a year, and if Methuselah was 73 years old when he died (our years), how old was Enoch when he begat Methuselah?

Let x equal Enoch's age.

\[ \frac{x}{12} = 73 \]
\[ x = 876 \]
\[ y = 25 \times 365 \]
\[ y = 9125 \]

which makes 5 years and a few days.

There have been many precocious youths whose deeds are recorded in history. Mozart wrote symphonies at 7. Thirlwall knew Greek and Latin at 4. Mirandola was delivering lectures on philosophy at 10; but Enoch begetting children at 5 surpasses them all.

Very respectfully,

Rosec Lamont.

THE NATIONAL RESEARCH COUNCIL ANNUAL MEETING

The annual summer meeting of the Executive Committee of the Division of Biology and Agriculture, National Research Council, was held at the Marine Biological Laboratory on Saturday, July 21st. Aside from the members, namely Messrs. L. L. Woodruff, Chairman, C. E. Allen, William Crocker, W. E. Johnson, W. C. Curtis, D. H. Parker, and J. R. Schramm, there were present also Messrs. Metcalf and Duggar, members of the Advisory Committee for the Division as former Chairmen.

One of the more recent important projects which the Division has been asked to sponsor, and which was considered at length at this meeting, is that for the promotion of investigations of the "effects of radiation upon organisms." Dr. W. C. Curtis of the University of Missouri, with whom the project originated, and who has been formulating plans for carrying it through, reported considerable progress in the development of this program.

The office of the Division of Biology and Agriculture has been located at Woods Hole during the summer months since 1920. At one of its annual meetings two years ago, the Division went on record endorsing the continuation of this practise of making Woods Hole its summer headquarters, because of the very definite value to the progress of all activities. The opportunities here for frequent and extended conferences in connection with projects being promoted by the Division are really unparalleled.

ZOOLOGY CLASS GIVES A UNIQUE EXHIBITION

An interesting demonstration of one hundred and fifty invertebrate species of the Woods Hole region was set up recently in the main corridor of the Brick Building by the class in Invertebrate Zoology. The animals were collected by members of the class on Monday from the mud and sand flats and beaches at North Falmouth, and representatives of Porifera, Coelenterata, Phylumhelminthes, Nemertinea, Annelida, Arthropoda, Bryozoa, Echi- noderma, Mollusca, and Chordata were included. A total of one hundred and sixty-three species were found and identified by the class on the North Falmouth trip in about three and a half hours of active collecting. This is the largest number of species found on any single collecting trip this year, the second highest number, one hundred and thirty-seven, being found on the trip to Hadley Harbor.

BIOLOGICAL NONSENSE

Infundibulum, acetabulum, anatomical terms

Chaeptopterus and Nereis and other wiggly worms

Besides those things which one can tell

By sight and feel as well as smell

Are always found where scientists dwell

In other words at the M. B. L.

A Fundulus is a mighty fish

On the scientific shore

But when seen out upon a dish

His might is a tale of yore.

Limulus of song and fable

Thank his stars that he is able

To keep from being a delicatessen

And served up hot all over, the mess in.

Here is Arbacia so round and spiny

His coat is red and far from shiny

But ever one tries in haste to seize him.

He should carefully make sure to appeal him.

The Starfish is so brown and slow

That when on a journey he would go

His strength and fortitude and might

Lie all concealed by the madreporite.

On Tuesday evening the Choral Society serenaded the Hon. Charles R. Crane on the occasion of his Mr. Crane had long been known as the patron of the arts as well as the sciences, so it is not surprising to hear that the Choral Society, and through it local music lovers, has also been the recipient of his beneficent assistance. It was a particularly fitting tribute, therefore, that the members of the chorale group paid to Mr. Crane in thus honoring his birthday.
Methods of Experimental Embryology
With Special Reference to Marine Invertebrates
(Continued)
E. E. Just
Professor of Zoology, Howard University

METHODS FOR EXPERIMENTAL PARTHENOGENESIS.

Despite the great deal of attention which it has received, experimental parthenogenesis still remains a fascinating problem. It constitutes an admirable approach to the analysis of some fundamental reactions of the egg; as a mode of attack on the phenomena of cell division or on chromosome behavior, for example, it is of significant value. Unfortunately, too many embryologists seem to consider experimental parthenogenesis a barren field. The Hertwigs' famous experiments, Mead's work on Cladosoma and Morgan's paper on the artificial production of atmospheres by salt solutions deal with the problem from the point of view of cell division; and the literature affords all too few contributions on the subject from this point of view. It is here that the great value of experimental parthenogenesis lies; leaving aside those results which show merely cortical changes in the egg, we may define experimental parthenogenesis as the artificial induction of cell division. If this be correct we must regard the work of the Hertwig, Mead and Morgan as the pioneer and most significant.

Some years ago Harvey made a valuable summary of the methods then in use for experimental parthenogenesis; more recently Herzst has performed a similar service. The reader will find both papers useful. The present article deals exclusively with Woods Hole forms, and details some methods which neither Harvey nor Herzst mentions; but it makes no attempt at an exhaustive treatment of the subject. Rather, its object is to present a few of the more simple methods for experimental parthenogenesis as a mode of analysis for embryological problems. I shall consider first the methods for the egg of Arbacia.

Though earlier workers reported the experimental initiation of development in marine ova, normally never parthenogenetic, it is to Loeb that we owe the refinement of the technique. His contributions on this subject make up one of the most brilliant chapters in experimental embryology. In his early work Loeb used hypertonic sea-water alone. His original work was done on eggs of Arbacia. Loeb's method consisted in treating the eggs for one to two hours in a solution of 90 cc. of sea-water plus 10 cc. of 2.5 M NaCl or KCl. He found that the increase of osmotic pressure of this solution was relatively small, amounting to about 40 per cent. of the osmotic pressure of the sea-water. As long as the osmotic pressure of the sea-water is raised about 50 per cent., electrolytes or non-electrolytes may be employed.

I use the following procedure: uninseminated eggs from one female of optimum fertilization capacity—i. e., free of perivisceral fluid, of high fertilizm content and known, by trial inseminations on samples, to give practically 100 per cent. normal membrane separation—are placed in 50 cc. of sea-water plus 8 cc. of 2.5 M NaCl. From this solution a few drops of eggs are removed at 20 or 30 minute intervals to 250 cc. of normal sea-water. After exposures from about 60 to 90 minutes, the eggs in sea-water will show rather abnormal cleavages without membrane separation. Some-what later than the corresponding stage in eggs from the same female inseminated at the time of exposure to the hypertonic sea-water, these eggs develop into abnormal bottom swimming forms. The untreated uninseminated eggs in sea-water (control) should, of course, give a single evidence of initiation of development. For the artificial production of cistasters the eggs should have a longer exposure than the optimum for cleavage.

The worker should always remove the eggs from the hypertonic sea-water at definite intervals. He should never depend upon one exposure of a given length of time, because the eggs of different females vary with respect to their response to hypertonicity. Therefore, in a series of exposures of increasing lengths of time he is more likely to determine the optimum exposure.

Later, Loeb discovered an improved method of experimental parthenogenesis which he published in 1905. This is the well known fatty-acid-hypertonic sea-water method—superior to the action of hypertonic sea-water alone because with it the eggs (of a California sea urchin) separate membranes, cleave less abnormally and develop into surface swimming forms. In other words, the development more closely resembles that of fertilized eggs. Curiously enough Loeb never succeeded in obtaining membrane separation in eggs of Arbacia by means of fatty acids, though other workers have. Loeb's butyric-acid-hypertonic sea-water method for Arbacia is as follows.
The SO-CALLED CENTRAL BODIES IN ECHINODERM Fertilization

(Continued from Page 5)

of definite contour in metaphase asters, which is called a centrosome or central body. Whatever the details may be as to the structural modifications, and whatever the terminology used, it is generally taken for granted that the central bodies or central areas delineated in these charts, like those of the asters and the chromosomes, are but a diagrammatic presentation of the usual ideas concerning central bodies as exemplified in a supposedly typical case such as the sea urchin.

The present investigation of fertilized eggs of the sand-dollar, *Echinarchaeus parma*, proves that contrary to the foregoing assumptions, individualized central bodies have no existence. It also shows what are the phenomena that have been misinterpreted as central bodies by previous investigators.

During the early history of the sperm aster the rays are equally faint on all sides. As the aster grows the rays become markedly distinct on the side between the male nucleus and the edge of the blastodisc. The aster continues to enlarge until it fills the egg, but it still maintains an obvious inequality as to the clarity of rays on the two sides. Meanwhile the nuclear fusion occurs. Soon after the aster fades until the rays become almost invisible. A dark, homogeneous, roughly-granular area is present at the center of the aster only when the rays are distinct. It does not exist either at the beginning or at the end of the history of the sperm aster when the rays are faint, nor does it exist on the venge side of the aster when the latter is at its maximum of clarity. It is present only during the time when rays are distinct and only on that side where they are distinct. This granular area is obviously a coagulation product of the inner ends of the rays and they are not absent. Only if the rays are distinctly fixed. The clear correlation between the occurrence of "central bodies" and the presence of distinct rays is invariable in all fixatives.

The cleavage amphiaster during its early history has very faint rays, and the structure at its center is like the cytoplasm, though slightly vacuolated. The rays are distinct, though delicate, during late prophase and early metaphase, and at that time the center is homogeneously granular. As metaphase, the rays suddenly become very coarse and clear. Simultaneously with this there appears at the center of the aster the condensed nucleolus-like group of closely aggregated vacuoles, which is called a centrosome by Boveri ('00). At early telophase the rays fade suddenly from the very clear and coarse condition to a clear but delicate one, similar to that of early metaphase. Simultaneously with this the center also returns to a homogeneously granular condition and the asters appear to be homogeneous.

Thus whatever there is of a so-called central body, whether granular or vacuolar, appears and disappears simultaneously with the appearance and disappearance of well-formed rays. In over a thousand fixed asters studied in great detail there are no exceptions to this relationship. These differentiations seen at the centers of fixed asters, which are termed central bodies are nothing but the coagulated focal point of the inner ends of well-formed rays. They never exist when rays are faint; they exist only if rays are distinct. The eggs are studied in a variety of fixatives, some of which clearly coagulate the rays, others of which do not. The so-called central bodies are always absent when rays are vaguely or faintly coagulated. They occur only if rays are distinctly fixed. The clear correlation between the occurrence of "central bodies" and the presence of distinct rays is invariably in all fixatives.

In the cleavage amphiaster the rays are clearer and lie closer together than is the case in the sperm aster. All cytoplasmic granules, with very rare exceptions, are completely excluded from the central area and from among the inner portion of the rays. They occur occasionally among the tips of the rays and are abundant in the surrounding cytoplasm. This situation is a contrast to the rays of the sperm aster, where there is a frequent occurrence of granules at the centers, as well as throughout the entire length of the rays. In those very rare cases where one or two granules do occur in cleavage asters, they may simulate centrioles.

The behavior of central bodies in nuclear asters of fertilized echinoderms is in complete harmony with central bodies in fertilized eggs of other classes. Central bodies of cyasters are always absent if rays are faint even though they do reach the center. They are also absent if rays are distinct peripheral but fail to reach the center. This relationship between the occurrence of central bodies and the presence of clear central rays holds good in cyasters no matter what are the modifications produced by twenty-four fixatives, by twenty modifications of the environmental factors, by artificial activation, and by many intervals in the astral history (Fry '28). In both cyasters and in nuclear asters, therefore, the so-called central bodies always appear and disappear in relation with the appearance and disappearance of clear rays. In both, they are nothing but the coagulated focal point of the rays, having no existence as individualized structures in the living egg.

The eggs have been carefully studied alive at high magnifications with water immersion objectives. They clearly show the astral structure.
THE SO-CALLED CENTRAL BODIES IN ECHINODERM FERTILIZATION

(Continued from Page 8)

...ures. The rays can be seen with great distinctness in the outer parts. The central areas are perfectly structureless and hyaline, except for the possible presence of nuclear material. Were the so-called central bodies seen on slides of coagulated asters, actual structures present in the living condition, it is at least probable that they would be visible since they are larger than nuclear structures that can be seen.

It might be suggested that the chemical composition of central bodies is similar to that of rays; hence a fixative that fails clearly to coagulate rays would also fail to show central bodies. The answer to this is as follows: the living aster shows faint rays at the beginning and at the end of its cycle; it has clear rays in the middle period. If a reagent is used that is capable of clearly fixing rays, distinct ones are found only on slides of eggs that were fixed in stages that had clear rays in the living condition. At other periods the rays are faint or absent on the slides, corresponding to similar situations that existed in the living eggs. If central bodies are entities independent of asters and are not just the coagulated inner ends of well formed rays, and if the chemical composition of central bodies and rays are similar, when a fixative is used capable of clearly coagulating rays, then central bodies should be present at some time other than those when rays are clear. The invariable absence of a central body when rays are faint or non-existent, and its presence when they are clear, is a significant correlation.

The structures occurring on the slides of the present study are the same as those described and illustrated in previous investigations (Boveri, '00; Meves, '02; Wilson, '05, '25; Wilson and Leaming, '07; Wilson, '97, '99). There are four types of phenomena which can be incorrectly interpreted as individualized central bodies. (1) The middle piece of the sperm gives rise to a tiny bilobed granule shaped like a horse-shoe having a knob at each of the open ends. This when cut in certain planes may assume various configurations, sometimes appearing as a single granule, other times appearing as double. Boveri ('00) interpreted these two appearances as stages in the division of the single central body of the sperm aster into two which later were supposed to become the centers of the cleavage asters. This bilobed granule, however, leaves the astral system about ten minutes after fertilization and wanders out at random into the cytoplasm. That it has nothing further to do with the mitotic mechanism has been proved by various investigators (Field, '95; Just, '27; Meves, '12; Wilson, '97, '99). (2) There may be a very occasional occurrence of the black, cytoplasmic granules at the centers of cleavage asters, and such granules may be few or numerous in sperm asters. These may be a source of error, since they simulate centrioles. (3) The condensed and clearly defined mulberry-like structure occurring at the mid-point of the aster during late metaphase, has been assumed to be an individualized "central body" despite the facts: that it exists only in late metaphase asters; that there is no such body in the preceding early metaphase; and that it quickly enlarges into a scattered vacular region in the succeeding anaphase. (4) Certain fixatives may produce coagulation products quite different from those formed by other reagents. Accepting the coagulation products produced by one fixative as "normal", (which Boveri ('00) did in the case of his picro-acetic mixture later described by Lee as giving "miscible results"), and dismissing others as "abnormal" may lead to erroneous conclusions.

This investigation proves that the structures here-to-fore identified as central bodies in echinoderm fertilization have no existence as individualized structures in the living fertilized eggs of Echinarchinus parma. As in most previous echinoderm studies, a minute body that could be identified as a centrosome is not found at any time, other than the bilobed granule, or cytoplasmic granules, both of which may simulate centrioles. The mulberry-like "central body" is shown to be but a brief passing phase of a series of coagulation products that exist only from late metaphase to late anaphase, when rays are very coarse and close together.

It can be safely concluded that these facts hold true for echinoderm fertilization generally, in view of the close similarity between the phenomena described by investigators for various species of echinoderms and those of Echinarchinus. How far these conclusions apply to central bodies in fertilization, in other groups, awaits further study. Whether or not the usually accepted assumptions concerning central bodies, outlined at the beginning of this report, will require modification, also awaits further research.

(Continued in Next Issue)

REVIEW

D. H. Tennyent
Professor of Biology
Bryn Mawr College

Dr. Henry J. Fry presented a well prepared and admirably illustrated paper on The So-called Central Bodies in Echinoderm Fertilization, based on his investigation of stages of fertilization and division of the eggs of the sand dollar, Echinarchinus parma.

His conclusions that the so-called central bodies seen at the centers of fixed asters, are merely the coagulated focal points of the inner ends of well formed...
Dr. George A. Harrop, Associate Professor in Medicine at Johns Hopkins University Medical School has left Woods Hole to resume his work in Baltimore.

**IN THE NEXT ROOM**

In the Next Room, the play presented this week by the University Players Guild, was very favorably received. This week's production was a mystery play, in contrast to those given before. The solution of the unexpected deaths of two of the characters remained obscure until well into the last act, when it was cleverly exposed.

The plot was built around the importation by Mr. Vantine of a mysterious Boule cabinet, which in itself caused the creation of the tragic events which occurred. The death of the important character and close-up of the similar fate of one of the conspirators. A detective agency added considerable action in the last part of the first act, though it was clumsy and presented in an extreme solution of the problem. Another "famous detective", from Scotland Yard of course, brought a surprising complication into the story. The other characters, each in his own peculiar way, also attempted to solve the mystery. In the end, the mystery was unraveled and the characters were satisfied with the solution.

Of the players, perhaps Mr. Vantine and Parks, his butler, were the most outstanding in their manner of presentation. The parts were played by Bretaigne Windust of Harvard, who has some very interesting acting, and together created the most entertaining elements of the play.

The necessary element of romance was provided by an attractive pair of young people. The girl, at the end of the play, was told by the criminal, when she caused his capture, that a woman in love could outwit ten demons. The roles of the lovers were very satisfactorily carried by Frances Smoll of Radcliffe and Erika Barnow of the University Players Guild.

As is usual in mystery plays, the characters of the police detectives were overdrawn. It seems to be a characteristic of mystery stories in general to represent detectives as by-the-book types, chewing individuals who rant and rave about in a most ineffectual manner. Gerald Harrington of Harvard upheld this traditional representation of a detective only too well.

The lines of the play were in themselves quite clever and called forth many hearty laughs from the audience, particularly in the old favorite scene of the proposition of breaking the news to the guardian.

It is a pity that the Guild has lost the habit of raising the curtain fifteen or twenty minutes late. We realize that they are playing before a limited audience and cannot afford to coerce their demands; nevertheless, with a little more efficient management and more firmness in respect to seating late-comers, the audience could have been satisfied.

The program opened with a group of four sacred numbers of those of the Italian polyphonic school, the two others from the modern pre-Soviet Russian school. It would be hard to single out any of the numbers from this group for special mention, but the general opinion seems to favor "Tu es Petrus" of Palestrina, and "God is with Us" of Kastalsky, as the high lights of the first part of the program. The latter has much of the charm of the rich alto voice of Mrs. Eva Stokey Evans as she chanted the famous Christmas Lesson, "Give ear, all ye of far countries," against a background of softly modulated voices repeating the phrase: "God is with Us."

The second part of the program, and by far the longer, presented types beginning with the early English polyphony of Purcell, and the English folk song as harmonized by Holst; down through the English of Gilbert and Sullivan to the modern Belgian school represented by Gaevert, and the Russians of the same period, Rimsky-Korsakov and Arkhangelsky.

Among these numbers, the devotional numbers of Gaevert and Sullivan were especially praised with "Brightly Dawns our Wedding Day," the madrigal from "The Mikado." Others in the audience were taken by "The Chimney Top" of Rimsky-Korsakov, a number so different from the much used—and abused—"Songs" from "Sadko" and "Coq d'Or." The two numbers by Arkhangelsky were as much admired as the others by the same composer at last year's program.

Common consent, however, seems to give first place to "Dusk of Night," perhaps because this was sung in English, which constitutes a sort of military-march for voice.

At the close of the second part of the program one of last year's favorites, "The Gipsy" by Zolotareff, was given an enthusiastic response to enthusiastic applause. To those who heard it for the first time the concluding "Hi-yo" came as a disconcerting surprise, which undoubtedly stimulated interest in hearing the number again.

The members of the Choral Society are to be congratulated for their modesty in attributing the chief measure of their success to the wholehearted and energetic work of Professor Gorokhoff who directed the rehearsals last Fall and through the present summer to such surprising effect. The Woods Hole community is greatly indebted to Mr. Gorokhoff's genius for making these lovely things possible. One would think that after a strenuous winter with the students of Smith College, the Director would feel the need of a complete rest. With the spirit of a missionary for better music, however, Mr. Gorokhoff plans each year to take up the work begun two years ago and the Laboratory, and nearby, lovers of vocal music. It is needless to say that we hope he will continue to find Woods Hole sufficient interest to make the Choral Society a live and productive organization.

The work of Mrs. Selig Hecht at the piano contributed greatly to the brilliancy of several numbers on the second part of the program which were not sung a cappella. Among those who helped to make the concert a success Mrs. Hecht's contribution must not be passed over in silence. This will especially appeal to anyone who has helped train any singing group through the long and arduous process of rounding a program into presentable form.

Mrs. Keefe, Packard, and Mrs. Stokey Evans, the officers of the (Continued on Page 11)
CHORAL SOCIETY IN SUCCESSFUL CONCERT
(Continued from Page 10)
Choral Society, have requested us in
the name of all those interested in
the concert, to express their
sincere thanks to the many patronesses
who contributed so materially to the
success of the undertaking.
The program and the encore in
the order in which they were
given are as follows:

1. Ave Maria - J. Aracdeli
2. Tu es Petrus G. P. da Palestrina
3. Cherubin Song
4. God is With Us - A. D. Kasatalsky
5. Brightly Dawns Our Wedlign Day - W. Gilbert, A. Sullivan
6. With Drooping Wings - H. Purcell
7. Colletta - F. A. Gervaert
8. I Love My Love - G. T. Holst
9. Spinning Top - A. A. Rimsky-Korsakov
Oh If Mother Volga (Encore) - S. W. Panchenko
10. Dusk of Night A. Arkhangelsky
11. The Brook A. Arkhangelsky
12. The Gipsy (Encore) - W. Zolotorieff

Our Classes
VALEDICTORY
The Editor has insisted that there
be one more class column. We pro-
tested that the classes have gone.
"That," said he, "is something.
Work it up into a column." Then the
editor left town.

In revenge we borrowed the Ed-
itor's Thesaurus Dictionary, looked
up "they have left" under "leave",
and found the classes have done all
sorts of things that we never ex-
pected of them. There are head-
ings: adjunct-remnant, leave-pro-
hibition, union-disunion, quest-eva-
sion, action-passiveness, contented-
ness, regret, transcurrsion-shortcom-
ing, appearance-disappearance, mark
obliteration, carelessness-neglect,
conventionality-conventionality
(there's a lead!), liberty-subjection
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the things that we never expected of
them.

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BARN BURNED IN WOODS HOLE
Fire Believed of Incendiary Origin Destroys C. R. Crane Property
(Standard Cape Cod Bureau)

Woods Hole, July 31—The old Jim Hutch barn on the Coonemes-
sett ranch belonging to Charles R.
Crane, New York and Woods Hole,
was burned to the ground early this morning by fire believed to be of
incendiary origin. The blaze was
discovered by Eugene Fisher and his
daughter, Miss Agnes Fisher, who
live on an adjoining farm, at 1:50
A. M. today.

When discovered the fire had
made good headway, and by the time the fire department reached the
barn after a nine mile run, the
building was doomed. The theory
of incendiaryism was advanced by
Fire Chief Ray D. Wells. This is
the second suspected incendiary fire
within a few weeks, the barn on the
Dutra place, which is now a part of
the Jarrett ranch, said that ordinarily there
would have been cattle and more
horses in the barn, but the cattle
were in the pasture. A short time
ago, Mr. Jordan sold several horses.
Mr. Jordan said there was no green
hay in the barn which might have
caused the fire and he agreed with
Chief Wells that the fire was set.
Neighbors who saw the fire said that
it seemed to start in the center
of the barn.

The firemen pulled the burning
barn down so that there would be
less danger to adjoining property
from flying sparks.

There was no clue as to who set
the fire.
THE COLLECTING NET

ROOMS AVAILABLE THIS WEEK IN WOODS HOLE
Louise Mast and Elizabeth Mast

<table>
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<tr>
<th>Name</th>
<th>Address</th>
<th>Size</th>
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<th>Double</th>
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<th>2</th>
<th>3</th>
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<td>1</td>
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<td>double</td>
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<td>1</td>
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<td>single</td>
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Dr. Gray Advances Theories On the Movement of Cilia

Since their discovery in 1834, ciliated cells have been shown to occur in nearly every group of the animal kingdom. Fine hyaline processes project from the surface of the cells and vibrate in such a way as to exert a resultant pressure on the surrounding medium, the pressure being maintained, of course, in a definite direction. The vibratile structures are seldom more than 1/500” long and their diameter is usually less than 1/10,000; in many cases the observed dimensions are much less, for cilia may be 1/2,000 in length and have a cross section of not more than 1/100,000. When observed under a microscope, most cilia appear to be moving very rapidly, although in fact the velocity of their movement never exceeds thirty feet per hour (or one mile per week!). An example may perhaps be useful; if a cilium is 30 microns in length and if its tip passes through an arc of 180° twenty-four times per second, then the distance travelled by the tip in one second is 3.14 x 24 microns per second, which is approximately twenty-seven feet per hour. The apparent high velocities observed under the microscope are partly due to the fact that the microscope magnifies linear dimensions, but does not affect the dimension of time; in addition to this, is the inability of the eye to focus clearly a series of events which occur within the short space of time occupied by one ciliary beat.

In as much as a cilium represents a very thin thread moving in a viscous medium at low speed, it constitutes a hydrodynamical system which has yet to be investigated as thoroughly as is desired. As is so frequently the case, the biologist is dealing with structures whose small dimensions involve controlling factors which are not the same as those applicable to larger objects. Stokes’ laws which define the resistance encountered by a small spherical body moving through water at a low speed, differs materially from the usual laws which define the resistance encountered by a large fish or by a torpedo moving at high speed. Until certain hydrodynamical problems have been submitted to purely physical analysis, a true understanding of ciliary movement will elude us, and biologists will be forced to do what they can with the limited data available. If discretion were the better part of valor I would state the biological facts and leave you to digest them if so inclined. I propose, however, to present the facts against a theoretical or speculative background, largely in the hope that some part of the picture may induce a physicist to cooperate in what is, to me, a fascinating subject.

When subjected to the usual methods of fixation and staining all ciliated cells exhibit much the same appearance. The vibratile elements appear as a series of fibrils bearing, as a rule, very little resemblance to the living organ: at the base of the cilium or flagellum there is always a granule or series of granules possessing a high affinity for basic stains. From these basal granules there may or may not project a series of intracellular fibrils, which personally I have never seen in the living cell. Many attempts have been made to base a conception of the ciliary mechanism on the morphology of the flagellum without any preparation. I humbly propose that none of them have stood the test of physiological analysis.

Starting from first principles we may regard all vibratile organs of locomotion as propellers setting in motion a current of water in a definite direction. There are two main types—the paddle and the screw.
THE MECHANISM OF CILIARY MOVEMENT

(Continued from Page 1)

both of which occur in nature. They may be regarded as paddles, whereas one type of flagellum is essentially a screw. In order that an object may be propelled by means of a paddle, it is essential that the thrust imparted to the water during the effective stroke should be greater than that during the recovery or reverse stroke. A paddle or a cillum whose forward motion is precisely the same as that of the element of a propeller although it may set up an oscillating disturbance in the water. An examination of certain cilia, which are known to act as efficient propellers, is possible if the frequency and velocity of their beat be reduced by experimental means. By exposing the frontal cilia on the gills of Mytilus to sea-water containing a limited excess of CO_, the speed and direction of the movement can be studied.

During the effective stroke the cillum is seen moving forward as a rigid rod with its full surface exposed to the water; during the recovery stroke, the cillum moves back in a flexed condition whereby considerably less surface is exposed to the resistance of the water. The recovery stroke is thus effected by the reverse of the movement which starts at the base of the cilium and travels to its tip. Moving cilia of this type have been shown to occur in many groups of animals and may perhaps be the most common type of ciliary propulsion. The simplest mechanical model of such movement is provided by a strip of curved steel wire fixed at one end. If the wire is deformed by means of a force which only bends the strip but also travels from one end to the other, the form of the wire conforms to that of a cillum during the recovery stroke. On releasing the wire from the stress, it travels forward along a path corresponding to the effective beat. Like all mechanical models of biological structure this conception of a cillum must be used with caution, since the speed of the effective beat is, unlike that of the recoil of a bent wire, a variable quantity. The model serves to illustrate, however, that a cillum can act as a propeller if a "bending" of the wave passing along and around the flagellum alter in form. Fast movement with strong propulsive power is characterised by waves of short length and high amplitude; however, the wave becomes less active, so that the wave length and amplitude increase. This is precisely what one would expect to observe if the waves represented regions of the flagellum in which releasing potential energy in a manner comparable to the bending and releasing an elastic filament. If a straight strip of steel wire is subjected to uniform bending force (f) along its longitudinal axis the strip will bend into the arc of a circle whose radius (R) is equal to EF/k where E is Young’s modulus, and K is the moment of inertia about the neutral axis of the strip (moment of inertia for uniform cross-section is equal to 2/3k). If the pitch is 2π/3, the radius is 2π/3k tan (α/2). In terms of flagellar movement these two expressions represent the amplitude and wave length of the flagellar waving. Here the amplitude of the wave is E/k and their wave length is 2π/3k tan (α/2).

In other words as the bending force becomes less intense, so the amplitude of the wave length of the disturbances passing along the flagellum will decrease. In this way we come to regard both ciliary and flagellar propulsion as the result of giving rise to forces along the length of the vibratile structures.

At this point we may enquire whether the mechanical energy stored in the cillum or the flagellum arises as such in the body of the cell, or whether it is generated in the filament itself. If a cillum or flagellum is detached from the cell distally to the basal granule, it is usual to find that all movement instantly ceases; from this one might imagine that the mechanical power of the cillum originates as such in the cell and is associated with the basal granule. Such a view, however, meets with strong theoretical objections, and is actually incompatible with certain types of movement. The wave by travelling along an inert flagellum is to propel an animal against the viscous resistance of water, the water must lose energy as it travels, and must therefore be removed from the cilium. The figures given by Riechert for the flagellum of Spirillum are correct, no such changes in form occur and we must therefore assume that the mechanical energy is generated in the water itself as it is being propulsed. Exact analysis of the form of the waves is now being attempted by cinematographic methods and it is hoped that definite information may soon be available. The results of such investigations will be of more interest if it is noted that the elastic cillum will store potential energy and will release this as kinetic energy when it straightens. A simple model can be made from a strip of paper cut from the page of the Collecting Net or most types of note paper. If a strip, about 3/4 wide be cut from the top of a page and moistened on one side, the strip bends along its longitudinal axis. It straightens again as the paper dries or the water diffuses equally across the thickness of the paper; if however, a strip is cut along the diagonal of the page, the strip curves into the form of a helix because the fibres of paper which absorb the moisture are no longer orientated at right angles to the longitudinal axis of the strip but are inclined at an angle to the new surface. Such a change in the distribution of water, will be sought in the living cillum?

Such a reorientation of water would occur if, along one side of the cillum, there existed an ionised colloidal system whose affinity for water depended on its electrical dissociation. If, for example, there were a series of protein molecules all on the alkaline side of their isoelectric point and there is generated at their surface a number of hydrogen ions, then the affinity of the protein for water will fall and the system will contract. If the hydrogen ions are now removed, water will return to the protein and the system will straighten out. The forces involved by such changes are very great and we may perhaps accept the model as a working hypothesis of ciliary movement.

Unfortunately, it has so far proved impossible to put this theory to experimental test, but we can get
some indications of its validity by indirect methods. If ciliary movement is a chemical process, as has been suggested, there may be a way of altering the speed and nature of the energy which is employed. The third step in the analysis of the ciliary cycle can be detected by exposing cells to \(H^+\) or to a reduced concentration of \(Mg^+\); under either of these conditions an instantaneous change occurs in the rapidity of the ciliary beat; by adding \(H^+\) the beat slows down and stops, by reducing \(Mg^+\) the beat quickens up. Each change is reflected in the \(O_2\) consumption of the cells and it looks as if we were dealing with an ionic mechanism of the ciliary machine, determining how much active substance is getting to the sensitive sites per unit time. I am inclined to think that it is this reaction which controls the rate at which an acid is liberated at a protein or other colloid surface, for it is certainly the reaction which immediately precedes the bending of the cilium. The mechanism of bending; if we imagine the bending as due to the liberation of \(H^+\) at an active surface—then the recoil occurs because of a recombination of the ions—this is the mechanism of rebound or relaxation by the surrounding matrix. Bending only occurs if there is a supply of energy and if calcium is present. In the absence of calcium the cell continues to dissipate energy and consume its full quota of oxygen but no movement occurs; further there must be a minimum quantity of water in the cell. This indicates that the active surfaces, which cause the chemical tend, are a calcium and water process. A basic calcium salt of a protein— which, in the presence of acid, loses its affinity for water and so contracts. In the absence of \(Ca^+\) the cell contracts and the cell experiences a mechanical strain and the throttle being open the engine runs without doing any useful work. Finally, if the cell is deprived of oxygen, ciliary movement will continue for about forty-five minutes at room temperature—after which movement ceases, to be resumed again after a definite period if oxygen is again available. Ciliary motion thus appears to be an anaerobic process; oxygen is required for the removal of the products of activity.

In many respects the whole cycle is similar to that of a muscle fibre and we may continue to look upon the two types of contractile processes as having the same fundamental basis. So far we have dealt solely with the individual cilium, but a cursory examination of most ciliated epithelia reveals the fact that each cilium is not beating independently of its neighbours. Any particular cilium is affected by the movements of those in front of it and slightly behind the one in front, and this gives the well known effect of the metachronal wave. The mechanical effect is, of course, to give a steady flow of water or a steady rate of progression; if all the cilia beat in unison, movement would be discontinuous. The nature and properties of the metachronal wave is, however, extremely obscurum; we know about a cilia but relatively little about the cells and their interconnections. Their relation to the validity of their conclusions. Bhatai failed to confirm their observations. Here again, the problem can be approached by experimental methods. It is always encouraging to find that flagellated cells can synchronize their movements without any organic connection being established. This occurs in spermatozoa or in a cloud of marine amoebae. The idea that cilia are synchronous in their movements is, however, not so easily carried over to the cilia of an entire organism starting from rest with its full ciliary power at work very rapidly attains its full maximum speed, whereas a larger organism of similar specific gravity takes some little time to reach its maximum speed. Similarly if the ciliary movement during motion is low then as soon as the organism shuts off its ciliary power the animal comes to rest—whereas the decision of its movements can be traced back by the equation:

\[ \text{Velocity} \times \text{Mass} = \text{Resisting Force Due to Viscosity} \]

for a typical ciliated organism, the animal comes to rest within 1/20th of its own length. There is no need for any braking mechanism. Further, if the specific gravity is low a ciliated organism can travel with equal facility in any direction. For moving heavy bodies, or for moving at a speed which cilia are useless, for they do not develop sufficient horse-power.

There are, however, two functions for which cilia are peculiarly useful. Firstly, they can drive a film of water over a living surface without involving any change in the form of the surface. Thus the bronchial and nasal passages of man are continuously cleansed by the action of their ciliated epithelium. The mucous which collects at the back of the throat during catarrah is quickly gathered by the bronchial cilia, just as the food of the Mollusca is collected at the mouth by the branchial epithelia.

The second function peculiar to cilia is the maintenance of a liquid current through narrow tubes at low pressures. As long as the tube is narrow, the cilia are efficient; but when the tube widens the cilia are unable to carry sufficient action in the inner layers of fluid and circulation is only possible at the higher pressures induced by muscular action. No ciliated current has a pressure of more than 1 mm of water—which illustrates how ineffective would be the effort of cilia to maintain the blood circulation of a large vertebrate animal. Yet in the world of invertebrate animals, where velocity of movement is low and where the habits of life are quiet, cilia play a most important and sometimes spectacular work. As Dr. Bidder has remarked "by the waving of hair 11,000,000" in thickness at a mean speed of 7 feet per hour, a single specimen of the sponge _Leucandra_ passes through its body a ton of water in six weeks’.

In conclusion I would like to refer for a few moments to the phenomena of ciliary reversal in the _Mezozoa_. Until fairly recently a reversal of the ciliary stroke was believed to be a fairly common phenomenon. Since, however, no

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THE MECHANISM OF CILIARY MOVEMENT

(Continued from Page 3)

propulsion can occur if the form of the effective and recovery strokes are the same, it follows that ciliary reversal must involve a reorganization of the ciliary machinery. One by one of the examples of ciliary reversal have shown the result of antagonistic currents set up by different tracks of cilia, the intensity of each track being controlled by muscular movements which interfere with its effectiveness. Under one set of conditions a particular track will be enclosed within temporary walls of tissue, which are erected by local muscular contraction thereby removing the cilia from the sphere of action. Under other conditions this track will be exposed and the other covered in. Almost the only remaining example of ciliary reversal remaining in the Metazoa is the result of the beautiful observations of Dr. Parker on the oral disc of Metridium where the current is reversed when the disc is exposed to food material. To anyone interested in the mechanism of the citum itself, this case is of extreme interest, and knowing Dr. Elmhirst of the Marine Station at Millport to be interested in the feeding mechanism of anemones I asked him to explain this process to me. He at once presented me with a reprint from which I quoted in a book as follows: "Longitudinal grooves run down the gullet, and when food is being swallowed the inflow is through the grooves; conversely a ciliary current does actually run down the gullet, and when food is being swallowed the inflow is along the grooves; conversely a ciliary current does actually run along the grooves. It therefore seemed to me to be just possible that this is what might occur at Woods Hole. On my arrival here I found Dr. Parker with my book in one hand and a Metridium in the other, and one of the most pleasant experiences I have had in Woods Hole has been the convincing demonstration by Dr. Parker that a true reversal of the ciliary movement back and forth may result from the absorption and discharge of water on one side of the ciliary axis has much that is suggestive about it and as an hypothesis it is certainly a very considerable step forward as compared with the earlier views advanced as explanations of this type of motion. The details of its accomplishment are not easy to visualize and this aspect of the hypothesis is its chief deficiency. Nevertheless it is a proposal that may be attacked experimentally and may in the end lead to a real solution of this perplexing problem.

The phenomenon of ciliary reversal, which was happily alluded to in Dr. Gray's lecture, is apparently a real complication. It is an unexpected phenomenon among ciliated protozoans and there seems to be good reason to believe that it is found in certain sea-anemones. The recent paper by Twitty, from the laboratory, contains very conclusive evidence of its presence in very young salamanders. It is therefore a process whose occurrence, though has emphasized more truthfully than this one the modern biological viewpoint. In a very clear and lucid way Dr. Gray has presented the main facts concerning the structure and function of cilia and thus laid the foundations for a right understanding of these perplexing elements. The real grasp of a biological problem comes only when mechanism and activity are considered together.

Cilia as effectors are second only to muscle. In the evolutionary race muscle and cilia began about neck and neck but as time went on muscle gradually drew ahead; for, as Dr. Gray put it, cilia never evolved into a system that could develop a high horse-power. Even their apparent rapidity of action as seen under the microscope is illusory. If we were to walk in ciliary steps we would accomplish only some twenty-seven feet per hour, a rate that shows well how poorly cilia compare with muscle. Nevertheless cilia are enormously effective in the lower animals in moving large volumes of fluid under low pressure. Thus the small sponge Leucandra is estimated to pass through its body no less than a ton of water in six weeks.

Dr. Gray in his lecture declared rightly for the living nature of cilia. They are not lifeless lashes that are whipped back and forth by the machinery of an active cell, but as truly living parts of the cell they carry out their own peculiar movements whereby a thrust is given to the adjacent water. How this is accomplished is quite unknown and yet Dr. Gray does not hesitate to formulate a scheme notwithstanding the uncertainty of the situation. Models to illustrate physiological processes are, as the lecturer confessed, dangerous inventions, and this danger is all the greater when the explanation thus offered is not open to direct experimental test. His view that ciliary movement back and forth may result from the absorption and discharge of water on one side of the ciliary axis has much that is suggestive about it and as an hypothesis it is certainly a very considerable step forward as compared with the earlier views advanced as explanations of this type of motion. The details of its accomplishment are not easy to visualize and this aspect of the hypothesis is its chief deficiency. Nevertheless it is a proposal that may be attacked experimentally and may in the end lead to a real solution of this perplexing problem.

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probably isolated, reaches from the lowest to the highest animals. As a real factor in the ciliary problem it adds to the complexity of the situation, but it is after all only an added complexity.

In two respects Dr. Gray's lecture was of unusual significance. Its presentation was a model of clearness and lucidity. It was apt and sufficiently illustrated and was marked in all other ways as a performance of very high order. If it was without the rough and ready charm, and simplicity of distribution as in many of our Woods Hole lectures, it showed a finish of high scholarly attainment and in this respect reflects great credit on Dr. Gray. It also points to what is often regarded as one of the chief defects of new-world biology; namely, the absence of a thoughtful and thorough going theoretic consideration of the subject. Dr. Gray's presentation was not only a successful display of the chief facts of the ciliary problem but it included, as already pointed out, a skilfully devised hypothesis that gave to these facts relevancy and significance. The Woods Hole Laboratory is fortunate in being able to attract to its doors such scholars as Dr. Gray.

**ALGAL DISTRIBUTION IN THE WESTERN ATLANTIC**

**Dr. Wm. Randolph Taylor**
Professor of Botany, University of Pennsylvania

While many factors bear upon the distribution of marine algae, the more important ones operating over large areas are fairly simple and few in number. The most important of these are temperature, salinity and currents. It appears that the mean temperature during the actively growing period of any species is more important than the annual mean, and that differences in temperature related to temperature must recognize this fact. It is notable that the deeper-growing algae are of wider distribution and less seasonal in appearance than the shore-growing algae, and further that the elements of the northern character and a summer transition conditions correspond in New England. It is therefore stated that in general the tropical flora is rather sharp, and the transition conditions correspond in the northern and southern territories. The number limited to the district is proportionately small. The warm temperate flora at Beaufort is principally composed of a winter group of species of northern character and a summer group with more tropical associations. The number limited to the district is proportionately small. The transition to the tropical flora of Florida and Bermuda involves great changes in the content of all groups, but especially of the Chlorophyceae, since this group is sharply differentiated in the temperate and tropical waters. The Florida flora contains no element not common to the West Indies, and only about 6% of cosmopolitan species in common with New England. While in this summary it is not possible to include the latitude, temperature and detailed flora data, it may be stated that in general the transition conditions correspond in the northern and southern territories.

Dr. Edwin Conklin left Woods Hole on Saturday afternoon for Maine where he will deliver a lecture entitled "How can the Human Race Be Improved" at the Mount Desert Island Laboratory in Salisbury Cove.

On October 9th Dr. Conklin will give the address at the dedication of the Shanklin Memorial Laboratory of Biology at Wesleyan University.

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**The Collecting Net**
Page Five
The Collecting Net

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Book Reviews

We have often thought that it would be appropriate for The Collecting Net to review occasional books which were written by a member of the laboratory or one which particularly concerned its workers. Dr. Baisell's suggestion that we might review all relevant books and donate them to the laboratory library was excellent one. If this plan meets with general approval we will initiate it at the beginning of next summer because it seems to us that in this way The Collecting Net might further increase its usefulness.

REVIEW

Dr. I. F. Lewis
Professor of Biology, University of Virginia.

The larger problems of oceanography, such as the distribution over wide areas of marine floras, have received comparatively little attention in the western Atlantic. Some serviceable and some excellent local marine floras have been published. The work of Farlow and of Collins on the New England coast of Hoyt at Beaufort on the Carolina coast, of Borgonien, Collins and Howe in the West Indies, and of W. R. Taylor at the Dry Tortugas have given precise and fairly complete information on which to base conclusions as to distribution. In his summary, Dr. Taylor included also data from the South American coast as far south as the Straits of Magellan. The examination of the collections of the Atlnughter and Hassel expeditions for comparison, the results confirm earlier generalizations. The northern New England flora changes to a southern temperate type about latitude 42° (Woods Hole is about 41° 30') from Cape Cod to Cape Hatteras. This "Long Island flora" is found, while south of Hatteras many tropical species occur.

In addition to a more thorough grounding of accepted ideas for the Atlantic coast of the United States the chief contribution of Dr. Taylor's talk is to a comparable analysis of distribution in South American waters. The value of such studies to oceanography is directly proportional to the grandness of the scale. To cover in fifteen minutes the mass of data, for which algologists will be grateful.

STROLLING PLAYERS HERE NEXT WEDNESDAY EVENING

(Continued from Page 3)

that the operation could be most painlessly and successfully performed under the anesthesia of an evening of solid enjoyment. Those who were here at this time last year remember the show performed by Captain Charles by Mr. Howland. This single performance netted $315, the greatest bulk of the Scholarship Fund, and was thoroughly enjoyed by everyone who came.

This year we have secured the Strolling Players of Boston, who will give a program of one-act plays on Wednesday evening at 8:30 P. M. The plays will be Percy Mackay's "Gettyburg," "Jean Marie" by H. Dre Theriut, a play used for years by Sarah Bernhardt as a curtain raiser, "The Acid Test," a farce, and one other, a burlesque. The press notices given the Strolling Players have praised them highly and feel that the evening will be a very enjoyable one. The seats will be 50c, $1.00 and $2.00, all reserved.

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WATER CONTESTS TO BE HELD ON FRIDAY

The annual Woods Hole water sports, so long a feature of the summer's activities, will be held this year on Friday, August the 24th, at 4:30 P. M. Boys and girls, separately, in three classes, up to eight, eight to twelve and twelve to sixteen, will compete in the following events: twenty-five-yard dash, tug race and dives. For those over sixteen there will be dashes, long distance races, relay races and the ever-popular canoe tosses.
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- The Biological Bulletin (M. B. L. Woods Hole, Mass.)
- Folia Anatomica Japonica (Tokio, Japan)
- The Journal of Parasitology (Urbana, Ill.)
- The Australian Journal of Experimental Biology and Medical Science (Adelaide, South Australia)
- Stain Technology (Geneva, New York)
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a meteorological station where daily observations are made. Two other departments of the Institute that supply continuous observations are the Hydrographic Station and the Seismographic Station.

A branch laboratory of our Institute is located in List, on the north-east German North Sea island of Sylt. It studies the schools between the chain of islands and the coast, large stretches of which are exposed, at low tide. At present the investigation at this branch-laboratory centers around the oyster, which in recent times has considerably decreased in number owing to an unreasonable exploitation of the banks. Experiments on breeding oysters, and also lobsters, are being carried out on a large scale. In this field the United States is many years ahead of us. A large part of our activities is devoted to the study of practical problems in fisheries. The Biological Institute is a collaborator of the well-known Northern European organization the "International Marine Investigations", which was founded in 1902 in response to complaints made by the large scale sea fisheries regarding the decrease and the irregularity of their yearly yields. The purpose of this organization is to find scientific foundations for a rational exploitation of the seas similar to those in the fields of agriculture and forestry. The German commission has at its disposal the special steamer Poseidon which makes exploration trips in the Baltic and the North Sea, as far out as the fish grounds of the Barent Sea in the Arctic Ocean. The first twenty years—interrupted by the war—have given fundamental information concerning the life cycles of fish, their distribution, breeding places, development, migrations (by marking etc.) and also to composition of the bottom fauna, the plankton, and the hydrographic conditions.

Certain species of fish of economic importance were studied in great detail, as for instance the herring, the plaice, the cod, the haddock and the valuable genera Rhombus and the Solea. In Heligoland we are at present taking stock of the various species in various regions and seasons of the year, according to age and race; also of the conditions of nutrition and growth, and fluctuations in the number of offspring from year to year. These fluctuations have been found to be considerable. They depend on many factors: on the number of enemies, and on the amount of food which the bottom and the plankton offer. This in turn is influenced by the amount of dissolved food substances in the water, and by the yearly fluctuations in the hydrographic conditions. In this we follow the quantitative methods of the Danish investigator Peterson (recently deceased) which represent a similar advance over the old methods of estimation in marine biology as were the quantitative plankton methods of Hensen and Lohmann. In this connection I should like to mention the successful breeding experiments of our botanist with plankton-plants, and the subsequently developed biological methods for the determination of the quantities of nutritive salts (nitrates and phosphates) that control plankton production in sea-water.

I will conclude my article with a list of the staff members of the Institute, their respective functions and fields of investigation.

Section A. General organization of the scientific investigations and management: Director, Professor Dr. A. Hagen. Support of laboratory work, supervision of the chemical, biological, and geological collections. Personal field of research: oyster research, survey of nutritive bottom fauna.

Section B. Zoology, in charge of Professor Dr. A. Hagen. Support and laboratory work, supervision of the zoological collections. Personal field of research: oyster research.

Section C. Ornithology, in charge of Dr. R. Drost. Center of bird-marking service in Germany, North Sea Museum, Meteorological Station. Personal field of research: bird migration, systematic and physiological ornithology, problems of preservation in nature.

Section D. Botany, in charge of Dr. E. Schreiber. Botanical collections, scientific instruments and chemical section of the Institute. Personal field of research: physiological problems, nutrition of fishes.

Section F. Marine fishery, in charge of Professor Dr. A. Wulff. Fisheries and vessels of the Institute, library, hydrographic station. Personal field of research: plankton, lobster culture.

Section G. Applied marine research; division of fish biology of "International marine investigations": in charge of Professor Dr. F. Heincke (formerly Director of the Institute). Personal field of research: fishery, biological investigations in connection with the "International Marine Investigations".

In Massachusetts there is a state law which requires motor boats to have an underwater exhaust or a muffler to eliminate the noise if a surface exhaust is used. The penalty for the infraction of the law may be as high as $25.00. The Camera is mounted on a heavy base which provides places for the microscope on one side and on the other side carries the illuminating apparatus. The latter includes an aspheric lens condenser with field of view iris diaphragm and a liquid filter cell. The source of light is a 400 Watt gas filled incandescent lamp, operating on a 110 volt circuit.

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Tissue Formation

COAGULATION IN RELATION TO TISSUE FORMATION

Dr. GEORGE A. BAITSELL
Professor of Biology, Yale University

Dr. Baitsell presented a paper bearing the above title on August 1. The author’s summary and two reviews of the paper follow.

It is apparent that a process of coagulation plays an essential part in the formation of the connective, or fibrous, tissues in the vertebrate animal body, in both the embryo and the adult. The evidence upon which this statement is based has been accumulating for several years and includes material from a number of vertebrate animals.

As is well-known the fibrous tissues, in general, are characterized by the presence of a large amount of intercellular material which is typically fibrous in character. The primary question in connection with the development of the fibrous tissue has been to determine the origin of the ground substance, or matrix, which finally becomes transformed into the various types of intercellular material characteristic of the different kinds of fibrous tissue. Is the ground substance formed from cytoplasm given off by the cells and therefore intracellular in its nature, or is it formed from the ground substance and therefore extracellular in its nature? Both views have had and still have their adherents. A further question regarding this primary-growth ground substance may be asked, namely: How does it become transformed into the fibrous intercellular material which is characteristic of the fully developed fibrous tissue? By some investigators it is held that a certain type of cell, the so-called fibroblast, moves through the intercellular spaces and spins the fibers from the peripheral cytoplasm. By others it is held that the fibers arise by a transformation of the ground substance independently of any direct connection with the cell cytoplasm.

The results that I have obtained from my studies have convinced me that the intercellular theory of connective tissue formation is correct for the tissues used. In addition to this evidence is at hand that the secreted ground substance undergoes a coagulation and transformation during its development which is identical, from the structural standpoint at least, with the process which takes place in blood plasma. In fact, in the repair of tissue infections and wounds, in the repair of tissue and the consolidation of the fibrous tissue which intertwine and anastomose as they ramify through the areas of the plasma clot of the culture medium. (Jour. Exp. Med., 21, 1915, p. 455).

In experimental wounds made by removing various sized pieces of skin from adult frogs there is a rapid coagulation of the blood plasma and lymph to form a coagulation tissue which fills the wound cavity. The microscopic study of preparations from this region shows that the coagulation tissue at first has a typical fibrin net. The process of transformation, apparently identical with that observed in the tissue cultures, results in the formation of a fibrous tissue, composed of heavy fibrous bundles, which is later invaded by the fibroblasts and becomes typical scar tissue. There is no evidence that the fibroblasts form any fibers after they appear in the wound area. (Jour. Exp. Med., 23, 1916, p. 739).

Experiments upon clotted frog plasma, without the presence of any living cells, have given the complete history of the new fibrous tissue and show that its formation is due to a fusion and consolidation of the fibroblasts under the influence of mechanical factors and entirely independently of any cellular action. The story of the structural changes is complete. The story of the chemical transformation which it is believed must take place is not known at all. (Am. Jour. Physiol., 44, 1917, p. 109).

In the development of connective tissue in the amphibian embryo the primitive forerunner is a gelatinous material (primitive ground substance) which is formed as a secretion around the notochord at a very early stage. The connective tissue fibers begin to form in the ground substance soon after it first appears. In regions which are free from cells it can be observed that the fibers arise in the ground substance by a

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COAGULATION IN RELATION TO TISSUE FORMATION

(Continued from Page 8)

The gradual transformation of the elements there present to form, first, a delicate, net-like material, and then the long, wavy fibers which are typical of connective tissue. From the structural standpoint this process appears to be identical with that observed in the transformation of the plasma clot. The material supplies no evidence of any fiber formation by the cells. (Am. Jour. Anat. 26, 1921, p. 447.)

In the development of connective tissue in the chick embryo the same method occurs as in the amphibian embryo. The secreted ground substance can be demonstrated in various regions of the body at a very early stage. It is at first homogenous in its structure, but fibrillation occurs by a direct transformation of the ground substance as has been noted above. (Q. J. M. S., 69, 1925, p. 571.)

In the testis of the guinea pig following experimental tubercularis a tremendous fibrosis shortly occurs in the intertubular areas. The situation is an ideal one for studying the method of development. It can be shown that the abundant exudate which is poured into these areas following the infection is the basis of the fibrous tissue. It coagulates, and then the elements become transformed into characteristic fibrils bundles composed of great numbers of wavy fibrils. The fibrous tissue thus formed encapsulates and infiltrates the tubercules which gradually develop in the infected regions. (Research done under a grant from the Med. Res. Comm. of the Nat. Tuberculosis Assoc; Trans. of the Tuberculosis Assoc.; 28, 1921, p. 282.)

The results which have been briefly indicated above present consistent data which have been amply confirmed by various investigators. From the structural standpoint there is no doubt, in my opinion, that the process of connective tissue formation in general is based upon coagulation and later transformation of body fluids. This process considered from the chemical standpoint presents many problems which are unsolved.

REVIEW

Dr. H. McE. Knower
Professor of Anatomy, University of Alabama

The present is an impressive presentation of this much disputed subject, with an effective technique of delivery which carried to the ears of the audience and enabled all to fully appreciate the points. Lantern slides were used to complete the story. Dr. Baisell has certainly given this theory of fiber formation in connective tissue his persistent attack on the problem since 1914 has been thorough and many-sided, with modern technique in both observation and experiment to search out the truth in the light of what has been presented and claimed by a long line of investigators. He has tried all sorts of experiments and methods on fresh and fixed tissues.

Every teacher of histology or embryology who uses fresh material has formed opinions on this controversial subject. Also even relatively elementary students trained by such methods find here a profitable field for gaining insight into fundamentals of cell structures, functional possibilities, actions and products. The material and methods are readily available for testing such results. The relationships of cells to one another and to the reactions to mechanical and chemical influences, the nature of fixation results, whether artifacts or not; and the understanding of what is normal and what is pathological can only be discussed nowadays in the light of such studies on fresh material, and by experimentation.

It may appear to some unnecessary to make this point; but, unfortunately, a tendency to examine chiefly fixed and ready-prepared slides still prevails in some courses of histology and embryology, especially in medical schools.

Reference to some of the articles to which Dr. Baisell has referred in his summary of his fourteen years of work brings up some interesting reminiscences. In 1893 Ross G. Harrison published in the Archie f. Mik. Anat. Bd. 42, a paper on "The development of non-cartilaginous 'fin rays'". The beautiful figures in this paper seemed then to the writer the most definite and conclusive series yet published to show the entire dependence of the fibres on the direct action of the cells. But these "fin rays" constitute a highly specialized type of fibres; hence Mal's more general study of tissue from amphibian and mammalian embryos seemed more applicable for use in teaching. Here again, however, fibres formation is in the cytoplasm of cells or in their processes, even though described as in an exoplasm of a syncitium. In 1922 Lewis (W. H.) disproved the strict syncitial conception, (see The Anatomical Record). In 1917 Mrs. Lewis reexamined this subject with her superb technique in living explants (Carnegie Institution Publication 226). Though she could not carry the developments to stages exactly comparable to the adult, on the whole she concluded that Mal's exoplasmic theory holds true. Mrs. Lewis' agreed with Ferguson's main conclusions for the origin of fibres and relations of the cells in the connective tissue of fish embryo.

In 1916 R. Isaac's began in my laboratory studies on the relation between fibres and ground substance in connective tissue. His results were published in The Anatomical Record. (Vol. 17, 1919.) The first paper was an experimental study of colloids along the lines of Hardy and A. Fischer.
which formed a good basis for his studies of the connective tissues. These papers furnish a most interesting series of observations on the properties and reactions of ground substance and fibrils. Isaacson concludes that fibrils (fibrils) are artifacts produced by various physiological processes, drugs, etc., or by chemicals in fixing the material. He discusses the effects of strains, etc., and relegates the cells to the general function of merely distributing material. On the whole, Isaacson confirmed Baitsell’s association of fibrin fibrils with those of the ground substance of tissues in the region of a clot; but he insists that there are no true living fibrils, merely more or less concentrated jelly material. Whether stiff in places. A small relative water content of the ground substance may produce heavy, tough fibrils.

Dr. Baitsell’s own papers 1915 and 1916 in the Jour. of Exp. Med. and especially that of 1917 in the Amer. Jour. of Physiology, with a later one of 1921 in the Amer. Jour. of Anatomy, contain ample experiments and discussion, with excellent figures, to support his claims and the theory of Hertzel. First, advanced in 1910 (Jour. Amer. Med. Assoc.) and also advocated by L. Loeb. This point of view departs fundamentally from other observers in deriving the fibrils from the ground substance of cellular tissue, with absence of any direct controlling action of the cells.

Baitsell however goes a step further than the others who have recently published on this subject, in that he identifies fibrin fibrils of the clot involved in wound healing or of intercellular exudates in infected areas with the definitive fibrillar substance. He recently described the spindle as a rather homogeneous jelly enclosing the chromosomes, only by interference of one kind or another could fibrils be made visible.

The experimental evidence presented by Dr. Baitsell in favor of the theory of the intercellular formation of connective tissue ground substance, while perhaps convincing from a histological viewpoint, is incomprehensible from a chemical viewpoint. According to this, fibrin fibrils continue as white fibrous substance, undergoing a chemical transformation to do so. The author declines to go into the chemical questions involved. This is still the debatable question and the writer feels the need of two or three high-power pictures in Dr. Baitsell’s fine series, to show the intimate relations of cells which invade the clot or exudate to pre-existing and newly forming fibrils. This will be necessary to clear up the doubt expressed by Maximow as to the continuity or identity of fibrinous tissue with the fibrin. (See Proc. of Soc. for Cytology, 1928.) Maximow, however, offers convincing evidence in other respects in support of Baitsell’s views. After talking with Dr. Baitsell and examining his illustrations, the reviewer feels confident that the necessary additional pictures will be forthcoming.

Ross G. Harrison’s expression of opinion as to the formation of connective tissue fibrils in the Balancer of Amblystoma in 1924 on page 412, Jour. of Exp. Zool. Vol. 41 is another strong endorsement of Baitsell’s views as to the derivation of the fibrils from ground substance. The immediate control or actions of cells. This statement is exceptionally well- phrased. It is all the more forcible because made in seeming contradiction of Harrison’s earlier study of the “fin-rays” which however may be in a special category.

Though he refers to Dr. Baitsell’s study of wound healing Harrison does not debate the matter of fibrin transplasme and. We believe this about sums up the present status of the discussion.

The reviewer sees an interesting resemblance between the discussions and the experiments carried on in the field just considered and that concerning fibrils and the structure of protoplasm. The fibers of the mitotic spindle also come to mind. Here again the question of artifacts produced by fixation, etc., has played a prominent part as in the case of the connective tissue fibers. The work of Chambers on the spindle raises the question whether any fibrils really exist. He recently described the spindle as a rather homogeneous jelly enclosing the chromosomes, only by interference of one kind or another could fibrils be made visible.

THE SO-CALLED CENTRAL BODIES IN ECHINODERM FERTILIZATION

Dr. Henry J. Fry
Assistant Professor of Biology
New York University

(Continued from Last Issue)

II. The Significance of the Method of Study for Cytological Research

The chief significance of this investigation lies in its emphasis upon the need of quantitative methods in cytological research. The difference between the method of study used by former investigators and that of the present work explains the equally wide difference in interpretation concerning central bodies in echinoderm fertilization developed by those workers and that proposed here.

The present method proceeds on the following assumptions: (1) The appearance of a cell component when enumerated may differ to a greater or lesser degree from its appearance when alive; in a very real sense, all coagulation products are “artifacts” of the living condition. (2) Within any one fixation, at each significant interval, it is necessary to study a large number of cells, chosen entirely at random, to avoid all unconscious selection of any one class. (3) Every part of the sample in each cell studies should be accurately measured and observations made concerning the physical structure of each. The surroundings, the structural elements should also be analyzed in the same detail. This should be done in tabular form so that every individual is carefully checked with reference to each of the independent variables. The tabular form is necessary otherwise other-wise omissions will be made when analyzing many cells each with respect to a large number of points. (4) If the component occurs in more than one section, it is necessary to study all the serial sections involved. In making certain measurements it is necessary to know in exactly what plane the component has been cut. (5) In compiling the data for each fixation, all class intervals are taken into account and none are omitted. Only those individuals are included within a class that are very similar with reference to all the variables. Unusual combinations of the variables as well as transition classes are listed separately so as to not pass by small but

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possibly significant groups by paying attention only to the larger ones.

The percentage of each class is accurately ascertained, yielding data necessary in determining which of the classes are significant.

Whatever the abnormality introduced by any one fixative, at least that is a constant throughout the various intervals of that series. If significant correlations are apparent they are at least present significant relationships in the living condition, despite any abnormalities introduced by fixation.

This technique is repeated in a similar manner in a group of diverse fixatives. If the relationship in apparent in them all can be harmonized, and if a conclusion can be reached that takes them all into account, it is probable that the results are valid for the living condition, although they must be used with great caution.

The drawings of the various classes are not each a delineation of a single "best" cell, but each dimension and the physical appearance of each part is an average of all the observations concerning that variable made in all the members of that class.

It is of course taken for granted that the investigator uses every means at his disposal to study the component in the living condition. This not only yields facts concerning its structure when alive, to use as a control concerning its structure when coagulated, but it may also produce data concerning its chemical components in the living state.

It is equally necessary to secure all possible data concerning the physical chemistry of the coagulation products by such means as: modifying the temperature and pH of the fixative; noting the effects of reducing and oxidizing agents; analyzing the divergent results when using widely different types of fixatives; analyzing the effects of various cations and anions; studying the effects of certain complex fixatives by using their components separately, in various sequences, in different combinations, and in various percentages; applying biochemical tests to the coagulation products; and similar points. The significant results of such investigators as Zirkle (26, 27, 28) in this field show how essential are such methods.

The usual cytological procedure is to use one to several fixatives and to select certain of the coagulation products as "normal", dismissing the others as "poorly fixed", without specified complete and quantitative consideration of all possible classes of coagulation products.

Both methods have the same aim, that of determining the "normal", i.e., deciding which coagulation products most nearly approximate the living conditions. They differ concerning the completeness of the analysis necessary to decide what is "normal". The present method is not a superficial study of many classes of coagulation products in contrast to an intensive study of the "best" types; it is an equally intensive study of all types, omitting none, in order to determine the "normal".

The old method is open to the danger that the "normal" is decided upon the basis of incomplete and partial data. There are widely divergent theoretical interpretations concerning cellular components such as Golgi bodies, chromidiosomes, chromidia, and similar structures. In many cases the different hypotheses are explained by the fact that one investigator uses a certain group of fixatives and draws his conclusions from that group of coagulation products, whereas another worker uses a different group of reagents and arrives at different results based on different coagulation products.

It is because of this situation that many of the results of cytological research, both past and present, are seriously distrusted in many quarters, and legitimately so. The present method of study brings strong additional evidence against the accepted cytological procedure. It constitutes not so much a negative criticism as a constructive suggestion. The application of simple statistical procedure involving the elements of quantitative scientific methods to cytological research, in conjunction with a more complete study of the physical chemistry of coagulation, will probably produce results far less open to criticism than those produced by the present method. It is fully realized that it is a serious matter to question so radically a method that has been used widely for many years. These statements will challenge discussion and will meet with strong opposition. The prophecy is made, however, that if future study of cellular components is carried on by this quantitative method, that many cytological facts, now assumed to be based on sound evidence, will be found actually to be based on a consideration of a selected group of coagulation products without sufficient consideration of other classes. Results will probably be attained in various fields, as contrary to the accepted ideas as are those here reported concerning central bodies in echinoderm fertilization.

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The play hewed to the line and let the chips of wit fall profusely. There was not a moment of the evening that was not dealing directly and fiercely with the subject of not too ardent playgoers. It was an audience which wanted a duller play with laughs fed to it out of a spoon. And instead of letting the audience laugh at the play, the play had laughed at the audience—which is a dangerous jest for any playwright to make. About half of the satire was received in silence.

Perhaps the one thing wrong with the play was that the space of rest between poignant lines was ignored. They came hot on each other's heels and there was no rest, no rhythm. The players clung to the play and refused to blur anything. The cast so thoroughly appreciated the piece that at times their enthusiasm bore down on the 'light comedy' until it was like the heavy results of a bride's first conscientious cookery.

Charles Leathertone who took the part of Hunter McAlpin the young husband, played his role with a charming and natural impulsiveness which has won him a deserved affection with his audience, and with that same charming impulsion he forgot many of his lines. But he has a knack of improvising when necessary and he is a good actor. It is to be hoped that he remains on the stage.

Elizabeth Fenner who played opposite him was her usual cool, intellectual and capable self. In her big speech at the end of the second act she was magnificent. Helen Field, who played the part of Maria McAlpin, entered into her part splendidly. One utterly forgot that she might offstage, be something else. Margaret Cook and Elisabeth Shaffer who took the parts of Matilda Mayhew and Sarah Henshaw did—"It was like the heavy results of a bride's first conscientious cookery."

THE NEW WAY

(Continued from Page 11)

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Development is progressive differentiation, coordinated in time and place, and leading to specific ends. There are innumerable problems of development, indeed almost every problem associated with living things finds illustration and illumination in developing organisms. It is as true today as it was exactly one hundred years ago when von Baer wrote his famous dictum that "Entwicklungsgeschichte ist ein wahrer Lichtstrahler". But the chief problems of development may be grouped around the three phrases of the definition just given, namely: (1) When and how do progressive differentiations arise? (2) How are coordination, orientation and regulation brought about? (3) How can one explain the teleological character of development where the end seems to be in view from the beginning? Only the first of these general problems has received adequate treatment hitherto; an important beginning has been made on problems of coordination and regulation; but with respect to the teleological character of development we are still most completely in the dark, and many biologists regard this as no problem at all; that is, they explain it by explaining it away, or else they deny that it is a problem for scientific investigation and turn it over to philosophers or theologians.

Inter-relations of Nucleus and Cytoplasm.

The earliest steps in differentiation consist in the formation in the cell-body of specific substances as a result of the interaction of nucleus and cytoplasm, and the general method of this interaction can be readily seen. During intervals between successive cell divisions the nucleus grows by absorbing soluble, dialysible substances from the cell body, whereas when the nuclear membrane is dissolved in mitosis a cloud of nuclear material, which could not diffuse through the nuclear membrane, is set free into the cell-body. Thus the nucleus receives relatively simple food materials and gives out elaborated products. In the earliest stages of oogenesis and spermatogenesis the nucleus at its maximum size nearly fills the entire cell; almost all of the material in the cell-body at this stage is absorbed by the nucleus in its growth, thus showing that at this stage most of the cell contents are dialysible; but as development proceeds and differentiation products appear in the cell-body the quantity of cytoplasmic material, which cannot be absorbed by the nucleus in its growth increases, while the relative volume of the nucleus decreases. Finally, in the mature ovum, although the nucleus is large, it is still only a fraction of the volume of the cell-body; and in later stages of differentiation the ratio of nucleus to cytoplasm continues to grow less until it may be only one hundredth part or less of the volume of the entire cell.

Undoubtedly cell-division plays an important part in ontogenetic differentiations; it facilitates interchange between nucleus and cytoplasm, it stimulates intracellular movements of orientation and localization, it leads to the more complete isolation of different substances; but all of these things may take place in the absence of cell-division, as we see in many highly differentiated protozoa and metazoans and tissue cells. In fact, the fundamental features of differentiation are the same in unicellular and in multicellular forms.

Promorphology of the Egg.

The early differentiation of polarity, symmetry and pattern of localization have long been known as the "promorphology" of the egg, a name which indicates that they are causally related to the morphology (Continued on Page 2)
of the embryo. Unlike the differentiation of the spermatozoon, which are largely lost to the ovum, each cell of the egg, these early differentiations of the ovum are the foundations of embryonic differentiations. They determine the polarity, symmetry, and type of cleavage, pattern of localization and general plan of development. Not until after these earlier and more fundamental differentiations have occurred does the effect of the genes brought into the egg by the spermatozoon begin to be felt. Consequently, while the share of the egg and the spermatozoon is approximately equal in later stages of development, as is shown by reciprocal crosses, their share in the early stages is not equal, since the promorphology of the egg determines the type of early development and consequently the general plan and pattern of the embryo. And this promorphology has developed either as the direct result of the activity of the genes in the ovarian egg or through stimuli or "inductions" received from the egg nucleus in the position of the egg in the ovary or its relation to other maternal tissues, which in turn are conditioned by maternal genes. But in support of the general equality of the sexes it should be said that the share of the maternal grandparent in determining the promorphology of the egg is often no direct evidence of such differences.

The orientation of intracellular movements by which different substances are segregated and localized and the mitotic spindles turned into particular positions so that cleavage takes a characteristic form for each species is one of the most important and mysterious processes in development. These orientations of movements in eggs and blastomeres, the active changemakers and the cells, for example as gastrulation where the ectodermal epithelium may become flattened and the endoderm columnar, the continued growth of cells in one axis, as in the notochord, all of these and many other similar phenomena give evidence of being mechanistic phenomena capable of a physiological explanation; even the circulation of protoplasm in a plant cell, and much less do we know what causes and directs the movements of chromosomes, centromeres, amitochondria and formaive substances are segregated and localized and development in a mechanistic manner, in which case the "organizer" in the developing organism resembles purpose there is no doubt that purpose exists in human life and, if mechanism is universal, sooner or later science must deal with this greatest of problems. Purpose in man and teleology in organisms may be fundamentally different. It is uncertain whether the evolutionary development would "resemble our own activities" as Spemann has suggested, and yet both of these be casual phenomena and the subject for scientific investigation. How is the greatest problem of development and one which so far from discouraging research should greatly stimulate it. The chain of cause and effect is endless and every cause discovered leads to inquiries as to the cause of this cause. We trace differentiation to inductions and these to "inductions" or "organizer" of formative materials and these to the promorphology of the egg, and all of these to genes, only to be met by the eternal question of the cause of this last link. We find mechanistic mechanisms of differentiation only to inquire as to the causes of these mechanisms. We find orientations, regulations and teleology only to be mystified by the immensity and complexity of these problems of development. But this is the method and these are the limitations of science, for nature is infinite and our science touches only
PROBLEMS OF DEVELOPMENT

(Continued from Page 2)

the hem of her garment. But so far from discouraging research it should stimulate those who are working in a field which has no limits and that our explorations will never end, will never lead to an ultima Thule because there is no such place.

REVIEW

By Dr. Frank R. Lillie
Professor of Embryology
University of Chicago

It is not intended here to make an attempt to evaluate this very notable lecture which sums up much of the experience of a great and experienced student of problems of development which important new additions to our knowledge are also included. A few impressions only will be recorded in this place, for the matters dealt with are not both in biology and in philosophy that a real discussion and review would necessarily be lengthy.

The new results, which may first be mentioned, concern two fundamental problems, viz: the extent to which the cellular differentiation may proceed without the formation of cell-walls, and the effects of centrifuging on the development of the egg. On the first topic: cell division must be ascribed to the egg of Ciona. In fact, Conklin draws the conclusion that at least most of the visible inclusions in different areas of the egg are not "organ-forming", but that the inclusions are, so that when such entities are formed, the developed development is never normal. In this way the most bizarre monsters may be formed, with their different organs out of all proper relation to one another.

To this distinction between the properties of formed substances in the egg and of entire areas, the reviewer heartily agrees. Conklin's results reveal a localization of the embryonic segregates in the ascidian egg before cleavage; and further analysis of the results should show, by the test of self differentiation, exactly how many segregates there are, and what their potency is.

The one criticism that the reviewer would make on this section of the lecture is that Conklin does not give full weight to his own results. It seems incomprehensible that the work of the same team, so that when such entities are formed, the developed development is never normal.

The conceptions of chemo-differentiation by successive steps from genes and gene products in interaction with cytoplasmic substances, production of "specific chemical substances" and normal differentiation, isolation, with resulting specificity and self differentiation etc. are mentioned sympathetically by Conklin in the section on physiology of development. These are old stalking horses of the embryologist, and not to be neglected without discourtesy. This is the best that may be said of them. They are saluted! and it is wise to pass on.

"Development is progressive differentiation coordinated in time and place, and leading to specific ends". This is a good definition. The problems of orientation, coordination and control are considered by Conklin in the aspects of development. They have led many to question the adequacy of mechanics to describe the world of experience. But Conklin does not follow Driesch in his vitalism. There is a middle ground of continued inquiry, and of philosophy. "Development is the most perfect example of telology in all the sciences." This problem Conklin thinks must be faced boldly, avoiding the pitfalls of vitalism and seeking the solution of our problem in mechanism "with which alone science is concerned". Such mechanisms, Lamarkism or Darwinism; but development presents difficulties at present insuperable on either line of approach. The problem is indicated but not grappled with here.

Professor Conklin's statement concerning his new results on the effects of centrifuging on the ascidian egg carry this subject a great step forward. In previous experiments, Lillie showed that if Conklin himself, and others it had been shown that displacement of the visible granules of the egg from normal locations by centrifuging might be accomplished without any obvious detriment to subsequent development (amnions, sea-urchins and mollusks). From this it followed that the displaced substances were not necessary to the differentiation when they were former localized, and also that they produce no onogenetically specific effects in the new locations; accordingly they can not be regarded as "specific formative" agencies in any strict sense of the word. The word "gene" from this that ontogenetic segregation is a function of the hyaline "ground substance" of the cytoplasm. Conklin had, however, reached a divergent result at about the same time in the ascidian egg which he announced only briefly (1909, Anat. Rec. 3, p. 153) viz: that specific organ formation followed the displacement of the substances.

This discrepancy has now been cleared up beautifully by the result announced in this lecture, that light centrifuging may result in a displacement of formed granules; but this may be compensated for without detriment to subsequent development but that with heavy centrifuging organ formation follows the displacements, and a heterogeneous assemblage of structures results. In the subsequent discussion Conklin shows that the results of such steps agree in general with previous results of a corporation. It must further be added that Conklin as among the most essential theorizers of continued inquiry, and of philosophy. Such a management as that outlined, no doubt has an influence on policy, a marked change of which has expressed itself in the present instance since the transfer of the Laboratory to the Long Island Biological Association. The policy undertaken by the Laboratory is now operated grudgingly important to biological research. Far from seeking an increase in the number of students enrolling in the courses given at the Laboratory during the summer, definite attempts are being made to reduce the number, so that more space may be given investigators, both in living quarters and in laboratories. It is expected that the number of students matriculated in courses will not exceed forty, while it may be kept at an even smaller number. In pursuance of this policy, the nature of the courses has been changed, and will be placed toward meeting the needs of carefully selected students. Students are made familiar with experimental methods in the courses in Physiology, Plant Ecology, and Surgical Methodology in Experimental Biology: and, beginning next year, the most elementary course in zoology given at the Laboratory will have a similar end, namely to aid the candidate who is considered fitted to carry on biological research.

Facilities for research have been considerably increased during the last three years by the erection of two new buildings, including the
George Land Nichols Memorial, and a student laboratory building, which releases the John D. Rockefeller, Jr., Fund, and makes it available for investigators. The old lecture hall has been refitted for research, making a total of some twenty rooms available at present. Two dwelling houses have been purchased and are being remodelled to provide small suites for investigators and their families. Over thirty acres of land have been purchased to provide sites for laboratory buildings, and opportunities for summer homes near the laboratory. Finally, the scientific equipment has been considerably augmented.

All of this represents a fattening of the laboratory's purse, and it is estimated that more than $15,000,000. The truth of Dr. Calkins' statement about science and purses is further substantiated by the fact that the number of biologists carrying on research at the Laboratory, that the summer has increased this year to twenty-four, the budget having increased from about $7,000 to about $45,000 in the five years since the transfer.

With this increase in funds available, the laboratories are equipped, of course, with gas, electricity, fresh water and sea water, aquaria, common laboratory apparatus, some special apparatus, operating rooms, and a chemical supply room. There is also a collecting launch. While all of the laboratories are located in wooden buildings, there are a small number of specially constructed vibroseis and tables, supported on concrete pillars which are free from contact with the building.

The private library of the Laboratory is unimposing, and the Department of Genetics of the Carnegie Institution of Washington, with 12,000 volumes, largely serials, is available for the use of the investigators at the Laboratory. Evening lectures are held during the summer; classes of nature study are given for the children of investigators and neighbors; and estates and gardens nearby are open on Saturday and Sunday afternoons. The social life of the Laboratory is quiet and informal.

The Biological Laboratory at Cold Spring Harbor is attempting to establish, in a relatively modest way, the value of such a laboratory to the advancement of biology, already so remarkably well demonstrated, on a large scale, by the Marine Biological Laboratory at Woods Hole. In their work the two Laboratories have the same broad purpose and, as would be expected, many of their methods of carrying out their aims are similar. However, there are some differences of method, perhaps the most striking of which has been the addition, at Cold Spring Harbor, of facilities for research on mammals. But this difference, while marked in practice, is not particularly marked from the viewpoint of policy. It is merely carrying a step farther a policy which has long been in practice at Oxford in extenuating, although not limiting research to work upon marine organisms. It is believed, by the officers of the Biological Laboratory, that this step makes the work of the Laboratory only the more catholic in extent, and has the additional virtue of co-operating with a wider range of departments of universities and of medical schools, at the same time giving the workers at smaller colleges opportunities of which they might otherwise be deprived. In the furtherance of these aims, the course of Surgical Methods in Experimental Biology was added to the curriculum of the Marine Biological Laboratory; and this statement about science and purses is further substantiated by the fact that the number of biologists carrying on research at the Laboratory was inaugurated four years ago with endocrinological studies carried out by Dr. W. W. Swingle and his graduate students from the University. Since that time the work has further embraced parasitological studies, experimental embryology, and experimental medicine, and even experimental pathology has been carried on with mammalian material. This work has brought in a group of medical investigators, as well as pure biologists, and has lent to the Laboratory an atmosphere which has seemed to result from the juxtaposition of experimental biology and experimental medicine, with a consequent mutual exchange of viewpoints and methods. The data which have been pleased to call "pure biology" and "applied biology." It is believed that such intercourse is of value to both groups, and provides a useful liaison between workers and methods that have, perhaps, been too widely separated.

At the Laboratory, the experimental biology occupied with marine organisms has been concerned of late with the study of certain tunicates which are usually called "starfish," Limulus and many other well known marine forms are also plentiful and are used from time to time by various investigators. Marine fauna at Cold Spring Harbor are doubtless less varied than at Woods Hole, but the forms occurring here are frequently present in unusually large numbers.

Some years ago the Biological Laboratory have available, nearby, excellent fresh water, as well as estuary and woodland collecting areas, the region being unusual by reason of the variety of mammals and plants frequently sought by protozoologists and physiologists.

The Laboratory is contemplating a departure from the usual policy and practice of similar stations in this country by the formation of a small permanent staff of investigators. Such a step would seem to be unusually practicable here, due to the proximity of Cold Spring Harbor; and, as illustrated by the feasibility of such a project at Cold Spring Harbor has already been successfully demonstrated by the Carnegie Institution. The permanent staff will in time, doubtless, be made up of two kinds, those who are definitely members of the staff, and those who are temporarily members during a sabbatical or other leave from another institution. Both groups will be paid by the Laboratory.

This policy will tend, doubtless, to keep down further rapid growth of the activities of the Laboratory during the summer. Thus it is probable that the size of the Biological Laboratory at Cold Spring Harbor, at that season, will remain more or less constant, maintaining its present relationship to the size of the Marine Biological Laboratory at Woods Hole. In any case the two Laboratories, as far as we see them, will continue to be mutually helpful, from the broad viewpoint of the advancement of biological knowledge. In working toward this advancement, I am happy to say, the administrations of both Laboratories are carrying on with complete friendship and harmony, and it is with this in view that the Biological Laboratory is happy and honored to have this opportunity of expressing to the Marine Biological Laboratory through THE COLLECTING NET, its high esteem and friendly regard.

THE MATURATION DIVISIONS AND SEGREGATION

BILOGOST, particularly cytologists and geneticists, have a habit of referring to one of the maturation divisions as the reduction and the other as the equation division. Wilson, McClung and Wenrich, however, all realized as soon as they were convinced that paragametic tetrad was applicable only to individual pairs of homologues of the pair under consideration. Therefore, an explanation showing why the transformation of terminal granules into chromosome vesicles which become densely chromatic and are maintained and transmitted, can be made up of two parts, those who are definitely members of the staff, and those who are temporarily members during a sabbatical or other leave from another institution. Both groups will be paid by the Laboratory.

Obviously, therefore, neither division can be referred to, accurately, as the reduction division, the term if applied only to the equal pairs of chromosomes and not to either maturation division.

As to the origin of the unequal homologues studied, the smaller member of the pair is the normal one. The larger one, apparently, is either of a different size and form, or is a change in chromosome. The transformation of terminal granules into chromosome vesicles which become densely chromatic and are maintained and transmitted, is now becoming constructed in certain individuals to form chromosomes. In one genus certain individuals were found which had both homologues of the pair under consideration of the larger type resulting in a tetrad which was still recognizable on account of a definite morphological feature but which was moved completely out of its usual position in the size series. Whether the factor of origin is correct, then, new chromatin has been organized to form a permanent component of the complex, and, granted that the chromatin bears hereditary factors, a mechanism in some progression change is shown. The change should be adaptive in character if we further assume that chromomeres are an indication of increased functional activity.

REVIEW

Dr. P. W. Whiting
Associate Professor of Zoology,
University of Pittsburgh

It is often a matter of wonder to the critical-minded that certain views generally accepted and reasonable enough for a certain period persist in text-books and in the mind of the majority long after the contrary has been proved. This has been generally held that of the two maturation divisions forming spore, sperm, or egg, the first or heterotypic is redundant, while the second or homotypic is essential. The morphological difference between the former and ordinary diploid

(Continued on Page 5)
mitosis doubtless gave rise to the concept that the peculiar phenomenon of crossing-over was not a natural process, but one peculiar to homologous chromosomes, as well as for heteromorphic euchromosome tetrads, the first division might be in some cases equational, in others reductional. It is high time that text books were changed and brought up to a date long since past.

Morphological heterogeneity of homologues has been explained in diverse ways. Point of spindle fibre attachment or post may vary. Fusion of chromosomes or parts of chromosomes may cause dissimilarity of synapsing mates. Dr. Carothers now suggests a third possibility, supported by the much-studied chromosome vesicles may, through a process of condensation become integral parts of the chromosome. Thus the quantity of chromatin is increased. It is even suggested that there may be a basis for progressive evolution. Does Dr. Carothers conclude that new genetic loci are thus created?

The objective facts of swollen clear vesicles and small dark vesicles connected with definite parts of de-finite chromosomes are undeniable. Is the process one of condensation bringing material from plasm to chromosome, or is it the reverse originating at a certain chromosome locus, spreading out into a vesicle crust which eventually disintegrates, affecting the entire cell, a link, perhaps, between factor and character?

It seems to the reviewer that the true significance of chromosomes is still out of the realm of speculation. It is unfortunate that time did not allow discussion of Dr. Carothers’ papers. Her exhibit of cytological preparations showing diverse ways. Point of spindle vesicles may, through a process of condensation become integral parts of the chromosome. Thus the quantity of chromatin is increased. It is even suggested that there may be a basis for progressive evolution. Does Dr. Carothers conclude that new genetic loci are thus created?

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out that our conclusions apply only this fish; but, if secretion occurs in the tubule cells of this kidney, it would appear extremely unlikely that it has been completely lost in the evolution of the mammalian kidney.

**REVIEW**

Dr. A. N. Richards
Professor of Pharmacology,
University of Pennsylvania

There is little need for extended published comment at the present time upon the extremely interesting work in which Dr. Marshall and Mr. Graffin are engaged. Some years ago Dr. Marshall committed himself to the theory that the renal tubule possesses secretory functions; now he is fortunate in having a fish which is apparently this very organ. From the data of analyses of blood plasma and urine presented, it was evident that the chloride concentration in the urine is always slightly higher than in the plasma. The figures which were higher than those assumed by them have been noted for other animals. It is obvious to conclude that Lophius kidneys must "secrete"; and if they do, then probably more highly organized kidneys possess a remnant at least of secretory capacity.

The investigation as yet has scarcely passed the descriptive stage and criticism would be unwarranted. But proof of secretion by exclusion of filtration will not be satisfactory unless filtration is experimentally demonstrated. For this purpose evidence is provided by the ordinary urinary constituents. From the above data, it seems fairly safe to conclude that we have here tubular excretion of all substances present in the urine. Since the concentrations of bodies in the urine is by no means the same as in the blood plasma, energy must be expended by the cells in excreree absorption. This could be demonstrated by a filtration of a depoproteinized plasma at one level of the tubule, and the reabsorption of water and certain solutes at another level; or by secretion by the tubule cells. The former of these hypotheses would appear adequate for the following reasons. 1. We have found no histological difference in the epithelium of the tubule at these levels. The blood pressure in the tubular capillaries or sinusoids must be very low, probably too low to overcome the osmotic pressure of the plasma proteins. 2. Normally the urine contains no glucose. If glucose is injected, no glycosuria results, and the same is true if phosphorin is injected alone or with a large dose of glucose. 4. Not all diffusible foreign substances are absorbed by this kidney. Ferrocyanide when injected intravenously does not appear in the urine. Phenol red and indigo carmine, substances for which there is some evidence for secretion in the mammal, are readily excreted.

Summarizing, it might be pointed out that our conclusions apply only this fish; but, if secretion occurs in the tubule cells of this kidney, it would appear extremely unlikely that it has been completely lost in the evolution of the mammalian kidney.

**FURTHER EXPERIMENTS ON GLOMERULAR ELIMINATION IN THE FROG'S KIDNEY**

Dr. A. N. Richards
Professor of Pharmacology,
University of Pennsylvania

(Continued from Page 5)

**THE COLLECTING NET**

**Summary of Evening Lecture Delivered on August 17.**

After a brief sketch of present opinion concerning the processes involved in the formation of urine, and a statement of recent results, obtained by direct observation and instrumental manipulation of the frog's kidney, an account was given of a series of experiments made in collaboration with Dr. A. W. Wexler. These were designed to trace the passage of phenol-sulphophenalein (phenol red) through the kidney of the frog and to identify the processes which occur. Phenol red was chosen because it appears to be treated by the kidney in a manner similar to that in which other normal urinary constituents are treated; and because it has recently been used in experiments by others (Marshall, Vickers, Cran and Edwards, Starling and Verney, Bensley and Starling) with results which have been interpreted by them as support for a secretory doctrine of tubule activity; and, finally, because it is a widely used reagent for clinical tests of impairment of renal function. In some of these experiments indigo carmine was used, another dye which has long been used for similar reasons.

The first question studied was that of the concentration in which phenol red exists in the fluid which is separated from the blood during its passage through the glomerular capillaries. The first attempts gave figures which were higher than that of the plasma because of the high concentration of the phenol red by plasma proteins. When, however, a method was introduced for closing the renal tubule in the Malpighian body during collection of glomerular filtrate, the results were consistently different; concentration of phenol red in the glomerular fluid was less than that in plasma by an amount approximately equal to the adsorbing capacity of the plasma middle of the dye. Similar data were obtained in experiments with indigo carmine.

The conclusion is that under the conditions of these experiments the living glomerulus permits the passage of phenol red and indigo carmine through its membranes in a manner similar to that of which obtains when plasma is filtered through colloidon; i.e., no "secretory" process is involved in glomerular elimination of these dyes.

To learn whether the volume of the product of glomerular filtration in the frog is sufficient to account for the total amount of phenol red excreted, experiments were made in which total elimination of phenol red of the whole kidney was measured, together with the concentration of phenol red in the glomerular fluid. From these data the volume of ultrafiltrate from the kidney was calculated which would be required to carry out from the blood the amount of phenol red eliminated. The results of the experiments are represented by the number of glomeruli which the kidney possessed gave a figure for average volume of fluid separated by each glomerulus during the subsequent period. This average compares well with collections actually made by Wexler, Walker and Richards. Hence it is clear that the volume of glomerular elimination is sufficient to account for the whole quantity of phenol red which the kidney excretes, and there is no logical necessity for assuming the existence of other excretory processes.

The second question concerned the existence of processes occurring within the cells of the renal tubule which might alter either the character of the secretion or its passage through the tubule or the amount of phenol red which it contains.

Experiments were mentioned which prove the existence of processes of resorption from lumen of tubule to blood; and evidence was outlined which shows (1) that a large percentage of the water of the glomerular filtrate is energetically reabsorbed from the tubule to blood vessels; and (2) that the wall of the tubule is highly impermeable to phenol red contained within its lumen. These two facts account for the small volume of fluid which leaves the kidney and the high concentration of the phenol red dissolved in it.

The second part of this question is the much debated problem of the existence of secretory activity of the renal tubule. The transfer of substance from blood to lumen of tubule as the result of expenditure of energy. Disebel was expressed in the adequacy of current evidences to demonstrate the existence of secretion by the tubule. Allusion was made to the experiment already published by Richards and Barnwell, in which the exciting surviving kidney of the frog lost its power to take up and highly concentrate within its tubules phenol red from oxygenated Ringer's solution in which the kidney was immersed. Brief exposition was made of the reasons which forced those experimenters to conclude that this phenomenon—apparently a striking demonstration of secretory power—is actually the result of diffusion of plasma phenol red and concentration there as a result of active exusion of water and selective impermeability to phenol red. Additional evidence in support of this view was found in recent experiments with Walker in which it is shown that the excised surviving kidney has no power to "secrete" the phenol red which is attached by adsorption to plasma proteins.

Allusion was made to the difficulties of the task of proving the negative side of such a question as that of secretion by the tubule. Certainly the greater part, if not all, of the available evidence upon which the theory of secretion of tubule function is at present based can adequately be explained by the demonstrable facts of glomerular elimination and tubular resorption when the logical implications of these processes are understood. The selective processes of tubular resorption are no less mysterious in their nature and control than are those implied in the term secretion. Resorption possesses the great advantage from the standpoint of the experimenters that it is demonstrable.
DEVELOPMENT RESPONSE TO LIGHT AND TEMPERATURE IN APHIDS

Dr. A. Franklin Shull
Professor of Zoology, University of Michigan

(Presented at August 20 Seminar)

A typical species of aphid comprises at least four types of individuals: (1) the males, (2) the gamic females, whose eggs require fertilization for development; (3) parthenogenetic females, and (4) wingless parthenogenetic females. The experiments already published, relating to the species Macrosiphum solanifoli, show that if the parthenogenetic aphids are reared in continuous light they are almost all wingless; that if reared in continuous darkness a few of them are winged; but that if they are alternated between light and darkness of certain durations, almost all of them are winged. The effect of alternating light and darkness is directly on the aphid itself, not indirectly through the plant, and occurs at a fairly definite time within two days before birth.

The new work shows that the effectiveness of this alternation depends on the intensity of the light. If an intensity as low as 5 meter-candles with darkness, the percentage of winged individuals increases with increase of the duration of the daily exposure to light, up to a maximum at eight hours of light and sixteen hours of darkness; decreases slightly up to twelve hours of light and twelve hours of darkness; drops sharply to almost zero at fourteen hours of light and ten hours of darkness; the usual number of winged individuals as at the eight hour and sixteen hour periods. These facts, in conjunction with the sharp decrease in wing-production from 100% to near zero, as the daily exposure to light is increased from twelve hours to fourteen hours, are taken to mean that the periods of darkness must be about twelve hours or more in length in order that wings may be produced.

Temperature has an important influence on the effect of alternating light and darkness. The results described above are obtained at 14° to 20° C. As the temperature rises above 20° there is a rapid decrease in wing-production, until at 26° no winged individuals appear. High temperature for only part of the day (eight to sixteen hours) does not inhibit the effect of alternating light and darkness. It appears to make no difference whether the high temperature is applied only during the light period, or only during the darkness; the usual number of winged individuals is produced if part of the time is spent at low temperature. What happens to aphids reared in continuous light at temperatures above 20° is not wholly clear, but there are some indications that the number of winged individuals rapidly increases with rising temperature in this range.

Only a tentative explanation of the above results may be offered. It is assumed that some substance (A) is produced in the light; that this is converted into another substance (B) in darkness; that B causes wing production; that this development when present in a certain amount; that twelve hours of darkness is required to convert A into B, or to convert enough of A into B to produce wings; that moderate quantities of B are present in continued darkness; and that continuous high temperature inhibits some essential step in these processes.

The control of wing-production under certain conditions has a further consequence that amounts almost to sex-determination a generation later. When gamic females appear, the gamic females are produced almost exclusively by wingless mothers, while the males are produced almost exclusively by winged mothers. Hence, when gamic reproduction is prevalent, the light applied to wingless females determines the sex of their grandchildren in almost all cases. Gamic reproduction is governed largely by temperature. If winged parthenogenetic females have been kept at low temperature (16°), they produce mostly gamic females. If they are changed to a high temperature (24°), they gradually become at one from the parthenogenetic females, and in the period of change they form intermediate individuals as the number of intermediate individuals are produced.

Light has a noticeable, though usually small, effect on gamic reproduction. Continuous light favors parthenogenesis, while eight hours of light daily favors gamic females. When the temperature is such as to leave the two types of reproduction equally likely, light may have a striking effect.

The production of males has not yet been controlled. It is known, as stated above, that they are produced almost exclusively by wingless mothers. Furthermore, among hundreds of such mothers, it has been observed that they sprang only from middle-aged or old females, never from young adults. The right combination for producing them at will, however, has not been discovered.

LIGHT AS A FACTOR IN THE METAMORPHOSIS OF THE LARVA OF ASCIDIANS

By Dr. Caswell Grave
Professor of Zoology, Washington University

(Presented at August 20 Seminar)

The free-swimming period of ascidian larvae ends abruptly with attachment of the larva to some fixed object and a relatively sudden metamorphosis characterized by the detachment of the larval absorbing system consisting of central and peripheral nervous system, light, static and tactile sense organs, notocord and bands of striated muscle cells.

The duration of the free-swimming period, under laboratory conditions, varies with the species from a few minutes (Molgula citrina) to several hours (Syconia of a large Polyandrocora lutea). The behavior of larvae during the free-swimming period consists of oriented movements that are characteristic of ascidian larvae in general. During a relatively short interval, immediately following its liberation by the parent, the larva swims actively at or near the top surface of the water in the illuminated side of the container (positive orientation to light and negative orientation to gravity); then follows a longer interval when it swims alternately upward and downward (alternate positive and negative orientations to light and gravity); finally it tends to remain at or near the bottom in the least illuminated area.

(Continued on Page 8)
LIGHT AS A FACTOR IN THE METAMORPHOSIS OF THE LARVA OF ASCIDIANS

(Continued from Page 7)

The behavior of larvae under this treatment, and the manner and place of attachment and metamorphosis, are affected significantly by the number of larvae treated. Treated larvae, in nearly every case, become attached before metamorphic change begins and their attachment is practically always made at some distance from the stomach. In untreated larvae (those standing in continuous light or darkness) attachment seldom occurs and metamorphosis takes place on the surface of the water on the bottom of the column of water. Exposure to light or darkness for three hours after the last exposure.

The responses and movements of larvae while undergoing treatment indicate something of the nature of the internal processes taking place. By using the first several exposures to light and shadow all larvae swim actively and continuously at or near the top of the column of water. After the first several exposures to light and shadow all larvae swim actively and continuously at or near the top of the column of water. Before the end of the interval of shadow, however, they tend to become inactive and sink to the bottom. From this behavior it is evident that an effective stimulus to energetic swimming is produced at the moment of the reduction of light intensity. It is as if a chemical change occurred, the liberation of energy occurs at the moment of the reduction of light intensity, the reverse change taking place with increase in intensity. This hypothesis however requires that the same level of light intensity two or three cases an abnormally high change, is the level of intensity which, in another case, conditions a kataleptic change.

In the normal habitat of the species it is evident that the behavior of the larva is effective in, and adapted to, bringing about attachment and metamorphosis within a relatively short time after liberation. Its positive and negative responses to light and gravity cause the larva to swim repeatedly up and down between the surface of the water and the bottom; that is, between two levels of light intensity, until a final stimulus to attachment and metamorphosis is released.

The larvae of four species of compound ascidians were subjected to this method of treatment sufficiently uniform intensity. In these "controlled" experiments, 30 one-minute exposures, each of one minute duration, followed by shadow of the same duration, were tried: a momentary shadow cast every second by a pendulum two inches wide, produced no effect whatever. Larvae subjected to such exposure for four hours had no response to those exposed to continuous light. The 20 and 30 second intervals accelerated metamorphosis in the most susceptible larvae, and even this treatment does not suffice for all, a few cases require exposure to some light followed by four hours continued larval life in darkness. Where the effect was temporary, it was found that a gradual return to normal may be followed by a slight advance beyond normal in the other direction. For instance, slight inhibitions of rate of fermentation may gradually disappear, and an actual increase in rate may follow. Two types of experiments were made to test the change in rate of carbon dioxide production following radiation, namely, (1) in which a single exposure was made and samples incubated immediately after exposure, and readings made at intervals thereafter, and (2) in which the single exposure was made, but samples were incubated both immediately and at intervals following exposure.

4. 50% of the cases in which stimulation occurred following exposures of less than 10 sec. in duration, at from 20 to 73 cm. distance from the center of the arc.

5. Preliminary studies indicate that the rate of cell-division is af-
ULTRAVIOLET RADIATION: STIMULATION AND INHIBITION
(Continued from Page 8)

In some studies it was found that where normality of form was the criterion for determining the degree of effectiveness of a dosage of radiation, only inhibitory effects were noted. For example, in studies on modification of development in the chick and in Fundulus heteroclitus, a stimulation effect there may have been, expressed itself only in an increase in speed of development, and in Fundulus in earlier hatching than in the controls. Experiments with the agglutinating power of egg-water showed only an inhibitory tendency.

From the experiments with yeast, and from the studies described above, it seems reasonable to conclude that the factor which determines whether the effect of radiation shall be stimulative or inhibitory, is a quantitative rather than a qualitative one. In other words, dosage must be taken into account.

Changes in water content in amoeba proteus

By Dr. S. O. Mast
Professor of Zoology, Johns Hopkins University

(Apresented at August 20 Seminar.)

Amoeba proteus consists of a very thin outer membrane (plasmalemma), a relatively solid layer to this (plasmagel) and a relatively fluid central mass (plasmasol). The relation in amount between plasmagel and plasmasol varies greatly in different individuals and in the same individual under different conditions; and during locomotion the plasmasol changes continuously to plasmagel at the anterior end and vice versa at the posterior end.

Amoeba is a very largely composed of water. It doubtless contains well over 95 per cent. The gel-sol transformation, adhesion to the substratum and various other vital phenomena appear to be closely correlated with the water content and changes in it. The processes involved in controlling the amount of water that amoeba contains are therefore of great physiological importance.

Changes in the water content of Amoeba are doubtless very closely correlated with changes in volume. They can, therefore, be fairly accurately ascertained by measuring the volume. Two methods with appropriate apparatus for doing this have been devised by Chalkley.

Indirect Method. In this method a series of pairs of outlines of an amoeba are made with a microscope modified so as simultaneously to project with a camera lucida two images, one as seen from above and the other as seen from the side. From this series of pairs of outlines, by various measurements and calculations, the mean longitudinal and transverse axes of the amoeba in different degrees of elongation are ascertained. These values are plotted and by extrapolation the point on the resulting curve at which the axes are equal is ascertained. The axes represented by this point equal the diameter of the amoeba in spherical form, and from this the volume can readily be calculated.

This method is accurate to within approximately five per cent.

Direct method. In this method the amoeba is drawn into a capillary tube and thus forced to assume a cylindrical form of known diameter and length. The results obtained in this way are under favorable conditions accurate to within approximately two per cent. Unfortunately it can, however, be applied only to amoebae under certain conditions. Under some conditions they are so adhesive that masses of cytoplasm are torn from them as they are forced into and out of the tube. The results obtained in marked change in volume; under others they are so fragile that they break. Moreover, the mechanical stimulation produced

(Continued on Page 10)
CHANGES IN WATER CONTENT IN AMOEBA PROTEUS

(Continued from Page 9)

by forcing them into and out of the tube produces considerable change in volume unless special care is exercised in the manipulation and description for recovery between successive readings.

The results obtained by Chalkley with these two methods may be summarized as follows:

Amoeba in 0.1 M glycero1 does not appreciably decrease in volume until after about two hours; then it decreases rapidly, losing 20 per cent. in an hour, after which the volume decreases fairly rapidly. Similar changes take place in 0.15 and in 0.275 M solutions. The time required and the extent of decrease differ considerably, however. In 0.15 M the decrease reaches nearly 30 and in 0.275 M a little over 50 per cent.

This decrease in volume is doubtless due to water. It does not injure the amoebae, for if they are returned to the culture fluid they very soon begin to move about freely.

Lactose: In lactose solutions the results obtained are similar to those with water, although this substance seems to be relatively more efficient in causing loss of water, for the amoebae in 0.15 M decreased 50 per cent. in volume whereas in 0.275 M they decreased only 29 per cent.

Urea: In urea 0.15 M the organisms, for about two hours after they are introduced, decrease in volume at about the same rate as they do in lactose of the same concentration, losing 30 to 40 per cent. during this period. After this the action of the two solutions differs greatly. In lactose the rate of loss gradually increases until it reaches zero; in urea it gradually increases until the organism dies.

Hydrogen ion concentration: Amoebae transferred from a culture medium which is slightly acid, to a series of modified Ringer solutions, appear also to be due to the effect of hydrogen ion concentration, resulting in flocculation of the intraprotoplasmatic film structure. It indicates, moreover, that the plasmagel as a whole acts somewhat like a semipermeable membrane.

The rapid decrease in the relative volume of the plasmagel after the initial decrease in urea as contrasted with only a very slight decrease in lactose, indicates that urea acts especially on the plasmagel making it more permeable, probably owing to a flocculating effect on a colloid in the intra plasmagel structure, similar to the effect it is known to have on gelatin.

The changes in water content correlated with mechanical stimulation and hydrogen ion concentration appear also to be due to the effect of these agents on the structure of the plasmagel, resulting in changes in its permeability.

It would thus appear that the water content in amoebae is very much thicker than the postulated semipermeable membranes of cells are assumed to be.

REVIEW

Dr. L. V. HEILBRUNN
Assistent Professor of Zoology
University of Michigan

To measure the volume of an amoeba with extended pseudopodia seems an impossible task. And yet in Mast's laboratory a method has been worked out which permits of such measurement. The results (Continued on Page 11)
Yours very sincerely,

Jacques Loeb
The Col

A weekly publication of the activities of Laboratory and Board

Robert Chamber
of Biology, N
Edwin G. Conklin
Prize
Lorande L. W
Protozoology:

Ware Cattell

Contril

Mrs. L. V. Heil
Virginia L. To

Busin

Ilse

Shirley E
New Bedford

May

RECO

The College Fund received $134.50 from last week. The $234.50 and this was paid to The Col with the incidental payment with the paid by The Col.

At this time we wish to thank those who contributed to the fund. The following members have contributed: Misses Molly Eason and Annalas last mentioned continuously in an unbroken manner.

TRUSTEES AND MEMBERS

The annual meeting of Trustees of the College Laboratory was held on August 1. E. Lawrence R. Calkins were elected President of the College Laboratory.

They replace Dr. Otto C. Glasser and Dr. I. F. Lewis and Dr. W. E. Garrey were elected to the Executive Committee until 1930. They replace Dr. Otto C. Glasser and H. Morgan of Columbia, Dr. B. M. Duggar of Wisconsin, Dr. H. S. Jennings of Johns Hopkins.

Lactose and in 0.1 M urea as the total volume decreases the gel/sol ratio at first increases and then decreases very slowly in the former. yet in almost a laboratory a method has been worked out which permits of such measurement. The results

(Continued on Page 11)
DEDICATORY ADDRESSES DELIVERED AT THE EXERCISES OF THE UNVEILING OF THE MEMORIAL TABLET TO JACQUES LOEB ON AUGUST 4, 1927, AT THE MARINE BIOLOGICAL LABORATORY

I. ADDRESS

Dr. Frank R. Lillie
President of the Corporation.
Marine Biological Laboratory; Professor of Embryology, University of Chicago

This Laboratory, where so many biologists have worked these forty years is a fitting place for memorials of their leaders. Dedicated to the advancement of Science and controlled by scientists, there is no place where greater reverence could attend them.

When this building was constructed it was planned that the bronze entablatures that adorn the exterior, should, in time to come, carry the names of the Founders of the scientific greatness of this institution. The perspective of time was, however, felt to be needful for selection, and the entablatures now bear conventional ornaments. In the meantime, as occasion offers, our interior walls may well bear memorials of those of our own times, whose memories we desire to perpetuate by a visible sign the memories of our deposed dead.

There is placed in the lobby of this building a bronze memorial tablet to Charles Otis Whitman "the first Director and the spiritual founder of this Institution". Besides this is another tablet dedicated to the memory of Louis Agassiz, whose final act, the establishment of the Anderton School of Natural History on the neighboring Island of Penikese foreshadowed the founding of our own institution. To-day we place beside these two a third tablet, in memory of Jacques Loeb, distinguished scientist, founder of General Physiology in America, and our own intimate companion for many summers, well remembered for friendly intercourse and for inspiring influence.

Jacques Loeb was born on April 7, 1859, in Mayen, Germany. He studied in Berlin (1880), Munich (1881), and Strassburg (1881-85) where he received the degree of doctor of medicine. In the four following years he was assistant in physiology in Würzburg and Strassburg. From 1889 to 1891 he was at the Naples Zoological Station. From 1892 he became Associate Professor of Embryology, University of Chicago, and invited him to Woods Hole. In the summer of 1893, at Professor Whitman's suggestion, he inaugurated the course in Physiological Botany which terminated only with his death.

Loeb died suddenly, still in the full flush of scientific vigor, on February 11, 1924, in Bermuda, where he had gone for scientific investigation. His ashes lie in the Episcopal burial ground of Woods Hole, marked by a granite stone, bearing only his name and dates, not far from the stone that marks the last resting place of Whitman.

The Marine Biological Laboratory honors itself in seeking to perpetuate by a visible sign the memory of Jacques Loeb in this place, as co-laborer in the advance of biological research, as teacher and apostle, as Trustee and proved friend. I therefore, on behalf of the Marine Biological Laboratory hereby accept this gift of the Rockefeller Institute for Medical Research, and herewith dedicate this tablet to the memory of Jacques Loeb.

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II. ADDRESS

(Continued from Page 2)

and his inclination toward humanitarianism was fed by the French philosophers, and he always looked to these writers as among the great intellectual and moral liberators of all time. In his book, "The Organism as a Whole," published during the great war, his tormented mind returns to them in the search for an anchor and haven of hope. "...and he turned to that group of free thinkers, who first dared to follow the consequences of a mechanistic science, to the rules of human conduct and thereby laid the foundations of that spirit of tolerance, justice, and gentleness which was the hope of our civilization..." until swept away by the great war.

But it was the advanced system of scientific training of the German university which emancipated Loeb intellectually by providing him with a foundation for his experimental studies. Loeb entered upon his university career at a propitious time; so much was the laboratory filled with eager investigators and their thought was dominated by many fundamental problems in physics, chemistry and biology. For a person like Loeb this fortunate circumstance could not fail to yield a significant result. His naturally strong, perspicacious, inquiring mind, already colored by the writings of the French philosophers and as such, was still strongly tending away from superstition and metaphysical conceptions, readily found a resting place in the growing physico-chemical beliefs of the time.

Loeb received the M. D. degree at Strassburg in 1884. To one looking to follow the story of his intellectual development it would seem natural that he should soon discover that it was not medicine as an art so much as medicine as a science to which he was turned. Medicine has in the past served as the doorway leading into science for not a few conspicuous men: through it passed Galileo, Gilbert, Young, Helmholtz, and in our own country, Ira Remsen. Even during Loeb's novitiate as it were, less than two years after he was in medical school he was already active in this science and quickly became interested in physiology.

It was very good fortune which directed Loeb to Strassburg and a fortune doubtless connected with his Abatian birth. Into that French-German environment, the German government projected after 1870 a center of higher learning staffed by a group of brilliant investigators and teachers. To the medical faculty it sent such men as Fick, Kühne, Schröder, Koch, Schwann, Schmiedeberg, Naunyn and Goltz. These were names to conjure with in biological chemistry, pathology, pharmacology, medicine and physiology. Loeb was attracted to Goltz, the pupil of Helmholtz, who was adding conspicuously to the then beginning knowledge of cardiac pressure, the mechanism of shock, functions of the semicircular canals, and the effects of excision of the spinal cord in the frog and dog. That the last-mentioned subject should be the one to claim Loeb's special interest is not perhaps remarkable in view of his philosophic convictions and as we shall see later, that Loeb experimented on the chain reflexes and overthrew Munk's thesis that the Rolandic area is composed of cellular "sensory spheres," by showing that the particular paralyses occasioned by each cortical excision are abolished as soon as the wound has healed. The interest in the centers of brain activity thus aroused was to be continued in his later investigation of tropisms with which he concerned himself at Naples, and which led him to substitute for the anthropomorphic conception of the responses of animals according to supposed capacities directing voluntary activity, the operation of tropisms or physico-chemical attraction, on the basis of which there was to arise a mechanistic conception of comparative psychology.

At this point it is desirable to trace a few steps in order to follow the particular events which were to influence so greatly Loeb's scientific development. Like other discoverers in science, Loeb was the product of his period. This central fact in his notable career will become increasingly evident as we proceed. At the threshold of his life's work circumstances brought Loeb from Strassburg to Wurzburg, to be the assistant of Fick, the prominent of the physiological school, then professor of physiology, whose contributions to knowledge in the domain of physical physiology are significant. The investigation of such problems as the physiology of muscle, the transferable substances of energy and heat production in muscle, as well as the publication of larger works on medical physics, would appear to be sufficient to have constituted the extraordinarily minded student of physiology to this particular master.

But whatever the benefit derived from this connection, it was small compared with the rewards in store from the chance association with Sachs which it brought about. The association produced results which led to friendship as well as to an impulse of direction in scientific pursuit which was to remain essentially fixed throughout Loeb's exceptional career. Rich and varied were the fortunate chance encounters with Sachs which turned Loeb's talents into the broad channel of general physiology. Has not Claude Bernard said that, the physiology is the basic biological science from which all others converge? Loeb was to find the truth of this axiom for himself and through his discoveries reveal it to a generation of investigators in a far distant land.

The botanist Sachs' personality and discoveries may be said to have dominated the field of plant physiology for more than thirty years, being typical of numerous remarkable figures. His influence continues to the present time. The physiology developed by Sachs was based on chemical and physical actions which he described under the term tropisms; heliotropism, hydrotropism, chemo- tropism, etc., reactions to light, chemicals and gravity. Loeb's alert mind grasped the significance of these phenomena not only for plants but probably also for animals, that we find him spending the winter months from 1889 to 1891 at the Naples Zoological Station, where the ideas he had formed could be subjected to experimental test. It was this period when he was in the making of his philosophic and scientific beliefs.

In a recent biographical sketch of the great physiologist, one of his distinguished pupils describes the studies leading to the idea of homoeosis, the development of the organism as a whole, as the basis of the doctrine of the physicochemical reactions. It is this period when Loeb was in Naples that he first looked into the powers of the human body, the so-called physiological functions, the so-called manifestations of life, to the status of physico-chemical reactions. It is in connection with the investigation of the physiological and physico-chemical manifestations of vital phenomena that Loeb has exercised so great an influence on his generation. This is not only for plants but probably also for animals, that we find him spending the winter months from 1889 to 1891 at the Naples Zoological Station, where the ideas he had formed could be subjected to experimental test. It was this period when he was in the making of his philosophic and scientific beliefs.

Fortunately, natural science had progressed further in France in the first half of the nineteenth century than in Germany. The influence of the discoveries of chemists such as Dumas and Berthelot and of others in the domain of physico-chemistry had brought the extraordinary figure of Claude Bernard, of whom Dumas said: "He was no mere physiological experimenter, but a physician whose scientific method, respect for whose laws leads to certainty in the sciences of living matter, assumed equal authority in the sciences of living beings." The stage was set for the new era in biology which was to be established in the rapidly expanding sciences of physics and chemistry.

A succession of remarkable men appeared and their accomplishments were destined to transform the conditions of the natural sciences. Thus, Loeb's generation of biologists was called upon to sustain a weight of investigative genius in the new fields of biology and medicine, and to the knowledge available to reduce to elements the so-called manifestations of life, to the status of physico-chemical reactions. It is in connection with the investigation of the physiological and physico-chemical manifestations of vital phenomena that Loeb has exercised so great an influence on his generation. This is not only for plants but probably also for animals, that we find him spending the winter months from 1889 to 1891 at the Naples Zoological Station, where the ideas he had formed could be subjected to experimental test. It was this period when he was in the making of his philosophic and scientific beliefs.

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Jacques Loeb Memorial Supplement of The Collecting Net

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sciences were to exert on physiology. Hence he threw his splendid talents into the study of biological phenomena along the lines of their physical and chemical activities, with results of which you are aware and which are as now conceived. How great this weight of investigative influence was can best be seen from a tabulation, which I present. The remarkable effect which the development of that composite science we call physical chemistry—a union of mathematics, physics and chemistry—was to exercise on biology, and in the application of which to the interpretation of phenomena of living matter Loeb was an outstanding figure, is preserved in the fundamental discoveries of Gibbs, Pfeffer, van't Hoff, Ostwald, Arrhenius and J. J. Thomson, with whose period Loeb's is in immediate contact.

Paraffin 1837-1887
Leibig 1803-1873
Wohler 1800-1882
J. Muller 1826-1882
Bernard 1813-1878
Ludwig 1816-1882
du Bois-Reymond 1839-1925
Helmholtz 1821-1894
Virchow 1821-1902
Pasteur 1822-1895
Fick 1829-1900
Maxwell 1831-1879
Dreschsels 1833-1904
Gott 1835-1894
Gibbs 1839-1901
Pfeffer 1845-1920
Emil Fischer 1852-1919
van't Hoff 1852-1911
Ostwald 1853-1932
Ehrlich 1854-1915
J. J. Thomson 1856-1940
Arrhenius 1859-1927
Loeb 1859-1924
Nernst 1864-1941
Dobzhansky 1893-
Einstein 1879-

It was characteristic of Loeb's agile mind that he should so surely and quickly catch the drift of thought and feeling, or the Zeitgeist, of the period and proceed to bend the new physico-chemical knowledge to the uses of physiology. This was only repeating what he had already done with Sachs's tropisms, and is something which fertile minds are always doing or striving to do. A mathematician has told me that the growth of mathematics in the last fifty years made possible Einstein's calculations, which corrected, and extended Newton's discoveries. Taken all in all, physical chemistry constituted for Loeb the chemistry, his fertile mind met the discoveries that should be made, and Pascal invented the paradox that, "We are in search of nothing, but of the search for things." Loeb gave himself no respite; each succeeding experiment more than doubled his greater intensity toward a goal always being approached and yet always eluding. Possessed of that vigorous quality of imagination which goes with a name of intuition between inspiration, and which in essence consists of a feeling in the mind that amounts to a presentiment of truth, he was a remarkably fruitful inventor of ideas or hypotheses, the experimental verification of which often marked a new direction in extending scientific knowledge. His prescience reminds one of Faraday, because of Loeb's uncanny gift of knowing the truth before the experiment was made. "I know what it is; the question is how to prove it." The proof might be long in coming, but it would come and then the result would be startling: Loeb's habit was to ponder, sometimes for years, the mode of attack of the problem appeared, and he then moved with precision and celerity. In this way fragmentary observations, partly received, partly genius in formation, fertilization led to the discovery of its production at will, and artificial parthenogenesis was discovered.

Newton said that he made his discoveries "by always thinking unto them till the first light of day by little by little into a full clear light." The power of long thought is something that goes with the highly original gift which we associate with genius.Buffon believed that he was "the first to think the first thoughts of man." Newton attributed his discoveries to "nothing but industry and patient thought." Claude Bernard's definition is more searching: "Genius is revealed in a delicate feeling which can catch the novel and infrequent phenomena; but this we must never forget, that correctness of feeling and fertility of idea can be established and proved only by experiment;" no, it is not quite true, or rather it is much more than that; but genius without patience is like fire without fuel—it will soon burn itself out." Loeb possessed the patience and industry; also, his industry was in excess of his physical constitution, so that he burned out his life before he consumed his talents.

In 1910 Loeb exchanged a professorship at the University of California for membership in The Rockefeller Institute for Medical Research. He organized at the Rockefeller Institute the Division of General Physiology, the first department of that kind to be created in the United States. It was fitting that Loeb, whose discoveries had so enriched general biological science, should have been the pioneer of general physiology in this country. The scientific story of the new establishment was such that in 1918 a Journal of General Physiology was called for and Loeb undertook the task of founding and editing such a journal. His removal to New York called for a modification of the research program. As may be observed from his discoveries in the field of physiology, his fertile mind met the new conditions. By dividing the research between New York and Woods Hole, Loeb's working facilities were enlarged; and this happy arrangement filled his last years with scientific opportunity commensurate with his needs, sympathetic scientific association, although gradual, with those recreative enjoyments which his intense nature required.

Loeb was of the type of the intensive individual investigator; hence his immediate pupils are not innumerable. But if Loeb's direct influence was reserved for a favored few, his wider influence has been shared by a large body of students and investigators and even by the general public. His personal contact with successive groups of scientific workers at Woods Hole, the Rockefeller Institute, and elsewhere has been of inestimable value. Loeb's profound knowledge and experimental experience, wide reading, liberal views often warmly expressed, vivid imagination widely dispensed, and his fund of sparkling wit made him at all times interesting and delightful companion. No one could have been kinder than Loeb in his human relations; and fortunate were those who came under the reign of his genial, many-sided personality. It is unhappily true of him "that he may be succeeded, but can not be replaced."

Jacques Loeb's life was spent in an ardent desire to interpret nature. It was peculiarly true of him, as has been said, that knowledge is at once the sole torment and the sole happiness. He believed that these could never be free play until the superstitions of our ancestors and of the vast majority of our contemporaries had been replaced by a scientific understanding of natural phenomena, particularly, of organic phenomena. These beliefs he realized in biology; he permitted himself to exhibit his ideas on the relation of his work to human affairs.

It is impossible this afternoon to review, in anything like detail, any one of the researches in which Loeb engaged. I must therefore confine myself to his latest work on proteins.

The significance of this work lies, I think, in the fact that Loeb gave us, for the first time, a clear conception of the mechanism underlying the chemical behaviour of a class of biological colloids of the greatest importance and gave us also a demonstration of the fatuity of

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He was led back to these speculations through his subsequent work on parthenogenesis, on permeability, on toxicity, on antagonistic salt action and on negative osmosis.

Always he was faced with the questions—Why do certain electrotyes enter the cell unimpededly, and not? What is the nature of the compounds formed between electrolytes and the constituents of the cell? Why do tissues swell in acid solutions and why can this swelling be antagonized by the mere presence of a neutral salt?

These, and a hundred other questions, he hoped might be answered by a quantitative study of the distribution of the charges within the molecules and under conditions where their indiffusibility was a certain factor.

Loeb's methods of work were as original as his ideas. Very few of them among his peers, could devise such simple means of deciding whether their hypotheses were eliminated errors due to the vagaries inherent in biological material by purely chemical methods. He repeated and again and again until possibility of error or of self deception was inconsiderable. The experiments reported in his papers represent only a fraction of those which he performed.

In designing experiments he was not satisfied with the quality to choose the procedure which would bring out the essentials of the phenomenon he wished to demonstrate. He wasted little time in unprofitable experiments. He had a remarkable ability, it seemed to me, in selecting those living forms whose organization was suited to the demonstration. He was sometimes baffled in his desire to prove unequivocally the physico-chemical nature of a given reaction, for the organism available, but he could wait years, turning to other experiments in the meantime, for the right organism to present itself. When chance brought the suitable form within his reach, he would inevitably return to his deferred problem.

He disliked complicated apparatus and distrusted unfamiliar methods. If an experiment seemed to necessitate complicated apparatus, he would often defer testing his hypothesis until a simpler method suggested itself.

The majority of his experiments were performed with unbelievable simple equipment. Even his latest work on the proteins was performed with characteristically simple procedure and an entire avoidance of complicating ingenious and complicated apparatus which workers in such fields usually employ.

When writing the results of his investigations for publication, Loeb's style was often provocative, and in his first enthusiasm over a discovery he sometimes indulged in generalizations which were shown by later and more detailed study to need modification. This led to occasional apparent inconsistences in his writings, which Loeb, with his mind always on the main issues, appeared to ignore. Such inconsistencies however proved often fataly attractive to the minds and pens of some of his less imaginative contemporaries.

To his disciples, and most of those who worked with him are proud to be called his disciples, he was, and his memory still is, a wonderful source of inspiration. Life in his laboratory was often strenuous, but his pervasive personality, his humanity, and his omnipresent humour, made it the most interesting, as it is the most stimulating of our memories.

**DR. LOEB AT WOODS HOLE**

**DEAN OF THE MODERN SCHOOL AND HEAD OF THE DEPARTMENT OF PHYSIOLOGY, UNIVERSITY OF MINNESOTA**

Dr. E. P. Lyon

Dr. Lyon became a student under Dr. Loeb at Chicago in 1894. In 1895 I accompanied Prof. Loeb to Woods Hole and was with him there several summers. Later, after he left California and came regularly again to Woods Hole I saw a good deal of him. His family was not near the personnel of the Institution. Some of them were captured and trained. It was fortunate, further, as an example to young workers; for I agree with Loeb that the simplest approach is the best approach, and that much recent work has been complicated with an artificial shell of technique and the result of laborious and graphical presentation that the kernel of fact can hardly be found. Of Loeb it was said: "Give him a collar-box and a piece of string, and he will make a discovery."

Loeb did not seem to read. One never found him sitting hours in the library or taking a few days off "to read the literature." He knew everything that was done, even in remote fields. He read, but he was not a word reader nor seemingly a paragraph reader. He grasped the contents of an article almost as in a flash. I don't know how he did it; but I think he got close to a small amount of good stuff and passed off the rest with a glance—it was glance enough, however, so that he had a pretty good idea of what anyone was doing. His dyslexia had been evolved. The parthenogenetic cell from which it arose was still an ovolab in that second future known as the Twentieth Century. Physiology thrives with growth, pains and cries on the first floor of the north wing of the "old" wooden building. (Then we called it the Animal Building.) Dr. Loeb's room was in the basement. In that room and the corridor next to it he did most of the important work—excepting perhaps the ion problems carried on at Chicago—which gradually established his international reputation. That room, I think, is the real Loeb Shore and the place where a tablet ought to be.
ed in its general relation to the rest, just as the book-detector is said to be able to place the fat man third left front and the blond lady sixth right and so on throughout a whole train. All I could say at present was that the system in operation was: "Thy ways are not my ways."

Dr. Loeb was in daily touch with his students, suggesting, assisting, enthusing. Never was a more inspiring teacher. The difficulty was, from a plethora of ideas and suggestions, to keep to a reasonably fixed path; also to find time to exercise one's own small string of ideas. His abstracted way of thinking aloud will be remembered. Much, much more was often said, than this: knowing the man intimately for years in all kinds of weather, and having called down his lightning on my heart, I realize I have ever known. And I think of him as my friend and intellectual father.

No longer a minor note ought to have been struck at this time. I turn to that side of him which his intimates know so well, his subtle, irresistible, bubbling humor. It was never better than in the care-free days of early Woods Hole. It seemed to me the ideas had been tingled when it touched you, but I think it never left a scar. Whether in anecdote or practical joke (Oh, he could play one!) or in jest at a friend's expense, for Dr. Loeb was always in action. Ideas—many ideas—were his papers. That is why, also, he was high-minded and he was genial.

"No," with explosive vehemence, I would say. "Now dis is zo"—a long pause followed. "We can't afford to this country. I recall the first worker who came early to the laboratory, but no amount of feeding the national debt through the house of his dreams. Usually, as it appeared to me, the ideas had either become common property or had come anew in some other mind.

If, therefore, I say to the friendly audience who will read this article, it is not to consider some of Dr. Loeb's animosities (always in matters of science) to have been justified, it is with a clear view of the essential justness of the man. For he was high-minded, and he was genial. Personally I can say no more than this: knowing the man intimately for years in all kinds of weather, and having called down his lightning on my heart, I realize I have ever known. And I think of him as my friend and intellectual father.

The shift in comparative psychology from the anecdotal method to experimental research, which came about so rapidly in America at the beginning of the present century, owes much to the influence of Loeb's work, although Thorndike's experimental methods determined the general direction of research. Thorndike with his puzzle boxes, his iron-willed behaviorists rule out their mazes, studied gross manifestations of animal behavior, especially in higher species, while Loeb was interested in the simpler responses of lower organisms. The tradition in animal research among psychologists, their special training, and the laboratory equipment available led them for the most part to follow the lines laid down by Thorndike. Loeb's insistence upon mechanistic principles and upon the analytic study of behavior determined a great extent the interpretations of the data. It is to Loeb's canons of research rather than to the special studies of animal learning that the rise of the Behavioristic school of psychologists should, I believe, be attributed. And it is interesting to note that this school of investigators is a product of the Behavioristic school of educators. The behavioristic school ideas of an extreme which Loeb never contemplated. Loeb's aim was to find a place for 'conscious' phenomena in mechanistic science; Watson and his fellow behaviorists rule out the notion of consciousness from scientific investigation altogether.

In human psychology Loeb's influence is less marked. The traditional study of consciousness, he said, is still dominant, except among those who approach the subject from the genetic standpoint. But even in this field the mechanistic interpretation which Loeb championed has gained considerable ground. More emphasis is laid on behavior as a phenomenon determined by physiological events; and consciousness is treated by many psychologists as something less than the efficient cause of behavior. Rather than as an efficient cause, Loeb's work, too, has undoubtedly led to a greater stressing of the reflexes and other elementary processes in psychology.

It appears, then, that Jacques Loeb's influence on psychology has been to a large extent indirect and subtle. His ideals have been adopted..."
rather than his methods of research. Many of us can bear testimony to Loeb's influence in determining their views as to the nature of "mind" and "mental phenomena." His aim was to bring psychology into closer contact with other biological sciences by reducing the special forms of activity manifested in behavior and consciousness to physicochemical terms. And this is now the general tendency of most of the psychologists even apart from the radical behaviorists. If psychology today can claim a place among the biological sciences, it is in great measure due to the contributions of Jacques Loeb and his associates, whose investigations on tropisms and other fundamental phenomena of behavior in the lower species have covered the borderline territory between general psychology and physiology.

**JACQUES LOEB AN APPRECIATION**

Dr. W. J. V. Osterhout
Member of the Rockefeller Institute for Medical Research

(From "The Journal of General Physiology" for the month of September 1928)

If I venture to write of Jacques Loeb, it is not to create a portrait but only to set forth facts to aid those who would follow in his footsteps. In this I bespeak the charity and kindness for young scientists. Loeb's name is among those *illuminati* who foresaw Portugal on account of the intolerance of the Inquisition: they settled at Mayen in the Rhine province several years before he was born. His father, Benedict Loeb, was an importer, a man of simple tastes, more interested in science (especially in physics, mathematics, and geology), in literature, and in collecting books than in business. He was extremely reserved, and much of an aesthete. He married Barbara Isay and their first child, Jacques, was born April 7, 1859, and was followed by a second, Leo, a year later.

The father's sympathies were strongly French and thus it came about that the eager mind of Jacques absorbed French as well as German culture, all the more because he lived in a region where French influence made itself strongly felt. His father, hating Prussianism, looked longingly toward the democratic institutions of France and of the United States. In 1873 the mother died and three years later the father followed her. Jacques, an orphan of 16, accepted a position in the bank of an uncle in Berlin. Shortly after, on the advice of an uncle, Professor Harry Sachs became his friend and was followed by a second, Dr. Leo Sachs, who had just received her doctorate in philosophy at the University of Berlin.

**Breslau**

He entered the Anskalihe Gymnasium in Berlin. It was a purely classical school, with very little science, from which he graduated at the head of his class, with special mention for fluency in Latin and German. His departure, however, gave him the opportunity of studying the "Philosophie der Griechen" with an inscription cautioning him not to become too liberal!

His teachers took it for granted that he would become a lawyer and with this in mind he entered the University of Berlin in 1880 and attended the lectures of the philosophers Paulsen. But he soon conceived that metaphysical philosophy could not give satisfactory answers to the two questions uppermost in his mind: Is there such a thing as free will? and, What are the instincts?

He seems to have conceived a distaste for metaphysics at this time and in his subsequent career the only philosopher who interested him appears to have been Mach.

The second semester of this academic year was spent at the University of Munich: he hoped to gain some light on the question of the will, he went to Strassburg, entering the laboratory of Goltz who was studying localization in the brain and endeavoring to give satisfaction to the theories of Munk and Hitzig. Here he remained five years and on the advice of Goltz took a medical degree in 1884 and the Staatsexamen in 1885. He then spent a year in Zuntz in Berlin where he continued his work on brain physiology.

The results of his work were presented in a thesis entitled "Die Sekstörungen nach Entfernung der Grobhirnwindungen" and promptly denounced the paper and its author in uncertain terms. There was nothing personal in this since it was merely a natural consequence of the rivalry between opposing schools at a time when bitter polemics were only too common in Germany. Nevertheless, it was a severe disappointment after five years of hard labor and it was a comfort to receive a letter from William James congratulating him upon his maiden publication: for this friendly act Loeb did not cease to be grateful and throughout his life he always seemed to be on the lookout to perform acts of kindness for young scientists.

He was now fairly launched on the scientific career which he pursued with extraordinary success and which revealed mental powers of which Munk and Hitzig could have but dimly imagined. He must continually find new ideas and new enthusiasms as an outlet for its energies. He had a passionate love of truth and what appeared to him to be true had to be so expressed that all could feel the inspiration and see the beauty of what he saw. He sought in vain for the solution of his problems in the current philosophies of the day: then came his conversion to mechanism. Faith in mechanism became the religion to which he devoted his life, and it was a religion which his love of truth forced him to test by the most rigorous scientific standards.

The ardor with which he labored was understood unless we realize that for a scientist nothing counts but the testimony of his conscience of its being free it cannot be controlled; this question must be tested experimentally. At that time it was customary to attribute volition to lower animals and it was natural to attack the problem of the relations that behavior might be controlled by operations on the brain led to his experiments with Goltz. But these did not seem promising, and for a time he was uncertain.

It was the privilege of Sachs to lead him in the right direction, for Loeb saw that if he could control animals as Sachs controlled plants the problem of the will could be attacked. He lost no time in setting to work: the results exceeded his fondest hopes and henceforth the way was plain. He went forward so rapidly that in two years he had published his first paper on animal tropisms that was to bring him fame.

In the fall of 1888 he returned to Strassburg as assistant to Goltz and while here he did some work in collaboration with v. Koranyi of the University of Munich. In the summer of 1889 he spent a term in Naples carrying on experiments on heteromorphosis and the depth migrations of animals (in the latter work collaborating with Professor of Physiology in Zurich and a former student of Goltz). He returned to Naples for the winter, where he devoted himself to experiments on heteromorphosis since he was convinced that not only the will of the animal but also the form and function of its organs and its course of development might be controlled by the experimenter, in contradistinction to concepts then prevailing.

At this time he was undecided whether he should continue to live frugally on his patrimony and devote himself wholly to research or accept an academic chair, which he dreaded because of its interference with his investigations. But he deemed that his new responsibilities made it imperative to find a position. And the more irritation at the military and political conditions in Germany, and having, like his father, a hatred of militarism, his thoughts turned toward

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JAQUES LOEB
(An Appreciation)

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America. But there was no position in sight. At last he had an inspiration: he would earn his living as an oculist, devoting part of his time to practice and the rest to research. He began to frequent the clinic of his friend Dr. Fick, in Zurich, but after six weeks gave up in despair, saying "I cannot live unless I continue my scientific work. These problems haunt me night and day - they are in me and I must do something." While in this state of mind he received an offer of a position at Bryn Mawr College from Miss Thomas (then dean of Bryn Mawr) which was accepted with enthusiasm.

He arrived in Bryn Mawr in August, 1891, to assume his new duties, having been delayed owing to the illness of his wife. He enjoyed Bryn Mawr. He had a few graduate students, among whom was Miss Ida H. Hyde. But the facilities for his work were insufficient and in January, 1892, Dr. White felt constrained to join his staff at the new University of Chicago, he accepted. At the same time he agreed to give the course in physiology at Woods Hole during the following summer.

At Woods Hole he found things in a state of chaos. The World's Fair was in preparation and only one university was then to harbor the scientific department to a floor. When the outcome was delivered by Wilhelm Ostwald, he decided to become a naturalized citizen and definitely took root in America. His work was at first largely concerned with tropisms and heteromorphosis and was involved in recent discoveries in chemistry and physics. He became deeply interested in the theory of Arrhenius and thus came to write the famous series of papers on the physiological effects of ions. A direct outgrowth of this was his discovery of artificial parthenogenesis and antagonistic salt action in 1899.

The summer of 1898-99 was spent in California at Pacific Grove, where he had, for a change, an interval last but one to be able to carry out this plan he devoted his time to writing. The outcome was the "Comparative Physiology of the Brain and Comparative Psychology" written in German and translated by Mrs. Loeb. This was not an isolated instance of her aid for she constantly cooperated with him in literary work.

Loeb was greatly attracted by the genial climate and the possibility of working all the year round, and when a call to the University of California came in 1902 he accepted. A laboratory was built for him at Pacific Grove not very far from the famous laboratory to be erected by Stanford University. The University of California Publications in Physiology began in 1903; in October of the same year the physiology laboratory at Berkeley under Loeb's dedicated, the principal address being delivered by Wilhelm Ostwald. In the following year Arrhenius and de Vries spent some time at the University of California to the great delight of Loeb who had become deeply interested in their work; this acquaintance ripened into a firm friendship. This is equally true of the later visits of Boltmann and his school.


In 1902, he made a call to California where Loeb had not realized how much he would be cut off from contact with his fellow scientists. He was naturally so ardent as to be in every place and in every way. When applying this he was able to give quantitative explanations of some of the most important properties of colloids and to reduce them to simple mathematical laws.

In the midst of this important work he was persuaded to go to Bermuda for a brief holiday. A few days later he was stricken with angina pectoris, and after a short illness his death occurred, on February 11, 1911. It rewarded the seeker his desire to work up to the last moment and to die in one of the places whose natural beauty appealed to his imagination. It seemed therefore in accordance with his wish that the end should come during a visit to Bermuda in the midst of the most active investigations of his life.

His ashes were brought to Woods Hole for internment. A memorial tablet was placed in the Marine Biological Laboratory in the Rockefeller Institute for Medical Research. It is bordered by the leaves of Bryophyllum, which had served for his experiments on regeneration. The wild heather in Bermuda had been delighted to see it everywhere blooming profusely.

Enshrined within this border are the chief subjects to which he devoted himself during a life time of unremitting labor. All of them represent fundamental problems of biological research. Though at first sight they may seem to present no obvious continuity it would be a great mistake to suppose that it is not a great mystery to which all his great investigators, each new question arose naturally out of the preceding. There was no running after strange gods or foreign problems. The task in hand demanded all his power of attention and it rewarded the seeker and the world in general.

In 1918 he founded the Journal of General Physiology (in collaboration with the writer) and a series of Monographs on Experimental Biology (in collaboration with T. H. Morgan and the writer), both of which are a great help in the education of medical students.

Among those who worked in his laboratory (either at the Institute or at Woods Hole) were F. W. Bancroft, M. G. Baum, R. H. Beut- ner, A. L. Hagens, C. R. Bardeen, Elizabeth E. Doorn, W. O. Redman King, E. v. Körösy, M. Kunitz, R. F. Loeb, Mrs. A. R. Moore, J. H. Northrop, H. Wasteneys, and N. Wuest. It should be added that a great deal of his work was done in connection with the Institute his labors were lightened by the efficiency and devotion of his secretary, Miss Nina Kobel. His previous studies were continued for a time and there were no new developments, such as the recent studies on the biochemical phenomena and on quantitative aspects of regeneration. He also took up anew the problems of proteins. It was a subject that had long attracted him; he had made a beginning years before but there seemed then to be no guiding principles suffi- ciently well established to make it possible to proceed with assurance. Nevertheless the problem was not constant in his mind and at length he discovered a way to attack it. In his earlier researches the dissociation theory of Arrhenius had furnished a clue and in the later work he found the stimulus to bring it to a successful issue. By applying this he was able to give quantitative explanations of some of the most important properties of colloids and to reduce them to simple mathematical laws.

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of stress and encourage him during the hours of depression, he lived largely apart in a world of ideals. They wrought in him so powerfully that he spoke to his followers with prophetic fire. They inspired him, dominated his life. He embodied Pasteur's profession of faith before the Academy, in the words now graven on his tomb: "Heureux celui qui porte en soi un amour, un idéal de beauté, et qui l'obeît."

The austerities which go naturally with high ideals, the temper of the artist in the finest sense of the word, was his, but he had also a tender heart which felt the sorrows of all who suffered, and his sympathy was always with the masses who struggle against oppression whether economic or spiritual. We must also realize that he had the temperament of an artist, running in the creative imagination, its brooding depression, its rare exaltation. He knew the heights and the depths but not the happy mean of mediocrity. That mediocrity of soul which accompanies this temperament at its best was also his: a fine scorn of injustice, grossness, and all unbeautiful things.

The outstanding feature of his intellectual equipment was his creative imagination. In this connection, the intimate and emotional urge of ideas which we call divination, the qualities that raise the seen above the common run. With such a temperament intense mental effort may result in exhilaration rather than exhaustion. If we should realize that it is quite different from the capacity for doing disagreeable work. To him research was a joyous adventure, however involved and that might be called drudgery.

It is no exaggeration to say that he lived in his work as do few men. It seemed as though his mind were continually occupied with his problems not only when awake but even during sleep when subconscious processes seemed to carry on with troublesome questions which might yield him a solution in the morning. When he reached a point where he was making no progress he turned to something else until these processes were readjusted and he could make a fresh start. He often found it advantageous to keep two or more pieces of work going on at the same time and that he could profit by thinking of one while he was working on the other, as when he undertook recreation in working with Byrophyllum during his researches on proteins. His career illustrates the fact that continual concentration of mind (purely spontaneous, and very difficult) is essential to the production of the kind of work of which he was the type. The impossibility of this was great so that the rate of heart-beat of these embryos could in fact be used as a rough thermometer.

"Why does each embryo have the same rate of heart-beat at the same temperature in contradiction to the difference in the embryonic rate of heart-beat in man?" The answer is, on account of the elimination of all secondary disturbing factors. In the embryo of Fundulus the heart-beat is a function almost if not exclusively of two variables, the mass of enzymes for the chemical reactions underlying the heart-beat and the temperature. By inheritance the mass of enzymes is approximately the same on one may easily say that all the embryos beat at the same rate (within the limits of the fluctuating variation) at the same temperature. This identity exists, however, only as long as the embryo is relatively quiet else the effect is the opposite since the heart begins to move at equality disappears since the motion influences the heart-beat and the motility of different embryos differs.

"In man the number of disturbing factors is so great that no simple formula for the elimination of temperature can be expected. Differences in emotions or the internal secretions following the emotions, differences in previous diseases and their after-effects, differences in metabolism, differences in the use of narcotics or drugs, differences in activity are all some of the number of variables which enter."

The urge of his mind was to see each subject simply and as a whole. To him it was necessary to purify the individual from every special part of a problem without considering its relation to all the rest. Processes in particular animals must be compared with those of other animals, of plants, and of inorganic nature. Nor was he satisfied to find that they had something in common but he must work until its real nature was evident, until his idea of it was so clear and simple to correspond to reality. To achieve this it was necessary both to simplify and to generalize in order to reach this degree of precision and power. To achieve this it was necessary both to simplify and to generalize in order to reach this degree of precision and power.

It was sometimes said that he pictured his problems too simply and was satisfied with explanations too simple to correspond to reality. But this was an important factor in his success for it encouraged him to attack complicated problems and provided him with an answer before he had reached the point at which he stopped was not as near as the ultimate solution as he himself thought this can
in no way detract from the value of what he actually contributed.

All his experimentation bore the hallmark of austere simplicity. It was a part of his temperament to distrust complicated apparatus. Few could devise such simple and decisive means of testing their hypotheses. He eliminated errors due to the variation in organisms by performing great numbers of experiments with immeasurable controls, repeating against and again until the possibility of error seemed to be eliminated. He showed remarkable sagacity in choosing the material where life processes could be studied in a clear and simple way by using the methods of physics and chemistry and he had great skill in finding the procedure which would bring out the essentials of the phenomenon in question. He wasted no time in unprofitable experiments. If he could not find an organism which would give an unmistakable answer to the question he put the problem aside until a suitable organism should be found. Though he might wait for years he was prompt to act when the right material presented itself.

Courage played a great part in his success. He did not select problems because they were easy, but because of their importance. That at the very outset he attempted to investigate the freedom of the will on an experimental basis illustrates this. With him one felt the power of a mind which gloried in difficult problems, with a confidence in its power to conquer that came from a long series of triumphs. It was a mind always alert, poised to turn easily in any direction, and operating with bewildering speed and certainty.

His courage sprang largely from his faith in the cause to which he consecrated his life: a conviction that mechanism could explain the most baffling mysteries. It almost approached a dogma and his zeal knew no limits. It was a militant faith calculated to move mountains and it grew fiercer with each new discovery. If a philosophy be judged by its fruits his convictions justified themselves for they inspired him to attack apparently impossible problems with an audacity that was often justified by important discoveries. One can almost suppose that he would have discovered more if he had been a vitalist?

This magnificent faith and enthusiasm seemed at times to transfigure him so that it was not strange that young men followed him gladly. He always encouraged their efforts and was eager to help them. He had a truly lovable and sympathetic personality that drew men to him, never desiring to quote the words of John Morley: “He was one of those simple, disinterested, and intellectually sterling workers to whom their own personality is as nothing in the presence of the vast subjects that engage the thoughts of their lives.”

Often dogmatic in expressing his views, he was always open to conviction and would at once admit the correctness of an opposing view if the evidence offered were sufficient. His criticism of opponents involved no personal malice and if they were in trouble none could be readier with assistance and sympathy. Indeed he was continually going out of his way to help people who were almost unknown to him. This quality greatly endeared him to his students who felt for him gratitude and trust as well as admiration.

It is difficult to understand how he absorbed in such great tasks could find time for so many other small ones. He dearly loved a joke even at his own expense. When in the midst of a tempest he would pour forth his soul in a spirit zealous, quick, and intense, his sense of humor was not to be denied. He would talk and laugh and at such times he was unsurpassable both for wit and humor. At such times he was unsurpassable both for wit and humor. At such times he was unsurpassable both for wit and humor.

From his multiplicity of learning was correlated by a synthetic imagination, an instinctive ability to unite harmoniously the diverse elements of different disciplines. He seemed to work in many fields and could pass without effort or hesitation from one to another. He mingled the best elements of French and German culture: he successfully combined the methods of the philosophers with the methods of the exact sciences to deal with vague and mystical biological concepts.

In all this he was aided by circumstances. His youth was a time of “Science and Drama” in the physiological sciences, when new wine was being put into old bottles, and the great impetus given to physiology by Claude Bernard and Johannes Muller was felt by a host of keen young workers of unusual ability and enthusiasm. At that time, too, the youthful science of physical chemistry was making extraordinary strides. Loeb appeared at the right moment to take advantage of these remarkable circumstances and to utilize them with astonishing skill.

Such are some obvious aspects of this many-sided man, superficial features easy to recognize; but it is hard to know his mind and heart is another matter.

Here we may perhaps pause to ask ourselves, How are we to remember him? He was an idealist, sympathizing keenly with all suffering, consecrating his gifts to humanity, finding in every discovery a weapon against superstition: a scientist with an artist’s soul, emotional, intuitive, creative: a thinker, strangely original, born to blaze fresh trails and teach new doctrines with a prophet’s zeal; and a dreamer, regarding the world from the poetic insight of a seer, and seeking, with creative imagination, rarely equalled, to sweep aside its mystery and set free the mind of man.

And he being dead yet speaketh.” His visions that have made others see visions, his ideals that quicken the heart of youth, cannot but continue to shed inspiration, in circles that widen more and more; and in shaping the soul of the future he may serve humanity more than he dared to dream.

A bibliography of Jacques Loeb appears in The Journal of General Physiology No. 1, vol. VIII. Those who desire reprints may obtain them from Dr. O. Whipple. The number of the reprint should be designated by its bibliography number. If no reply is received when a request is made it is an indication that the supply is exhausted.
Due to the generosity of the General Education Board the Jacques Loeb Laboratory, an integral part of the Hopkins Marine Station of Stanford University has recently been completed. It is situated at Pacific Grove on the shore of Monterey Bay, 130 miles south of San Francisco, and occupies a site near that of the laboratory formerly used by Dr. Loeb which was erected by the University of California. This concrete building, 150x90 feet, is situated near the spot where Loeb discovered the artificial parthenogenesis of *Strongylocentrotus purpuratus*.

The laboratory is equipped with modern conveniences for chemical, bacteriological and physiological work. Resident research workers, under the leadership of Dr. L. B. Becking, Herzstein Professor of Biology, Stanford University, will insure continuity in the investigations. A physiologist, a biophysicist, an organic chemist and a bacteriologist have been appointed and expect to spend the full academic year at the Laboratory. Besides the permanent staff (reinforced by three assistants and a mechanician) facilities are provided for a number of visiting investigators and for a restricted group of graduate students. The ocean near Pacific Grove has much to offer to attract the biologist. There is an abundance, a variety and a continuity of organisms not easily met with anywhere else. Sea urchin eggs are available the year round and the giant kelps abound in a great many forms.

The Jacques Loeb Laboratory welcomes visiting investigators in biophysics, biochemistry, bacteriology and general physiology. Applications should be made to the Director.

Pacific Grove is connected by through Pullman trains with both Los Angeles and San Francisco. The total distance from Chicago is 67 hours.
REVIEW

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obtained are of great importance quite apart from the direct information they give in regard to the physical behavior of the amoeba protoplasm. In the modern study of laboratory material at the beginning of this undertaking.

Briefly, the method adopted consists of exposing the animals to ultra violet radiation for a short period,—long enough to free them from their bacterial associates, but not long enough to injure the Planarians themselves; then placing them in a salt solution whose calcium-potassium balance and concentration have been worked out for this form in particular, and differ considerably from those in use for vertebrates. To this is added a 5% volume of a peptic digest of worms, which affords nutrient material, presumably in the form of proteoses, about \( \frac{1}{3} \) to \( \frac{1}{2} \) mm. in diameter, are then taken from a given region of the worm and placed in a hanging drop of the salt and nutrient solution over a deep depression slide. These slides are then sealed and reversed, and kept in the dark, at a temperature of \( 10^\circ \sim 15^\circ \) C. Under these conditions the cultures remain alive for as long as six weeks.

The explant, if taken from any region of the worm except the ganglion or the pharynx, contains various more or less differentiated cells such as muscle, ectodermal epithelium, digestive epithelium, flame cells; but in addition to these it contains a relatively large amount of parenchyma, or packing tissue, composed of comparatively small and homogeneous cells. These are present in approximately equal quantities in all parts of the worm, with the exception of the cephalic region, where much space is occupied by ganglionic material; and they are by far the most numerous type of cell. These parenchyma cells are not highly differentiated; they are mesenchymatous in form, and very loosely held together. They are hard to fix, and histological studies on trichads show little definite structure for them,—merely numerous irregularly scattered nuclei, with ill-defined cytoplasmic boundaries. In a freshly dissected worm they appear round or ovoid, often possessing of broad flat pseudopodia.

During the first 12–18 hours in culture, parenchyma cells have this same appearance. While they are in this condition amitotic division figures are frequent. After 24–36 hours in culture, however, many of the parenchyma cells have lost their pseudopodial form, and put out processes, mostly fairly short at first, but long in some cases even at this time. Monopolar and bipolar arrangements of these processes are the most common, but multipolar and bipolar forms are frequent. By the time the processes have grown a little longer and more branching (48–72 hrs.) the resemblance to an

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invertebrate nerve cell is striking. These are non-medullated, of course, and they never become as protuse in their branching as vertebrate nerve cells. The branches often appear to be anastomosed. Groups of tiled parenchyma cells are often found with their axes in approximately the same direction, indicating a common influence of some environmental factor or factors.

This behavior of parenchyma cells when freed from the influences which are effective in the organism as a whole is, a behavior which one might expect from nerve cells that are taken from packing tissue. What happens when explants are made from the ganglion region or the pharynx, and therefore contain considerable numbers of definitive nerve cells to begin with? Much the same thing. But the processes are longer, and reach their maximum length in a shorter time,—24 hours or so. After that time they begin to use up the substance of the cell; one sometimes sees a long strand with no cell attached, or with only a small swelling somewhere along its length. The outgrowths have pseudopodial ends, and often anastomose with one another along the length or out of the nucleus, nucleolus and a few granules, and which it has been shown previously are the most adaptable in acclimation of any cells in the Planarian body. Therefore it appears significant that these parenchyma cells, when freed from the integrative influences which affect them in their normal position in the intact worm, and allowed to spread freely in a tissue culture, should after a certain time differ in the direction of which is normally the dominant tissue—nervous tissue.

Dr. Murray's work on the cultivation of planarian tissues is an important addition to the meager tissue culture studies on invertebrates. Vertebrate tissues have been cultivated extensively. In contrast, the total amount of work done on invertebrate may be briefly reviewed.

In 1915 Davidov attempted to investigate the behavior of nematine cells in culture, but found that the explants survived only as regenerating balls. Much later (1925) Zweibach could not feed the ciliated cells of Anodonta with substances in solution, and obtained results similar to those of Davidow. Dobrowolsky (1916) made successful cultures of marine invertebrates, such as Torpedo, using plankton for a medium, and the hanging drop method, and success being due to the addition of muscle sugar. Sterilization difficulties forced her to give up her work on Octopus and Gehia. Goldschmidt (1915, 1916) studied the sperma
togenesis of the moth Lafia, using hemolymph as a medium. M. R. Lewis (1916) successfully cultured tissues of the hermit crab, sea anemone and Limulus, using sea water as a medium of simple cultures. The observations were made upon the plasma or fluid of the animal. Later, spermatogenesis in the grasshopper was carefully studied by Kronzowsky and Rumanewicz (1922) implanted the fragments of regenerating ends of earthworms in a medium of agar and tissue extract. Cell division and outgrowth were obtained for periods of about seven days and the cells, though embryonic in character, remained true to their types, e. g., epihelial, or muscular cells. Leo Loeb and his collaborators have made intensive studies on the ameobocytes of Limulus, using the hanging drop method with a great variety of solutions as media. A tissue-like mass of agglutinated blood cells is used for the explant.

Dr. Murray (1926) has studied the cricket egg follicle.

The technique for growing vertebrate tissues has been so completely worked out that the beginner will experience little difficulty. This is not so for invertebrate work. Much of the above work was unsuccessful because of difficulties which were not overcome. Detailed and extensive studies were usually not made in connection with that which was successful. Dr. Murray's recent paper on the salt concentrations of the media indicates the importance of further investigations in this field.

Work with lower phylogenetic animals in general may be comparable to the work with embryonic vertebrate tissues. Both grow well in simple salt solutions, but the growth is improved by the addition of other substances, such as small amounts of peptone, dextrose, etc. Adult vertebrate tissues seem to require embryonic extract for growth (Carrell), although this view has been modified somewhat recently. This has been best in a salt solution equivalent to Ringer's solution for cold-blooded vertebrates in which the ratio of the calcium to the potassium ions was relatively higher than in Ringer's solutions. It has also been observed that migration and amitotic division are stimulated with these two substances. Sheep serum, an entirely different medium, is used in the same manner, and other foreign media were used without injurious effects. Successful cultures in one invertebrate should open up the field for similar work in many others, enabling explanation of end results not analyzable by other methods.
RESPIRATION OF FISHES

By Dr. F. G. Hall
Professor of Zoology, Duke University

(Essaying Lecture delivered at the Bureau of Fisheries)

The respiration of fishes, as in the case of other animals, means the exchange of gaseous substance taking place between the organism and the surrounding medium. Such a process is essential to the life of all the animals. The study of respiration is a broad field for work, and is one in which are found some of the most brilliant investigations in physiology. Our knowledge is still far from complete in some respects, and new facts are needed to make the subject more intelligible.

Three lines of attack on the problem of fish respiration have been made at the fisheries: The determination of the oxygen consumption under different circumstances, analysis of the blood of fishes under asphyxia, and a study of the rôle of the swimbladder in respiration.

If the fish are allowed to remove oxygen from a closely confined environment, their blood becomes concentrated owing to the loss of water. There is an increase in the concentration of hemoglobin, iron, red blood corpuscles, phosphorus, and non-protein nitrogen. Sodium chloride does not increase in concentration but remains at a constant level. During this asphyxia the spleen decreases in size, and it is believed that it acts as a storeroom for iron. The oxygen capacity of the blood increases during asphyxia but not in proportion to the amount of hemoglobin. Inasmuch as the oxygen capacity of asphyxiated blood may be restored to a value consistent with the hemoglobin concentration by the addition of a bicarbonate, it is believed that a non-volatile acid is responsible for the lack of uniform relation between the amount of hemoglobin and the oxygen capacity of the blood.

The oxygen consumption of fishes varies with the species. It appears that the more active fish, such as the mackerel, consume more oxygen than the more sluggish flounders and toad-fish. In an individual fish, temperature seems to be the factor which has the greatest influence on the rate of metabolism. The variation in the rate of oxygen consumption is proportional to the temperature change. The rate of metabolism, in accordance with the van't Hoff principle, increases one tenth for each degree Cent. increase in temperature. A second factor which influences the quantity of oxygen consumed in some fishes is the oxygen tension of the surrounding medium. If the oxygen tension is lowered, a decrease in the removal of oxygen from the water occurs. This has been shown by determination of the rate of metabolism of the puffer-fish.

An interesting observation obtained from the study of fish respiration has been variations found in the amount of hemoglobin in different species. There seems to be a general correlation between the activity of the fish and the ability of its blood to carry oxygen. A few cases may be cited to illustrate this point. The mackerel and bonito, which are two of the most active species along this coast, have very high concentrations of hemoglobin, while the puffers and toad-fish have a very low one. Intermediate are such fish as the sea robin, hake, scup, butter-fish. The menhaden is higher, but not in proportion to the amount of hemoglobin contained. Sodium chloride does not increase in concentration by the addition of a bicarbonate. The mechanism by which this is accomplished is not yet thoroughly understood. It is believed that the swimbladder of fishes offers opportunities for the study of physiological processes which have a bearing on the controversial question of whether gases are secreted or diffused.

The swimbladders of fishes offer no direct connection with the outside atmosphere, apparently obtain their gases through a gland known as the "rete mirabile." The mechanism by which this is accomplished is not yet thoroughly understood. It is believed that the swimbladder of fishes offers opportunities for the study of physiological processes which have a bearing on the controversial question of whether gases are secreted or diffused.

The normal gaseous content of the swimbladder is ordinarily found to be close to that of the atmosphere. In the case of oxygen-want, oxygen leaves the swimbladder and apparently returns to the blood, thus indicating that the organ acts as a reservoir on which the blood may draw in time of need. The primary function of the swimbladder appears to be hydrostatic in fish with closed swimbladders, but it may be wholly respiratory in fish with open swimbladders.

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THE MILLPORT MARINE BIOLOGICAL STATION

RICHARD ELMHIRST
Superintendent of the Station

The Firth of Clyde is a beautiful fjord in the northern part of the isle of Arran, and has proved attractive to many generations of holiday makers. Such temporary influxes of people have always contained a fair proportion who were devoted to the study of some branch of the natural sciences, and their efforts were always welcomed.

In the 1890s, Dr. Hall was in Scotland, studying the blood chemistry of the fish. He was particularly interested in the oxygen content of the blood under different conditions. He found that the oxygen content of the blood of asphyxiated fishes was lower than that of normal fishes. This led him to conclude that the oxygen content of the blood was higher in normal fishes than in asphyxiated ones.

Dr. Hall also studied the iron content of the blood. He found that the iron content of the blood of asphyxiated fishes was higher than that of normal fishes. This led him to conclude that the iron content of the blood was higher in normal fishes than in asphyxiated ones.

Dr. Hall was particularly interested in the role of red blood cells in the transport of oxygen. He found that the number of red blood cells increased in asphyxiated fishes, but not in normal fishes. This led him to conclude that the number of red blood cells was higher in asphyxiated fishes than in normal fishes.

Dr. Hall was also interested in the role of red blood cells in the transport of carbon dioxide. He found that the number of red blood cells increased in asphyxiated fishes, but not in normal fishes. This led him to conclude that the number of red blood cells was higher in asphyxiated fishes than in normal fishes.

Dr. Hall was also interested in the role of red blood cells in the transport of other substances. He found that the number of red blood cells increased in asphyxiated fishes, but not in normal fishes. This led him to conclude that the number of red blood cells was higher in asphyxiated fishes than in normal fishes.

Dr. Hall's work on the blood chemistry of the fish was very important, as it helped to establish the importance of the red blood cells in the transport of oxygen and other substances. His work was also important because it helped to establish the importance of the red blood cells in the transport of carbon dioxide.

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THE MILLPORT MARINE BIOLOGICAL STATION

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the public a large part of the late Dr. Robertson's collection, and a considerable number of microscopic preparations of marine organisms. The aquarium consists of a public part and a smaller section containing tanks for the use of workers. For sea work there is a 20-foot motor boat for use near the Station and a 40-foot vessel the M. B. Nautilus fitted with a 30 H. P. engine for use farther afield. One of the strongest points of the Station is the great purity of its water supply. Clean sea water is pumped daily into a storage tank, whence it gravitates via the aquaria back to the sea, which means that the animals are kept living in a flow of clean sea water. The sea water in the region of the Station has an average salinity of +3 parts per 1000. Then, too, the geographical position is ideal; not too close to any large town, but within a day's reach of any of the fjord-like lochs which penetrate right into the Highlands, or the open waters in the southern part of the sea.

The great desideratum is more work space. At Easter time particularly, the laboratory becomes overcrowded with students and workers so that one dreams of the day when more class space and work rooms will be available.

THE BIOLOGICAL LABORATORY OF DROBAK

By Dr. Hjalmar Broch
Director of the Universitets Biologiske Station, assistant professor at the University of Oslo

The biological laboratory of Drobak which opened in 1849 had fishery investigations originally as its main object, and was only partly connected with the University of Oslo. However, the fishery investigations of Norway very soon parted with fixed marine stations as general working bases, and about 1900 the biological station of Drobak was transformed into a purely University laboratory. Two years later an administrative director was appointed as leader, working directly under the central administration of the University. From 1902 to 1916 Professor Dr. K. E. Schreiner was director; he was followed by Professor Dr. Otto Louis Mohr, and in 1920 the present director succeeded to the leadership. During all these years the entire "staff" of the laboratory has been a combination of the existing director and his faithful Olsen, who has acted as keeper since 1902.

The equipment of the station is rather primitive; there are arrangements for a few small laboratory aquaria with circulating salt water, and the station possesses a 35-foot launch, and two small row boats. The collecting gear is primitive, but is sometimes altered according to the demands of the moment.

In its recent state the biological station of Drobak is a summer laboratory of the University of Oslo, and is open only during July and August. Owing to different circumstances it holds a rather unique position, to a large extent acting as an elementary laboratory in histology where students of medicine may get practical training in making histological preparations. Together with this it serves as an elementary teaching laboratory for students of zoology and botany, who have opportunity to make their first acquaintance with the living animals and algae generally met with in the more or less deficient fiords of southern parts of Norway. Last but not least, biologists also have performed special studies during their sojourn here, or collected material for such studies. For instance we may here recall the fundamental cytological studies of C. and K. E. Schreiner, many of which are based upon marine animals such as Myxine and Tonna, and the work of O. L. Mohr on the subject Locusta. During later years more themes for the University degree have been worked out on the basis of fiord fauna, and in the last few years Bjorn Fyn has mainly based his fine experimental study concerning sexuality in Clava on observations and material collected at the station. Many foreign scientists have visited the station and contributed to science by studies of material collected in the Oslo-fjord at Drobak.

All this work performed to the service of Minerva has in the most pleasant way been linked to bathing and excursions, the environs of the stations being rather lovely, with sheltered bays and scattered islands covered by a rich vegetation. Picnics are thus easily arranged. Through all years the directors have thought it their duty to have the useful work combined with agreeable intermezzos as far as it is possible with our disagreeably small means.

THE MARINE BIOLOGICAL LABORATORY OF LE CROISIC

By Dr. Alphonse Labbe'
Founder and Director of the Laboratory

The Marine Biological Laboratory of Le Croisic was founded in 1914 with funds furnished by the city of Nantes, and by the late Prince Albert of Monaco. Because of the war, it was opened only in 1914 and has at first only a private establishment. In 1922 it was administratively and officially connected with the Laboratory of Natural Science in the Medical School of Nantes.

The small fishing port of Le Croisic is the end station of a railroad line direct from Paris to St. Nazaire-La Baule. The laboratory, a private villa, the property of the

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city of Nantes, is situated on the port of le Croisic at the entrance of le "Traict du Croisic"—a large marine lake which is filled and emptied with the rise and fall of the tide. The laboratory has five work rooms and a library of about 1000 books; it is equipped with water, gas, and electricity.

There are facilities for histological research work on plankton and night fishing with lights. The coastal fauna and algae are very rich for the general shore conditions including sand, rocks, tide pools, mussels and oyster beds.

In August and September, we have eight or ten workers; the laboratory, which is to be enlarged, could not accommodate more people. Those who worked in 1926-27 were M. Fauré-Fremiet of the Collège de France, Infusoria of the brine pools, Infusoria of plankton; research on the egg of Sabellaria; physico-chemical cytology of amoebocytes (in collaboration with Professor Nichita of Bucharest).

Fontaine of the Oceanographic Institute; role of pressure on animals; physico-chemical research on the coastal waters.

Henneguy, member of the institute; professor at the Collège de France who died this year and whose loss we deplore; cytological and histological research of the Eolidae.

Hourq, professor at Nantes; Copepods of the tide pools.

Michel (of Paris); regeneration in the Annelids.

Pirlot (of Liege): reaction of the egg to different agents.

Portier, professor at la Sorbonne; physiology of the larvae of Insects of the coast.

The Director, Dr. Labbe, has been studying for ten years the physico-chemical variations of the brine pools in relation to their fauna and flora; this work has proved very suggestive from a general biological point of view.

The station has no special publication since the laboratory has been opened the work done here has been published in various French journals.

The fourth lecture in the series on oceanic biology at the U. S. Fisheries Biological Laboratory was given on Thursday night, August 16, by Dr. H. B. Bigelow of the Museum of Comparative Zoology, Harvard University on the subject of "Specific Problems in Oceanic Biology." Since Dr. Bigelow's lecture was given extemporaneously and with his characteristic, inimitable informality no digest of his remarks was secured. We are, however, able to present a summary of his views by Dr. H. U. Sverdrup, Geophysical Institute, Bergen, Norway, who is visiting Woods Hole in the interest of developing oceanographic research.

Summary

BY DR. H. U. SVERDRUP
Professor of Dynamic Meteorology, Geophysical Institute, Bergen, Norway

This is not a critical review of Dr. Bigelow's talk because I have no criticism to offer. I am not a specialist on the problems which he dealt with but I am sufficiently familiar with several of the European fisheries to know that the research work of these institutions is directed towards the same questions that Dr. Bigelow placed in the foreground. Often the most difficult part of the work in these problems is to put the questions and, therefore, it is most gratifying to find the same trend of thought on both sides of the Atlantic Ocean. The very fact that the same problems are regarded as fundamental may indicate that the investigations are following sound lines. However, I agree with Dr. Bigelow when he expresses his dislike for the word fundamental and hesitates to use it because we do not always know enough about a problem to call it fundamental.

This is as I said not a critical review, it is rather an attempt to summarize some of Dr. Bigelow's views so far as I understood them. Dr. Bigelow claims that he does not know anything about the sea and maintains that every investigator who has spent the better part of his life at sea is willing to admit his ignorance. Dr. Bigelow is right when he, as he evidently did, uses the word knowledge as synonymous with understanding. It is true that we have collected a number of data. The fishery investigators have during many years made measurements of fishes, they have counted the year marks on the scales and determined the age of the fishes, they have brought together an enormous amount of statistical material, but these statistics have not given us any better idea about the life cycles in the sea. The statistics have served to make us see some of the problems and in a few cases to formulate them, but they have not given us any understanding of what really is going on, they have not given us any knowledge of the sea in the sense in which this word is used by Dr. Bigelow. This statement shows the dimensions of the problems of the sea with which the fishery investigators deal and also that these problems cannot be solved unless they are attacked from a scientific point of view. However, not all fishery problems are of scientific interest. When the haddock fisheries cease to be profitable because the banks have been overfished, the question of how to increase the output is not a scientific but an economic one in which protection and legislation is involved. But there are other questions of far reaching importance.

Dr. Bigelow pointed out that it has been found that the catches of mackerel off the New England coast, of sardines off the Baja California coast, and of cod and herring in the Norwegian waters, are subject to enormous variations. These variations have nothing whatsoever to do with the fishing method or the intensity of the fishing. The fishermen were continued with greatest efforts in the years when the yield of fish was small but in spite of this the yield later reached unexpected amounts and the variety of fish which a few years ago was not again filled the market. One "reason" for this has been found. Investigation of the age of the fish has shown that certain year classes are strongly represented in the catches while others are practically lacking. If no new numerous year class appears before the old vanishes we obviously reach a year or years in which the fisheries bring poor returns, but if on the other hand two or more numerous year classes appear in succession the returns will be very great. A study of the herring catches along the coast of Norway has shown that during the years 1907 to 1918 the year class was dominating which in 1907 was four years old,—the herrings which were "born" in 1903. The question arises: Why was this year so strongly represented, why was this special year extraordinarily favorable to the development of the fish eggs?

This question leads to the study, not of the young fish which is able to take care of itself, but of the eggs and the larva, to the question of the food which is available for the tiny and helpless creatures which are to develop into the fish of economic importance. And this study leads again to the fundamental problem —and in this place the audience agreed with the speaker that the word fundamental was the proper word—the fundamental problem dealing with sea water as the container of life. Which of the physical and chemical properties of the sea water and processes in the sea water are of importance to the development of life, why do they change and how do the changes affect the life cycles? The speaker threw interesting sidelights on the characteristics of sea water as an environment for life and had to admit that our knowledge of the deeper problems is negligible.

These problems have to be attacked from a purely scientific point of view. Science wants to understand what goes on in nature and wants to make use of this knowledge, when possible in order to forestall the interest of developing oceanic biology.

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ON OCEAN BIOLOGY

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SUMMARY
By Dr. H. U. Sverdrup
(Continued from Page 16)
ast the events of the future. Here the interests of pure science and of fishery investigation meet. Fishery investigation has in this field started out from the practical end of the question with the purpose of developing means for predicting the coming variations in the output of the fisheries, but experience has taught that this goal can not be reached by means of statistical data on length and year classes; it can only be secured by gathering knowledge, by arriving at understanding. Every one who has followed the development of fishery investigations in this country and in others will know that a great part of the investigations of fisheries departments is now placed on a purely scientific basis and that these bureaus in many respects are the institutions which are best equipped for attacking the fundamental problems in marine biology.

THE REMINISCENCES OF A MEDICAL MAN
Dr. Alfred Meyer
It is a privilege of age to reminisce, but not necessarily in public. However I have been encouraged to do so by the Editor of The Collecting Net who sent a representa- tive to watch that object in scene. II health puts strict limitation on any extensive endeavor in that direction and therein lies the readers' salvation.

In 1878 I was a young medical student at the University of New York, Leipzig. Leipzig was then the Mecca for post-graduate work on the part of young American doctors, having displaced Paris and London in the affection of an earlier generation of Aesculapians, and latterly, I believe. I present- ed a letter of introduction to Prof. Julius Cohnheim, a pupil of Virchow, and then head of the Pathological Institute with Prof. Wegener second in command. The first question Cohnheim put to me was, 'Did I know Dr. William H. Welch of New York?' I was con- pelled to answer in the negative. Welch had just completed his 'Arbeit' in Cohnheim's laboratory on the cause of pulmonary oedema. Cohnheim remarked that Welch was a very able man with a brilliant future, a prediction of remarkable accuracy, which Welch heard from my lips many years after. Cohnheim, not long before this, had inoculated the anterior chamber of rabbits' eyes with tuberculous material, and had as a result of this work become an ardent exponent of the infectious na- ture of tuberculosis. Koch's dis- covery of the tubercle bacillus was announced to an astonished world about four years later. Cohnheim and Strumpell of the Univ. of Vienna were in the midst of their acrimon- ious discussion in the medical press on the origin of pus. Cohnheim, of course, after his observation of di- aperesis in the mesentery of the frog, was laying the main stress on migration of leukocytes, and Strick- er, because of his studies of inflammation on the bloodless cornea, accentuated the importance of fixed tissue cells. I heard echoes of this wordy war a year later in Solomon Stricker's laboratory. The most popular staining reagents in use in Cohnheim's laboratory were methyl violet and Eosin blue. The microtome was new to me, although it was probably used at that time by a few individuals in New York. At Dr. Carl Heitzmann's laboratory in New York I had worked at an earlier date, all cutting of tissues was done free hand with a razor, and mounted in glycerine and asphalt. At Cohn- heim's Canada balsam was the vogue. One of my fellow students here (as he had been at P. and S.) was Dr. William H. Halsted, later one of the four founders of the Johns Hopkins medical school. An- other fellow-student was Dr. (now Sir) Robert W. Phillip of Edin- burgh, who founded the first tuber- culosis dispensary in the world, and whose organization of the anti- tuberculosis work in Edinburgh was to serve as a model for similar endeavors in every civilized country. For this he was knighted by the King of England some years ago and this year received the Trudeau medal from our own National Tuberculosis Association, making him the first foreign recipient of this great honor. My last recollection of Weigert dates back to the summer of 1879 when I saw him riding astride his chair through the dining hall crowded with students celebrating at a Commers the end of their medical course. Many medical men of the U. S. are familiar with the name of Prof. Strumpell, for his laboratory work on general medicine had a great vogue in this country 25 years and more ago. In 1878 he was first assistant at the medical clinic at Leipzig, later professor of medicine at Breslau and again at Leipzig. He rivalled Mueller of Munich as a great clinical teacher. In the year of which I speak he was a handsome youth and charming personality, and to his }
THE REMINISCENCES OF A MEDICAL MAN
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cantor in the neighboring Thomas Schulke. When I revisited Leipzig in 1906 the latter building had been torn down and replaced by an American department store. I could not help thinking that the destruction of this historic building did not square with the reputed idealism of the German people. Another interesting personality in the medical faculty was Prof. Thiersch, chief surgeon. He was a good diagnostician, skillful operator and a most respected teacher. His name is perpetuated by Thiersch's fluid, which probably is to be found on many shelves in the M. B. L.

The Gewandhaus concerts, the greatest concerts in the world at that time, were a great delight, when I was a boy. Tickets of admittance, usually at a high price, were usually handed down as heirlooms by old Leipzig burghers. At one of these concerts I was fortunate enough to hear Saint Saens in person. I am fully as much a music lover as a medical man.

In 1906 I visited Metschnikoff at Göttingen. The real meaning of the facts came out with the genetics of the matter were studied. The three characters of voices are simple Mendelian classes AA, AB and BB of a factor pair A and B inherited in the usual way. The marriage of a soprano and a sopranino which have the same genetics formula AA will give exclusively soprano and basso in children, and tenor and contralto will be more Mendelian race.

A tenor marrying a soprano will have mezzo-soprano daughters, the sons becoming at all events baritones. Finally, a baritone marrying a mezzo-soprano all types may occur.

Data derived from observation of families were given in the lecture, and the physical side of the question was elucidated by pictures of sound curves. Such curves were shown of the basso, baritone, and tenor which form a series of progressing complexity. From the analysis of the partial tones, which were made for a large number of cases, an exact physical characterization of the three different voice types resulted. An a study of the distribution of the voice types in Europe from Sicily to Denmark brought out some very interesting facts. Let p represent the frequency of the gene A in a country; then the frequency of the gene B. Then we find a striking decline of p from values of 61.4 in Husum (north) to 12.4 in Palermo (Sicily) which fact is to be explained by the continental migration from Asia to Italy. This migration brought the basso-soprano to Italy. On the other hand, continental migration from the East brought tenor-contralto voices to Central Europe and the same thing happened in America as the Frisians children from the islands. The Frisian islands have according to Virchow a population that is most stable and was least affected by the continental immigrations into Central Europe.

Incidentally we observed great variations in musical ability. We found this ability extremely low on the Frisian islands; and a sharp division line can be traced from Mesina on Sicily to the highly musical Messina from decidedly less musical Reggio di Calabria.

Another table showed results of family observations of a gene that regulates the direction of the hair-whorl. The clockwise sense is dominant, the anticlockwise recessive, the former lying, in the mean, slightly on the right side. The heredity of whole whorls was also explained, and its relation to the single whorls demonstrated. This led to the important question of the geographical distribution of the genes of the direction of the hair-whorl shows any relation to the geographical distribution of the singing voice genes mentioned above. Such a relation was sought to exist with a high degree of probability in Germany. The frequency of the gene for the anticlockwise sense of the whorl is in Germany 12 percent higher than that of the gene for tenor-also. This fact must be interpreted in the sense that both genes belong to one and the same complex of genes. There is reason to assume that these genes were brought to Germany by the same continental migration. No such parallelism could be observed in Italy. This discrepancy was explained by the basis of observations given above, namely, that two or more genes have to be distinguished, one of which has the frequency r of the anticlockwise gene, the other having a frequency of its own. A study of the same line of attack on these questions was given -by the discovery of blood groups by Landsteiner, and the study of their genetic behavior.

It is known that there exist four blood groups: O, A, B, and AB, which are distinguished by agglutination-reactions between blood corpuscles and plasma. The genetic interpretation of these reactions was, up to very recent times, dis...
HEREDITY AND HUMAN RACES

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putable; but the theory presented by the lecturer seems to be definitely supported by extensive material gathered by Schiff and others. According to this theory there exists three allelomorphs, A, B, and R, present in every population with the frequencies of p, q and r. It follows from this theory, and is confirmed by all observations, that between the four blood groups the following relation exists:

\[ 1=3a+b+3c+3d+3e+3f. \]

The distribution of the p, q, and r values varies racially considerably. In the first place it can be seen that the genes must be very stable, since two racially so closely related peoples as the Turks and Hungarians show the same p, q, and r values although they lived separated from each other by other peoples for many centuries. In a still more direct way Verzar could demonstrate that German colonists in Hungary who emigrated from Heidelberg three hundred years ago, still show the same distribution values as the population of Heidelberg. In a similar way we find the same values in gypsies and their relatives, the Hindus, from whom they have been separated for an indefinitely long time, and B-gene live under entirely different climatic conditions. It is therefore not surprising that the numerous attempts failed to prove the existence at the present time of a selective value for the genes (differences in resistance against disease, etc.). On the other hand it is almost unavoidable (as will be shown later on) to assume that such selective value with regard to the B-gene and the A-gene actually existed in a not very remote past of the history of mankind.

The general outline of the present distribution of the B-gene is as follows: the O-group is everywhere the largest group; however, it is not a unit. To the O group belong the red Indians, the Negritos of the Philippine Islands, and, as can be demonstrated, indirectly, other primitive races of Asia which have not yet been examined. The Australian natives possess the O-group and the A-group but no B-group.

If we consider the distribution of the value p, q, and r which we can calculate from the groups, we get a very clear picture of the distribution of the B-gene. If we combine newer determinations in Russia with the findings for the Chinese and Japanese it follows that the B-gene has a maximum in Chinese Turkestan, Tibet, and Russian Turkestan, and from this region the gene decreases in frequency in all directions. For the centre itself, however, no observations are available as yet. The gradual decrease of the B-gene is observable also in Europe in the direction from East to West, showing values of 12% in Warsaw down to 4% in England.

The known facts of the migrations of human races which were demonstrated in the lecture show that the present distribution of the B-gene can best be explained by an assumption of a spreading of the gene from the previously mentioned regions in Asia. According to Brueckner and Huntington, the migrations were caused by climatic changes which led, since the last glacial period, to an increasing desertification of formerly inhabitable regions of Middle and Central Asia. Haldane, Jennings and A. R. Fisher have shown by mathematical calculations that a dominant gene which has selective value will, in a comparatively short time, predominate in the distribution of the genes. It is therefore plausible that the B-gene being dominant over R, very soon became preponderant throughout the whole secluded area of Central Asia (in all probability in Chinese Turkestan) and later on, when this region became less inhabitable, diffused by migration into the neighboring regions. Hereby it gradually replaced the A and B gene in the native population, especially in the more promaximal regions of India, China, Siberia ete. Consequently the A-gene today shows two geographical separated maxima, one in Japan and Korea, and the other in Europe. Similar facts of distribution and substitution phenomena were found in recent years by Metcalff, the Dobzhansky's and others, and in both plants and animals.

As to the constitution of the B-gene population we can make the statement that it hardly possessed Mongolian traits, since many races as for instance the Hindus, received the B-gene without Mongolian traits; on the other hand there are the red Indians who received Mongolian traits without the B-gene. From this we can also deduce that the selection of the A-gene must have taken place after the separation of the red Indians from their Mongolian relations.

Landsteiner tried to show that the same A and B-genes occur in anthropoid apes. Hirsfeld related that to a polyphyletic origin of man. The complete identity is doubtful and it would be impossible to understand how a B-line of mankind that lived isolated for millions of years in Middle Asia, suddenly emerged in the more promaximal regions of the world.

It must be remembered that similar mutations repeatedly appear without direct phyletic connections, in mammals and other classes of animals. If we have to believe that the B-man came from the B-ape, then with equally good reason we would have to accept that the blue-eyed man came from the blue-eyed dog.

It is more difficult to say something about the distribution of the B-gene before the time of the spreading of the B-gene. We find in Asia a similar decrease in frequency on the outskirts of the A-region, to which belong Australia on one side and Africa on the other.

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The fact that the Tajiks of Central Asia, who represent the farthest eastern people with blue eyes and fair hair, shows a comparatively high percentage of the A-gene, is an important new discovery. Here also we come closest to the facts when we assume that the A-gene was formed in a period before the formation and the spreading of the B-gene.

The formally permissible assumption that the selection took place in favor of the B-gene becomes untenable when we consider that this presupposes an antecedent R-gene under climatic conditions and among human races distinctly different; furthermore, such an interpretation can in no way explain the relation which exists between the A-gene and the B-gene, without recourse to new hypotheses of selection between these genes.

According to the principle which we followed, the selection is effective in a population in which a certain gene is determined, even if the extent is somewhat geographical and racially.

The investigations here presented, lead to the following ideas and conceptions. We have in the history of human races corresponding to the oscillating conditions of the ice periods, periods of isolation and spreading. Different strains are isolated into the same isolated area. The genes which have no selective value, preserve their original proportions during that time of inbreeding and mixing. New genes which are acquired or come important under the new conditions and are selected. Later, on this new level, the process repeats itself.

Counting the genes in the present time, we may expect that the genes coming from the same levels will reveal that fact by the same proportions. Counting a sufficient number of genes, we can therefore distinguish the levels. We can hope to contribute something to the knowledge of the trend of human evolution by combining, in this way, genetics and anthropology.

THE COLLECTING NET

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In the first year of its publication, “Shumway” was adopted in thirty-seven schools and colleges. The distinctive feature of the text is the use of two methods of presentation. The comparative method is employed in lectures and reading, while the sequential method is utilized in the laboratory. An outstanding feature of the book is the inclusion of a section on laboratory technique which covers the methods of preparing embryos for study.

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